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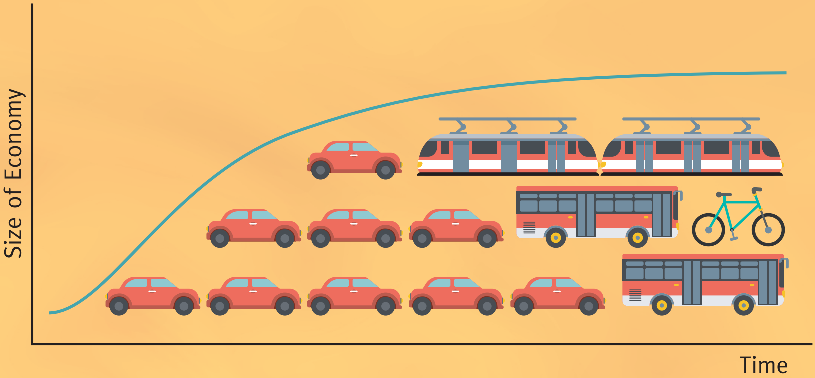

Steffen Lange

Macroeconomics Without Growth

Sustainable Economies in Neoclassical, Keynesian and Marxian Theories

metropolis

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Editorial

In economics and management studies, sustainability is increasingly being discussed from various angles representing an impressive plurality of methodological and conceptual approaches. Advancing these approaches and critically reflecting traditional views of economics are the aims of this book series. It is an outlet for excellent research in sustainability-related economics and management studies with recognition in teaching and research contexts. Through a peer-review process, high quality standards are met to ensure visibility for forward-looking concepts and findings in the respective communities. The series seeks to contribute to the solution of pressing social and ecological challenges for our societies and to instigate debates about them in the academic disciplines as well as in the broader public. Going beyond a singular focus on ecological questions, the series' topics cover a wide spectrum of sustainability issues in all economics and management-related domains analysed with pluralistic methodologies. Building bridges to other disciplines is much welcomed including the social sciences, the humanities as well as the natural sciences..

Manuscript Submission and Review

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Macroeconomics Without Growth

Sustainable Economies in Neoclassical, Keynesian and Marxian Theories

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Preface

This is a much needed book. It does not only fill an important research gap, but essentially opens up a vast field for (macro-)economic analysis and theory. Steffen Lange most elegantly visits many influential theoretical concepts in economics with his interest in the conditions for sustainable zero-growth economies. Through his open and unideological approach, he combines power-houses in the economics discipline with concepts that were hitherto considered as heterodox or even outside the economic disciplines.

The particular strength of the book is its unideological and, in the best sense of the word, academic approach to the different schools of thought in the realm of economics. Integrating different approaches such as Neoclassical, Keynesian and Marxian theories in the interest to understand their contributions to the questions at hand makes the book pluralistic in an outstanding way. Lange applies an interesting pluralistic method for his synthesis of the different theoretical findings and contributions that are at times complementary or conflictive.

The book is rigorous in its structure and its most systematic discussion of each and every relevant theory. It is a good read and full of interesting perspectives for anyone interested in macro-economic theories of environmentally and socially sustainable zero-growth economies. Even though some of the final results are highly demanding for the current political practice, they guide interesting ways of future political and societal developments.

I hope that this thought-provoking milestone in the Degrowth-debate finds many readers inside academia as well as in actual political and societal practice.

Bernd Siebenhüner (Oldenburg)

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B	Population size	h	Profit share
B^s	Bonds supplied by firms	H	Average working hours per worker
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c	Constant capital	i_{m-1}	Interest rate deposits
C	Consumption	I	Investments
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C_d	Consumption in dirty sectors	I_h	Investments in human capital
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C_W	Consumption out of profits	j	Prime unit costs
d	Proportion between borrowed and equity capital	J	Investments in Research
D	Dirty goods	k	Capital intensity
D_K	Demand for capital goods	K	Capital stock
D_K^D	Demand for capital goods to replace depreciation	l	Labour coefficient
D_K^N	Demand for net capital goods	L	Labour supply
e	Share of retained savings	L^d	Labour demand
E	Emissions/Pollution	L^s	Labour supply
f	Share of additional investments saved	m	Mark-up
g	Rate of economic growth	M	Materials used in production process
$g_h at$	Rate of economic growth per capita	M	Money capital
g_B	Rate of population growth	n	Influence of the average price on individual prices

g_E	Growth rate of emissions/pollution	N	Quality of nature/environment
$g_H(t)$	Growth of average working hours per worker	NCR	Non-class revenues
g_{IP}	Growth rate of pollution intensity	o	Long-term changes in the inducement to invest
g_K	Growth rate of physical capital	p	Profit rate
g_L	Growth rate of labour supply	p_K	Price of capital goods
g_{LS}	Growth rate of labour supply	P	Prices
g_R	Growth rate of real GDP	P	Production process
g_R	Growth rate of natural resources use	P_B	Price of bread
g_R^{chain}	Growth rate of real GDP, chain-weighted	P_C	Price of computers
g_R^{pres}	Growth rate of real GDP, present year as base	P^e	Expected price level
g_R^{prev}	Growth rate of real GDP, previous year as base	P_F	Price by single firms
$g_Q(t)$	Growth of the employment rate	P_S	Price of shoes
g_T	Growth rate of the state of technology	q	Consumption rate out of profits
g_w	Growth rate of hourly wages	q	Organic composition of capital
G	Government spending	Q	Labour participation rate
G_c	Government spending in clean sectors	Q_B	Quantity of bread
G_d	Government spending in dirty sectors	Q_C	Quantity of computers
G_g	Gov. cons. of energy-intensive services	Q_S	Quantity of shoes
G_h	Government investment in human capital	r	Influence of non-normal profit rate on investments
G_{mc}	Gov. invest. in energy-conserving capital	r_I	Risk of inflation
R	Supply of natural resources	Π_{cb}	Central bank profits
s	Savings rate	Π_f	Entrepreneurial profits
s	Sales	π	Inflation
s	Surplus value	ρ	Time preference
s^{ac}	Surplus value used for constant capital	σ	Elasticity of subst. between production factors
s^{av}	Surplus value used for variable capital	Σ	Influence of changing capital stock on investments
s^c	Consumption out of surplus value	τ	Sales tax
S_K	Supply of capital goods	Υ	Overall effectiveness of research activities
S_K^A	Additional supply of capital goods	Φ	Ratio of abatement to production
$SSCP$	Subsumed class payments	ϕ	Output elasticity of natural resources
$SSCR$	Subsumed class revenues	χ	Intermediate goods

T	State of technology	Ψ	Interest payments by firms
T_P	State of technology regarding pollution	ψ	Credit constraints from banks
u	Rate of unemployment	Ω	Average pollution per unit of production
U	Difference between clean and dirty investments	ω	Point in time when dirty sector has disappeard
v	Capital coefficient	$\varGamma$	Share of profits earned by new investments
v	Variable capital	ε	Elasticity of substitution between the two goods
V	Velocity of money	ε	Influence of former income on expected income
w	Wage rate	$\varTheta$	Normal rate of profit
w	Value of production	ϑ	Probability that research leads to invention
W	Wages	$\varLambda$	Influence of firms' savings on investments
x	Intermediate goods	$\varXi$	Preferences
X	Difference between clean and dirty consumption	$\varPi$	Influence of a change in profits on investments
X	Expenditures to secure monopoly revenues	ϖ	Productivity of research activities
Y	Level of production	ϱ	Factors influencing investments
Y^A	Production used for abatement	$\varSigma$	Number of investors
Y_c	Aggregate demand in the clean sector	ς	Rate of natural regeneration
Y_{Cum}	Sum of production over time	$\varUpsilon$	Money capital
Y_d	Aggregate demand in the dirty sector	$\varUpsilon_t^B$	Money capital financed out of borrowed capital
Y_D	Aggregate demand	$\varUpsilon_t^E$	Money capital financed out of equity capital
Y_r	Realized income	$\varPhi$	Ratio between equity and borrowed capital
Y_R	Real GDP	$\varOmega$	Size of sectoral change
Y_R^1	Real GDP with base year 1	Б	Taxes
Y_S	Aggregate supply	Д	Wealth
z	Factors influencing the wage setting	д	Real wealth
Z	Second type of prod. factor besides labour	e	Real government expenditures
α	Parameter with changing meaning	Ж	Advances from the central bank
β	Parameter with changing meaning	З	Loans
γ	Parameter with changing meaning	И	Inventories
Γ	Resource-augmenting state of technology	и	Real inventories
δ	Rate of capital depreciation	Й	Firms revenues

η	Inventories to sales ratio	Л	Government debt
η^T	Target inventories to sales ratio	ф	Real Consumption
θ	Intertemp. elast. of subst. for consumption	Ц	Interest paid on borrowed capital
κ	Influence of abatement on pollution technology	Ч	Sales
Λ	State of environmental regulation	ч	Real sales
μ	Material costs per unit	Щ	Dividends
ν_e	Influence of investments on overall productivity	Ъ	Bills
ν_p	Influence of investments on single productivity	Ь	Bonds
Ξ	Potential output	Э	Production costs
ξ	Costs of intermediate products	Ю	Firms expenditures
Π	Profits	$Я_e$	Expected future demand
Π_b	Bank profits	я	Rate of capacity utilization

Chapter 1
Introduction

> Above all, there is an urgent need to develop a resilient and sustainable macro-economy that is no longer predicated on relentless consumption growth (Jackson, 2009b, p. 12).

The theme of this book is to provide a substantiated macroeconomic analysis of the conditions for sustainable economies without growth. There are good reasons to investigate how high-income economies can be organized without growth in the 21st century (1.1). The central question is not only how economies can be organized without growth, but also how this can be done in a sustainable manner (1.2). The present work investigates this question by applying theories from three macroeconomic schools of thought: neoclassical, Keynesian and Marxian (1.3).

1.1 Research Topic

The most prominent debate regarding an end of economic growth is on how this growth affects the environment. There are two opposing views on this issue. The first points out that further economic growth is compatible with the required level of emission reductions. The basic argument is that economic growth is growth in value (measured in GDP) rather than growth of a material magnitude, resource use or even emissions. Therefore, there is no categorical connection between economic growth and the state of the environment. Sometimes it is also argued that economic growth is necessary for environmental sustainability. The reasoning behind this points out that investments in clean production are required to achieve large reductions in emissions. Such investments also lead to economic growth.[1]

Adversaries point out that continuous economic growth is incompatible with environmental sustainability. The most common rationale argues that it is technically infeasible to sufficiently decouple the two. Another central point is that decoupling economic growth from one environmental problem leads to other environmental problems.[2]

Empirical scenarios show that reductions in emission-intensities have

[1] These and further key arguments of this perspective are summarized in section 2.2.2.

[2] Key arguments from this perspective are covered in section 2.2.3.

to be of a tremendous magnitude, which would be without precedence in economic history. One plausible, even obvious possible strategy is to reduce – or at least stop increasing – the level of production. From this perspective, it makes sense to investigate negative, zero or less economic growth as one component of a strategy to remain within planetary boundaries:[3]

> The conclusion shows that key climate targets are unlikely to be reached if economic growth continues on a global scale. Therefore, even a minimal consideration of the precautionary principle requires being open to stringent climate policies that may result in low or even negative growth (Antal and van den Bergh, 2016, p. 7).

One possible objection to investigating economies without growth out of regard for the environment is that economic growth should be seen as having no importance: When the objective is to achieve environmental sustainability, why talk about economic growth at all? Why not instead determine which changes are needed for environmental sustainability and implement them?[4]

There is a reason for discussing concepts for economies without growth nonetheless, namely that environmental effects are not the only relevant issue with regard to economic growth. The literature[5] presents multiple arguments for an end of growth. Four reasons are – in addition to environmental issues – central to the debate:

1. Economic growth is found to be insignificant for, or even detrimental to, social welfare. Studies on subjective well-being challenge the positive connection between well-being and growth in consumption. While it questions the significance of economic growth, this literature emphasizes the importance of low economic inequalities for high levels of economic welfare.[6] Sociological and cultural studies find relations between diverse social and individual problems on the one hand

[3] See section 2.2.5 for a more detailed discussion on decoupling from theoretical and empirical perspectives.

[4] This position is often called *a-growth*. See section 3.2 for a discussion.

[5] The discussion on economies without growth is grouped around four concepts: *steady state economies*, originating from Herman Daly's work in the 1970s; *degrowth*, with major contributions from the research group *Research and Degrowth*; Anglophone contributions from the central authors Tim Jackson and Peter Victor on *prosperity and managing without growth*; and *Postwachstum*, advocated by a diverse group of German-speaking proponents. These concepts are discussed in detail in chapter 3.

[6] This literature is discussed in more detail in section 2.1.3.

and activities and attitudes related to economic growth on the other.[7] From this point of view, organizing economies without growth has the potential to improve social welfare.

2. It is argued that economic growth is necessary for social and economic stability within the existing economic system and its institutions. Economic growth is related to several types of stabilities. First, growth is regarded as necessary to prevent large-scale unemployment. As employment is important for individuals both economically as well as socially, high unemployment constitutes a reason for social instability.[8] Second, growth is also argued to be necessary for stability in society as a whole because it appeases distributional conflicts between different social groups.[9] Third, macroeconomic stability, in particular regarding monetary aspects, supposedly depends on economic growth.[10] If environmental policies lead to zero or negative growth rates, it is essential to address these issues. In other words: When zero growth is introduced due to environmental reasons, it is necessary to also address how issues of social and economic stability can be taken into account.
3. Proponents of economies without growth argue that an end of economic growth in early industrialized countries can contribute to alleviating global inequalities and injustices. One reason is the impact on global climate change: Early industrialized countries bear a major responsibility for climate change, while low-income countries suffer disproportionately from the consequences. Reductions in the level of production in the former could help to prevent climate change and therefore reduce the consequences for the latter. Another reason regards the access to global resources, i.e., mineral resources, agricultural land, water, etc. Less demand by the global north would facilitate access by the global south.[11]
4. A different set of research discusses whether the economies of early industrialized countries are characterized by diminishing rates of economic growth. If economic growth further declines in the future, it

[7] These issues play important roles in existing concepts on economies without growth, see chapter 3.

[8] The relationship between economic growth and employment is an important topic throughout this work. See in particular sections 3.6.5 and 22.6.

[9] See section 3.4 for a further discussion.

[10] See in particular section 3.6.7 and the discussions in part III.

[11] This issue is particularly present in the debate on degrowth, see section 3.2.

> is necessary to start finding solutions now to the potential resulting economic and social problems.[12]

Discussions on economies without growth attempt to analyse and find solutions to these (and sometimes additional) issues. In other words, they discuss how economies can be organized so that they are environmentally sustainable, facilitate a high level of social welfare, reduce or abolish global inequalities and cope with the new situation of declining rates of economic growth.[13] This has been attempted by other strands of literature as well.[14] The unique feature of the discourse on economies without growth is that economic growth is regarded as a connecting link between these issues. More precisely, it is argued that an end of economic growth is regarded as necessary or at least helpful to achieve these goals.

In principle, one could also investigate these issues without talking about economic growth. One could study how the economy has to be redesigned in order to be environmentally sustainable, lead to high social welfare, be socially and economically stable, promote global justice and cope with the circumstances that currently cause low growth rates in the early industrialized countries. But such an analysis is in the very least extremely challenging and maybe even impossible. This is because the issues are so diverse and complex. A researcher would not know where to begin with her analysis, as there are a countless number of possible sets of conditions that could solve the problems.

The issue of economic growth constitutes an analytical link between these issues that allows them to be connected. If the analyses are correct that zero growth would help to achieve these environmental and social goals, then it makes sense to link the issues via the aspect of zero growth. In other words: The major motivation to investigate economies without growth is to facilitate an integrated analysis of and combined solutions to these issues.

Another motivation to question economic growth is that it facilitates new analytical perspectives. Often discussions on these issues assume economic growth (sometimes explicitly, sometimes implicitly) and try to find solutions based on this assumption. Questioning economic growth triggers new types of questions and opens up new combinations of solutions to the issues. As Giorgos Kallis puts it:

[12] See section 2.1.2 for a discussion on the empirical relevance and section 2.3 for theoretical explanations of declining growth rates.

[13] These discussions are summarized in chapter 3.

[14] A recent historical example are critical analyses of economic globalization, which refer to a similar set of social and environmental problems.

> [The] persistence to defend degrowth is productive: it forces to research questions that no one else asks. Sure, we can in theory use fewer materials; but then why do material footprints still grow? What would work, social security, money, look like in an economy that contracts? One who is convinced of green growth won't ask these questions (Kallis, 2015b).

The subsequent question is, then, what contribution can be expected from a macroeconomic analysis. There are many sophisticated books, research articles, reports and other publications on how economies without growth can function. But the number of contributions from macroeconomic perspectives is very limited. The economics profession in general has been comparatively silent on the topic (Pollitt et al., 2010). Many of the existing analyses rest on the theoretical framework of ecological economics, which has contributed greatly to understanding the economy-environment relationship but is less insightful regarding macroeconomic analyses, or as Spash and Schandl (2009b) put it, "[e]cological economics has no specific macroeconomic approach" (p. i).

The present work is intended to help fill this gap of analyses from macroeconomic perspectives. By applying it to three prominent schools of economic thought, it connects discussions on economies without growth to important macroeconomic discourses. Due to the width of the topic, various central macroeconomic aspects are discussed – aggregate supply and demand, investments, employment, technological change, ownership structures, market conditions and many others.

The investigation leads to sets of macroeconomic conditions for sustainable economies without growth. These are initially developed for each school of economic thought. An initial contribution is therefore to point out whether and how sustainable economies without growth are possible within each macroeconomic paradigm.[15] Furthermore, the results are compared and integrated across the paradigms in order to come closer to a comprehensive set of conditions for sustainable economies without growth.[16]

1.2 Research Object

How economies can be organized without growth is a large and complex issue. In order to be able to conduct the investigation, economies without

15 The results can be found in chapter 9 for neoclassical, chapter 14 for Keynesian and chapter 19 for Marxian theories.

16 This is done in part V and leads to a synthesis of conditions in chapter 23.

growth are defined, followed by differentiating the research question and specifying the specific research contribution of this work.

1.2.1 Economies Without Growth: Definitions and Restrictions

The research object is narrowed and clarified in three ways: (1) economies without growth are defined; (2) the kinds of economies that are investigated are specified; (3) population growth and international considerations are excluded from the analysis.

(1) In existing concepts for economies without growth, there are multiple notions on what the aspired transformation implies for the development of gross domestic product (GDP). The concepts differ in their analyses on whether economies have to shrink before they can become environmentally sustainable. When they reach this state, authors of all of these concepts argue that the economies will be characterized by a relatively stable level of production. At the same time, GDP does not need to stay exactly constant but can plausibly fluctuate somewhat over time.[17] This is what is meant by economies without growth. Hence, *economies without growth are defined as economies with a constant level of production – as measured by GDP – in the long run, while allowing for short-term fluctuations*. The term *zero growth economies* is also used frequently and interchangeably with economies without growth.

Economies without growth and zero growth economies are *not* equal to the following terms: *a steady state in economic growth theories* (constant relations between macroeconomic variables) *steady state economies* (economies with a constant level of material throughput); *economies in a stable steady state* (economies with constant stocks and flows); *economies in a stationary state* (where no macroeconomic variable changes at all); or *degrowth economies* (where production declines).

(2) The present work is intended to improve the understanding for high-income, early industrialized countries in the 21st century, because the motivations for an end to economic growth may not apply to other country groups[18] and because the applied macroeconomic theories, were intended for industrialized countries. The analysis focusses on the early 21st century because it is refers to the current economic and environmental situations of such economies. [19]

(3) Finally, the analysis is restricted to zero population growth and closed economies. The assumption of zero population growth seems to be a reasonable simplification, as the populations in most early industrialized

[17] See chapter 3 for a more nuanced discussion of the four concepts.

[18] See sections 2.1.3 and 2.2.

[19] See section 2.3.

countries are not expected to change significantly in the 21st century (United Nations, 2015).[20] The assumption of closed economies is more problematic, as many early industrialized countries are deeply integrated into the world economy. Both simplifications have been made to narrow down the research topic to a manageable level of complexity.

1.2.2 Research Question(s)

Organizing economies without growth is not an end in itself. As Kallis (2011) puts it: "None in the degrowth research community has argued in normative terms for 'striving for negative GDP growth' " (p. 874). As argued above, the perspective is rather that an end of economic growth is a common prerequisite to achieving diverse social and environmental goals. Five goals were highlighted above: environmental sustainability, social welfare, social and economic stability, global justice and coping with declining growth rates.

Of these five goals, the first three are explicitly discussed in the analysis. They are slightly reformulated in order to be able to investigate them within macroeconomic theories. Instead of social welfare, the goal of low economic inequalities is used, based on the arguments in section 2.1.3. Social and economic stability are reduced to economic stability.

Global injustice is not taken into account in the analysis, due to the restriction to a closed economy. The issue of coping with declining growth rates is taken into account in a different manner than the other issues, because its relation to economies without growth is different. Zero growth implies that the economies are transformed from the current situation of declining growth rates to economies with zero growth. The analysis therefore takes into account the reasons for declining growth rates in the first place and connects the conditions for zero growth to them.

Hence, this work investigates which conditions lead to *sustainable economies without growth*, where sustainability refers to the three dimensions of environmental sustainability, social welfare and economic stability.[21] This main research question is subdivided into four subquestions. The focus on the analysis is on macroeconomic conditions for economies

20 Large numbers of migrants can alter this situation. But due to the fact that all international aspects are excluded from the analysis, migration is not taken into account either.

21 The author is aware of the fact that using the term sustainable when taking into account solely environmental sustainability, economic inequalities and economic stability may not do justice to the concept of sustainability. The term is nevertheless used in order to be able to include at least a limited number of relevant social and environmental issues in the analysis of economies with zero growth.

without growth (subquestion 1). As argued above, zero growth is not an end in itself, but a precondition for achieving social and environmental goals. Therefore, the investigation also focuses on what additional conditions facilitate environmental sustainability (subquestion 2), low economic inequalities (subquestion 3) and economic stability (subquestion 4). Based on the results from these four subquestions, the main research question is discussed.

Main research question.
Which macroeconomic conditions lead to sustainable economies without growth?

Subquestion 1. *Which macroeconomic conditions lead to economies without growth?*

Subquestion 2. *Which macroeconomic conditions facilitate improvements regarding environmental sustainability in economies without growth?*

Subquestion 3. *Which macroeconomic conditions facilitate low economic inequalities in economies without growth?*

Subquestion 4. *Which macroeconomic conditions facilitate economic stability in economies without growth?*

1.2.3 Research Gap

Several authors have already investigated economies without growth using macroeconomic frameworks. These investigations take one of the four following forms.

First, there is a large strand of literature within ecological economics on limits to economic growth due to physical considerations, such as entropy laws and the role of energy use for increases in labour productivity. While these contributions are of great importance for the physical side of the economy, their connections to common macroeconomic frameworks are weak (Spash and Schandl, 2009b).[22]

Second, there are various authors who argue for an automatic end of economic growth, including analyses from classical economists and contributions from both supply side and demand side perspectives. They provide a helpful analysis on the current state of affairs in early industrialized countries. Usually, these investigations regard low growth scenarios as undesirable, however. Therefore, they commonly do not ask under

[22] See chapter 3.

what conditions economies without growth can generate positive results concerning social and environmental goals.[23]

A third set of investigations conduct general macroeconomic analyses but do not base them explicitly within macroeconomic theories. In other words: These contributions discuss the central macroeconomic aspects, such as aggregate demand, aggregate supply, technological change, the monetary system, etc., but they do not formulate this analysis by explicitly referring to a comprehensive macroeconomic theory or model. A good example is the seminal book *Prosperity without growth* (Jackson, 2009a). Jackson does an excellent job of combining elements from different schools of economic thought, in particular approaches from ecological, Keynesian and Marxian economics, in order to analyse why the economy grows. He does not use a full-grown theory or model of either of them, though. Another example is the very insightful and concise book *Postwachstum* (Schmelzer and Passadakis, 2011). The book entails a good analysis of the drivers of economic growth. But as this analysis is not explicitly based within a macroeconomic framework, the connections between the analysis and the proposals for post-growth economies remain weak. Similar arguments could be made on various other prominent contributions such as Daly (1991), Victor (2008), Latouche (2009), Paech (2012), Seidl and Zahrnt (2010b), D'Alisa et al. (2014) and several others.[24]

Contributions from a fourth group explicitly base their analyses within well-formulated theories or models, but make use of very specific models and/or examine very specific issues. Two examples illustrate this point. Victor and Rosenbluth (2007) analyse conditions that lead to social and environmental goals and at the same time generate zero or very low growth rates. They do so, however, by using a very specific computer-based model, with all the limitations concerning theoretical comprehensiveness that come along with it. A second example is the sophisticated discussion on the relation between the monetary sector and zero growth economies.[25] Due to their formal approach and very specific issue, such contributions are unable to take into account other considerations apart from monetary flows (these specific models are summarized for each school of economic thought in the introductions of the respective parts – chapters 5, 10 and 15).

In short, there is a lack of research on conditions for economies without

[23] See section 2.3.

[24] See chapter 3.

[25] See section 3.4.4.

growth based on well-established, comprehensive macroeconomic frameworks.[26] The present work is intended to contribute to filling this vacancy.

1.3 Research Design

This present work applies a plural set of macroeconomic theories to one specific economic issue. In the following section, the sequence of methodological steps is first described. Then the logic of using theories to investigate a state of affairs that only potentially exists – i.e., sustainable economies without growth – is laid out. After that, the selection of theories is explained.

1.3.1 Course of the Investigation

The investigation starts with a summary of the existing literature on economies without growth (part I). In the following four parts (II – V), a total of 29 theories from three different schools of economic thought are investigated with regard to the main research question and the subquestions. This is done in three methodological steps.

1. Step one is to investigate within the logic of each theory which macroeconomic conditions lead to economies without growth (subquestion 1) and which additional conditions help to facilitate environmental sustainability (subquestion 2), low economic inequalities (subquestion 3) and economic stability (subquestion 4). In order to study these theories, they are first replicated in a comprised fashion. Some theories are refined or formalized to improve the investigation. Afterwards the conditions are deduced.
2. The second step is to analyse the macroeconomic conditions for sustainable economies without growth from the perspective of each economic paradigm. This is done in the last chapters of parts II, III and IV (chapters 9, 14 and 19).
3. Step three is to execute a specific pluralist method[27] on sustainable

[26] To some degree, Binswanger (2013) is an exception. He investigates the feasibility of zero growth within a comprehensive macroeconomic framework. His analysis is nonetheless different to this work in two ways. First, he uses a macroeconomic theory that he has developed himself and is therefore not well-known to many economists. Second, he investigates whether zero growth is feasible within the currently existing economic system but does not ask what conditions need to change in order to facilitate it.

[27] The method applied is based on the method of *interested pluralism* as developed by Dobusch and Kapeller (2012). Such methodological approaches are relatively uncommon in the economic discipline, as economics is characterized by a monist understanding of science (Dobusch and Kapeller, 2012). A distinction is made between methodological and theoretical monism.

economies without growth. The central conditions from the three economic schools of thought are compared, integrated and synthesized. This is done in part V.

1.3.2 Logic Behind the Application of Macroeconomic Theories

All of the theories investigated explain the level of production and its growth and therefore refer to the first research subquestion. The explanatory power varies from theory to theory in subquestions 2 – 4. Several theories apply to each subquestion, while others only relate to some of them.

The logic of investigating the theories in order to gain insights into conditions for economies without growth is as follows: The theories claim to point out the central mechanisms determining the level of production and its growth. Assuming that these explanations are indeed relevant[28], the argument is presented that they also relate to the changes that are necessary for economies to generate zero growth.

Methodological monism concerns the question of whether social sciences and in particular economics should apply the same or different methods than natural sciences (Blaug, 1992). Theoretical monism implies that individual scientists argue within one certain economic paradigm and are of the opinion that their paradigm is best in explaining economic phenomena (Dow, 2004). The goal of monist approaches is to develop one paradigm that is able to explain the largest set of phenomena possible (Dobusch and Kapeller, 2012). Not only do scientists within the dominant, neoclassical (or mainstream) paradigm take such an approach (Lee, 2011), but also many heterodox economists (Dobusch and Kapeller, 2012) as well. The monist approach has been criticized on several grounds (see e.g., Fullbrook (2008) and Garnett et al. (2010)). According to Garnett et al. (2010) there have been two waves of contributions on pluralism in economics. The first wave in the 1970s and early 1980s called for a variety of theories, which were supposed to primarily co-exist. Interaction between the theories was not a major issue. In a more recent second wave, the argument is instead in favour of a pluralism that entails strong interactions between different schools of thought: "Second-wave pluralists were dissatisfied with the notion of science as empire building or paradigmatic one-upmanship, a monist view they ascribed to many mainstream economists as well as to their first-wave critics" (Garnett et al., 2010, p. 2). The method applied in this work (in particular the comparison and synthesis in part V) is based on one approach from this second wave.

28 Within the discussion of the theories it is assumed that their respective causal chains are true. Whether this is actually the case is discussed at the end of each chapter.

1.3.3 Selection of Theories

The central purpose of this work is to provide a solid theoretical macroeconomic basis for analyses on economies without growth. This is why well-established macroeconomic theories have been chosen for the investigation. The prime criteria for selecting schools of thought are therefore comprehensiveness and prominence of economic theories. There will always be some arbitrariness in such a selection. The present study draws on Marglin (1984), who, when looking for approaches "to the determination of growth, distribution and prices", comes to the conclusion that "there were two distinct lines along which alternative models [to the neoclassical theories] could be developed, one deriving from Karl Marx and the classical economists, another from John Maynard Keynes and Michal Kalecki" (Marglin, 1984, p. 5). Similarly, Wolff and Resnick (2012) argue that neoclassical, Keynesian and Marxian approaches are "the three most important economic theories contesting in the world today" (p. 347). Therefore, these three schools of thought have been selected.[29]

Within these schools of thought, there are numerous single theories and models. Among these, two criteria were the important for the selection process. First, prominent theories were preferred, because their prominence is an indicator for their quality and because the investigation becomes more relevant when a higher share of readers is already acquainted with the theories used. Second, theories were chosen that link up to discussions in the literature on economies without growth. A good example is the theory by Jonathan Harris (section 13.2) that is not well-known but is one of the few contributions on sectoral change from dirty to clean production.

There are fewer theories from the Marxian school of thought than from the other two. This is due to two reasons. First, Marxian approaches are less effective in situating the discussion on economies without

[29] Other plausible schools of economic thought would be environmental and/or ecological economics. Many relevant aspects of environmental economics are included in section 2.2.2 and chapter 8. Perhaps it is ecological economists who have made the largest contributions to the question of economies without growth to date. Their major insights are summarized in section 2.2.3. Both perspectives therefore are included in the analysis of this work.

growth within economics.[30] More importantly though, Marxian theories are broader in scope than the average single theories from the other two schools of economic thought. Therefore, only a limited number of Marxian theories is covered, but they are analysed in their complexity.

1.4 Structure of the Present Work

The subsequent parts are structured as follows:

1. Part one encompasses the state of research on economies without growth. It lays the analytical ground of what is to come afterwards. It entails more detailed discussions on whether economies should be organized without growth. Most importantly, the state of research on proposals for macroeconomic conditions for sustainable economies without growth is laid out. The part ends with an intermediate summary of those conditions.
2. The second part encompasses the investigation of neoclassical theories. It entails fundamental theories, endogenous growth theories and theories with environmental aspects. Their analyses lead to a set of conditions for sustainable economies without growth and three distinct scenarios relating to different types of technological change.
3. In the third part, Keynesian theories are investigated. The investigation of fundamental theories, monetary theories and theories with environmental aspects leads to a wider set of conditions as in the neoclassical part. Four Keynesian scenarios for economies without growth are developed that relate to reductions in working hours, redirected technological change and sectoral change.
4. The Marxian part entails two distinct approaches. Marx's analysis that relates to competitive capitalism and the Theory of Monopoly Capitalism. Both are combined with ecological Marxian analyses, leading to two distinct scenarios for sustainable economies without growth.

[30] Marxian theories have almost disappeared from macroeconomics (Lee, 2009; Heise and Thieme, 2015). Prominent textbooks exclude Marxian analyses entirely (e.g., Blanchard and Illing (2006), Mankiw (2003), Romer (2006) and Mankiw (2010)). Already in the 1980s, Solow (1988) argued that "most serious English-speaking economists regard Marxist economics as an irrelevant dead end" (p. 2) and according to Stigler (1988), the writings of Marxists "have virtually no impact upon the professional work of most economists in major English-language universities" (p. 1733). More recently, Mankiw (2010) claimed that Marx's macroeconomic analysis is "now-discredited" (p. 49). Subsequently, Marxian theories are less auxiliary in connecting the discussion on economies without growth within economics.

5. In the final part, the results from the four prior parts are compared, integrated and synthesized. This leads to a set of macroeconomic conditions that incorporates the results from all three schools of economic thought.

Part I

Foundations

Chapter 2
Background

Early industrialized countries are currently depicted by low growth rates (Teulings and Baldwin, 2014). One could therefore argue that they are already on a path towards becoming economies without growth. At the same time, these low-growth economies are characterized by strong social and environmental problems. Unemployment rates are significant, economic inequalities are rising and environmental goals are not being achieved (Seidl and Zahrnt, 2010a). These economies, which are supposedly in a secular stagnation, are therefore not equal to *sustainable economies without growth* as defined above. As Spash (2007) argues, the end of economic growth that comes about automatically is not the same as consciously organized economies without growth. Economies have to become "[s]maller by design, rather than smaller by disaster" (p. 712).

The transformation of the existing low-growth economies (by disaster) towards designed sustainable economies without growth must take into account the current state of affairs. In other words: It is necessary to understand why economies currently depict low-growth rates and generate social and environmental problems in order to develop necessary conditions for sustainable economies without growth.

Therefore, this chapter discusses the background based on which conditions for sustainable economies without growth can be developed. First, it is central to define GDP and put it into historical and theoretical perspective. Therefore, section 2.1 covers how GDP is measured, how it developed from the industrial revolution onwards and what role it plays in welfare economics. Whether economic growth or economic inequalities are decisive for economic welfare is also discussed.

Section 2.2 covers the relation between economic growth and environmental aspects. In this section, several concepts from environmental and ecological economics are developed that are important for the further analysis in parts II – V. Additionally, this section also touches on the circumstances under which a sufficient decoupling of economic activities and environmental emissions is feasible.

Third, theories on the stationary state and secular stagnation are discussed (section 2.3). These theories attempt to explain the declining growth rates in early industrialized countries.

2.1 On Economic Growth

2.1.1 Measurement of Economic Growth

Many economic growth theories simply state that they deal with the growth of production. However, measuring production can be very complex. Most theories circumvent this problem by assuming economies have only one final good. As real world economies have many goods and the composition of goods changes over time, the situation is more complicated than that. The issue of what GDP actually measures is important with regard to the question of what economies with zero growth look like and in particular the question of decoupling (see section 2.2.5).

2.1.1.1 Real GDP, the GDP Deflator and Chain-Weighted GDP

When opening an economic textbook, the definition of GDP is usually something like this: "Gross domestic product (GDP) is the market value of all final goods and services produced within an economy in a given period of time" (Mankiw, 2010, p. 21). The basic idea is therefore that the value of all final goods and services traded within a country in one year are added together.

A problem is how to measure this value, in particular how to compare the goods and services of one year with the goods and services of another year (Chancel et al., 2013). If the goods stayed the same over time (the existing goods do not change and no new goods are introduced) and if the prices of the goods did not change, the issue would be simple. Multiplying the number of goods by their prices gives nominal GDP. As in this case, nominal GDP and real GDP are equal, the rate of growth in real GDP can readily be calculated. Table 2.1a gives an example for two goods (bread and shoes) over three years. Multiplying the quantities of bread (Q_B) and shoes Q_S with their respective prices (P_B and P_S) gives the real GDP (Y_R) and its growth rate g_R.

Table 2.1: Calculation of Real GDP Growth With GDP Deflator

Year	Q_B	P_B	Q_S	P_S	Y_R	g_R
1	10	1	2	10	30	
2	9	1	3	10	39	0.3
3	8	1	4	10	48	0.23

a GDP Growth Without P. Changes

Year	Q_B	P_B	Q_S	P_S	Y_R^1	g_R^1
1	10	1	2	10	30	
2	9	1.1	3	11	39	0.3
3	8	1.2	4	12	48	0.23

b GDP Growth With Price Changes

The first issue is how changes in prices can be accounted for in GDP measurement by using a GDP deflator. Table 2.1b gives an example in which the prices of both goods rise over time. Real GDP is now denoted with Y_R^1, implying that it is measured by using the prices in period 1. The development of real GDP is the same as in table 2.1a, as a mere change of prices does not alter it.

In the 1990s, a new measure was introduced due to three problems with the normal GDP deflator. First it is argued that "for periods far from the base year, base-year prices have little relevance" (Landefeld et al., 2003, p. 10). For example, the prices of computers from the 1960s have little relevance for the situation today. The second issue is related to this: When some good becomes cheaper (often due to technological change), it will be consumed more – and other products will be consumed less as individuals have limited income. This is called the *substitution bias*. Therefore, over time, goods that become cheaper make up a larger share of GDP. Using the normal GDP deflator, these goods are multiplied by their price of the base year. This leads to large increases of GDP and, it is argued, to overestimated economic growth (Steindel, 1995). Together these two effects lead to the third problem, namely that "the entire history of real GDP growth changes each time the base year is switched" (Steindel, 1995, p. 2). Depending on the price constellation of all goods in the base year, GDP in all other years change.

Table 2.2 illustrates this problem. Instead of bread and shoes, the economy now consists of bread and computers. The quantity of computers (Q_C) also increases, but their price (P_C) decreases over time. This leads to high growth rates of real GDP when the base year is always year 1 (depicted in column g_R^1). A first remedy is to always take the prices of the previous year in order to calculate the growth of real GDP from one year to the other (row g_R^{prev}). This leads to lower growth rates, as intended.

A further approach is to take the average of real growth measured based on the prices of the previous year (g_R^{prev}) and the present year (g_R^{pres}), giving the "chain-weighted" GDP (row g_R^{chain}) (Landefeld et al., 2003, p. 8). This leads to even lower rates of real economic growth in the example chosen.

2.1.1.2 Implications for Economies Without Growth

These issues relate in particular to two aspects of economies without growth. First, they consider the question of how economies without growth affect the kinds of goods produced. The simplest form of a zero growth economy would be one in which each year the same products are produced. More realistically, the products would change over time, however. Two arguments are relevant here: (1) When the price of products decreases

Table 2.2: Calculation of Real GDP Growth With Chain-Weighted GDP Deflator

Year	Q_B	P_B	Q_C	P_C	g_R^1	g_R^{prev}	g_R^{pres}	g_R^{chain}
1	10	1	2	20				
2	9	1.1	3	10	0.38	0.38	0.29	0.34
3	8	1.2	4	5	0.28	0.22	0.14	0.18

due to technological change, zero growth economies may still imply an increase in consumption, as the falling prices decrease the real GDP over time.[1] (2) Even more importantly, an increase in prices of dirty goods (e.g., due to environmental taxes) may shift consumption towards clean products, due to the substitution bias. The loss in material welfare is therefore less severe than would otherwise be the case.

Measurements of GDP also relate to the issue of decoupling economic growth from environmental aspects. Authors who argue for that decoupling is feasible, point out that an important reason for economic growth is the improvements in the quality of goods rather than the production of additional goods (Paqué, 2010). While this argument holds, there are also mechanisms in the opposite direction. When goods become cheaper due to a decreasing labour coefficient, they enter GDP with a decreasing weight, while material use may stay constant or even increase (when labour is substituted by energy). It is therefore an open question whether changes in the quality of goods support or hinder the decoupling of GDP growth from environmental aspects.[2]

2.1.2 A Short History of Per-Capita-Growth

High economic growth rates are a recent phenomenon from a historical perspective. Only since the 18th century did per capita income start increasing at significant speed (Maddison, 2006).

2.1.2.1 Growth Since the Industrial Revolution

Maddison (2006) argues that there were five phases of economic growth in early industrialized countries with different levels of growth rates: 1820-

1 As will be argued in section 2.2, this process can be limited when the energy input is to be decreased, because decreasing prices often depend on the substitution of labour by energy.

2 To the best of my knowledge, there are no scientific investigation on this issue (T. Santarius, personal communication, January 09, 2016), which is why the issue cannot be analysed in more detail here

1870, 1870-1913, 1913-1950, 1950-1973 and 1973-1998 (see table 2.3)[3]. (1) Following the industrial revolution, growth of GDP per capita rose well above the low growth rates of the centuries before, at 1.00%/1.42% (for West European countries/Western Offshoots). (2) In the second phase, industrial production was increasingly accompanied by a globalisation of markets. That further increased the growth rates to 1.33%/1.81%. (3) The third period was strongly influenced by the two world wars. During this time European countries grew less (0.83%) than the Western Offshoots (1.55%, in particular the USA with 1.61%). (4) The post-war period was characterized by rebuilding and the catching-up of European countries (3.93%) compared to the USA (2.44%). (5) The last period was marked by lower growth rates (1.75%/1.94%) because the effects of rebuilding and catching-up were no longer felt and due to several other effects which are discussed in the next section.

Table 2.3: GDP Per Capita Growth Rates 1820-1998

Time	1820-1870	1870-1913	1913-1950	1950-1973	1973-1998
West European Countries	1.00	1.33	0.83	3.93	1.75
Western Offshoots	1.42	1.81	1.55	2.44	1.94

West European Countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom. Western Offshoots: Australia, New Zealand, Canada, United States (Maddison, 2006, p. 186).

2.1.2.2 Exponential or Linear Growth After the Second World War?

Turning to a closer look at the last decades, table 2.4 (row "Growth rates") displays the average growth rates since 1960 of high-income OECD countries. They elaborate on Maddison's results. In the 1960s, growth rates were very high; this decade is still part of Maddison's fourth phase. In the 1970s, a new phase begins which he calls the neoliberal order. Within this phase, growth rates are lower than in the 1960s, but also vary significantly from decade to decade. Comparing the 1960s, '70s, '80s and '90s,

[3] The table includes numbers of Maddison's (2006) categories *Western European* and *Western Offshoots*. These are almost equal to the category *early industrialized countries*. For example, Lanne and Liski (2004) use a list of early industrialized countries that only additionally includes Japan and excludes Norway.

average growth declines from every decade to the next. This trend seems to persist concerning the 2000s and 2010s, though here it is less clear.[4]

Analysing this downward trend, several authors come to the conclusion that high-income countries display a linear rather than an exponential growth path (Afheldt, 1994; Reuter, 2002; Pollitt et al., 2010; Altvater, 2005; Bourcarde and Herzmann, 2006; Wibe and Carlen, 2006; Diefenbacher et al., 2009; Lange et al., 2016). The main argument is that many high-income countries grow constantly in absolute terms – each year the economy grows by a certain amount. When economies grow over time, the growth rate therefore declines from year to year. Row "Absolute growth " in table 2.4 displays average absolute per capita growth for the same countries as before. These numbers give anecdotal support for the hypothesis of linear instead of exponential growth. Absolute per capita growth rates are relatively constant regarding the first four decades (551, 482, 536, 536). Numbers for the 2000s and 2010s are again difficult to interpret.[5]

Table 2.4: Growth Rates and Absolute Growth of GDP Per Capita 1960-2013

Time	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2013
Growth rates	3.82	2.63	2.18	1.79	0.98	1.24
Abs. growth	551	482	536	536	334	440

Growth rates (simple average of per capita growth rates) and absolute growth (simple averages of absolute growth per capita) in high-income OECD countries. Source: World Bank (2014), own calculations.

4 The 2000s and 2010s are special cases. In this period, growth rates are largely driven by the economic crisis beginning in 2008. The average growth rates for the 2000s are lower because growth rates for 2008 and 2009 were negative. For the period 2000-2007 the average growth rate is 1.83%, higher than in the 1990s. Similarly the numbers for the 2010s need to be interpreted with caution. First, there are only four years of observations. Second, the relatively high growth rate in 2010 (2.25%) drives the average but is probably due to a recovery after the crisis of the years 2008 and 2009. Nevertheless, it can be said with certainty that growth has remained below 2% on average and therefore no significant reversion of the negative trend or even a come back to the growth rates of the 1950s, '60s and '70s can be observed.

5 On first sight the average absolute growth seems to be lower (334/440). However, the average absolute growth from 2000-2007 is higher (627).

Several authors have looked into this relationship empirically and come to similar conclusions. Bourcarde and Herzmann (2006) investigate the growth patterns of 21 high-income countries and argue that the majority display linear growth rates, some have clear exponential growth rates, while several cannot be clearly identified. They use national growth rates instead of per capita growth rates and base their analysis on case studies only. Wibe and Carlen (2006) investigate economic growth per capita in 28 countries statistically and also find linear rather than exponential growth in the majority of cases. Extending the analysis to recent years, Lange et al. (2016) come to similar results and conclude: "In contrast to the prominent view of exponential economic growth, a constant growth might be closer to the truth of what has happened in some mature economies within the last 40-50 years" (p. 24).

2.1.2.3 Implications for Economies Without Growth

The previous overview serves as an empirical background for the analysis at hand. Several stylized facts are important for the subsequent discussions. First, significant economic growth per capita is a recent phenomenon, beginning with the industrial revolution. This point is relevant concerning the question under what conditions is future economic growth possible with regard to technological change and the use of fossil fuels (see section 2.2). Second, there seem to be different phases of capitalism, with different macroeconomic conditions and subsequently different paces of growth. This suggests that changes in macroeconomic conditions indeed alter the pace of economic growth and opens the perspective on possible future scenarios (see part V). Third, growth rates have declined over the last decades. This observation has led various authors to argue that industrialized countries experience the end of economic growth. Such low growth rates therefore characterize the current situation of early industrialized countries. Conditions for economies without growth need to be connected to this empirical fact and its theoretical explanations (see section 2.3).

2.1.3 Economic Growth in Welfare Economics

The desirability of economic growth is deeply entrenched in mainstream welfare economics (2.1.3.1). At the same time, empirical results challenge the view that economic growth contributes to social welfare (2.1.3.2). This has led to several theoretical explanations (2.1.3.3) and implies several conditions for economies without growth in order to generate high social welfare (2.1.3.4).

2.1.3.1 Economic Growth and Utility

Utilitarian philosophy has been crucial for formulating economic theories. Most parts of welfare economics are grounded in this line of thought. Utility is the central concept to understanding welfare (Bohnen, 1964). Bentham (1907) first developed a coherent utilitarian theory. He argues that all actions of human beings aim at maximizing overall (aggregated) utility. His definition of utility is: "By utility is meant that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness, (all this in the present case comes to the same thing) or (what comes again to the same thing) to prevent the happening of mischief, pain, evil, or unhappiness to the party whose interest is considered" (chapter I, I.4). This applies to the utility of a society as well as to the utility of an individual.

Two hundred years later, Sen (1988a) points out three central principles of utilitarianism: (1) "Welfarism, requiring that the goodness of a state of affairs be a function only of the utility information regarding that state" (Sen, 1988a, p. 39), (2) sum-ranking, "requiring that utility information regarding any state be assessed by looking only at the sum – total of all the utilities in that state" (p. 39) and (3) consequentialism, "requiring that every choice, whether of actions, institutions, motivations, rules, etc., be ultimately determined by the goodness of the consequent states of affairs" (p. 39). To sum up: In utilitarian thought, (solely) aggregated utility counts for evaluating situations, and actions should be geared towards maximizing these aggregated utilities.

Material aspects such as the level of income play an important role in the work of Bentham and other early utilitarian thinkers, but is not the sole determinant of welfare (Boadway and Bruce, 1984). Later, utility has been defined in more narrow, material terms. Pigou (1932) argues that the concept of economic welfare should be restricted to such aspects that can be measured in monetary terms, because other aspects can simply not be examined due to a lack of data: "Hence the range of our inquiry becomes restricted to that part of social welfare that can be brought directly or indirectly into relation with the measuring rod of money. This part of welfare might be called economic welfare" (Pigou (1932), I.I.5) For economic welfare, the level of income is of central importance: "The economic welfare enjoyed by anybody in any period depends on the income that he consumes" (I.VIII.3).

Pigou's (1932) analysis comes to the conclusion that more income enables more consumption and therefore leads to higher welfare. A problem of this analysis is that it is unable to compare the consumption of different goods. The kinds of goods consumed may change significantly over a longer time period (see section 2.1.1). How can a comparison be made of two bundles of goods consumed that are very different? The theory of revealed preferences gives an answer to this question (Samuelson, 1938) and has been of major importance for successive welfare theories (Boadway and Bruce, 1984). Consumers reveal their preferences by their actual consumption behaviour. Hence, when consumers are willing to pay higher prices for goods, they gain more utility from it. The chain-weighted calculation of GDP in section 2.1.1 is a concrete application of this line of thought.

In sum, the idea that economic growth increases welfare is therefore deeply entangled in welfare economics, most importantly due to the assumption that consumption is the main factor that determines utility. GDP is argued to be a good measure of utility as it represents willingness to pay.

At the same time, welfare economics contains a central concept that questions the desirability of additional economic growth above a certain level. The concept of decreasing marginal utility implies that the utility stemming from the consumption of a certain good decreases with the number of goods consumed. Due to the same logic, there are diminishing marginal returns to income (Boadway and Bruce, 1984). Hence, at a certain point the positive impact of income on utility becomes negligible. Accordingly, Keynes famously argued that "[a] point may soon be reached, much sooner perhaps than we are all of us aware of, when these needs are satisfied in the sense that we prefer to devote our further energies to non-economic purposes" (Keynes, 1933, p. 365).

2.1.3.2 Empirical Results

There are three major issues in the empirical literature on the relation between economic growth and social welfare.

The first issue deals with the question whether increases in income lead to higher social well-being on a national level. Various authors point out that additional income does not increase average subjective well-being or the share of people reporting high subjective well-being (Easterlin (1974); Easterlin and McVey (2010); Frey and Stutzer (2002); Dolan et al. (2008); Diener et al. (1993); Frey (2008); Layard (2006); Diener et al. (1999); Graham (2009)). Other empirical research finds a positive relation between economic growth and average life satisfaction in high-income countries (Hagerty and Veenhoven, 2003). The opposing parties in this discussion either come to the conclusion that "[o]btaining certainty must wait until longer and better time series become available" (Veenhoven and Hagerty, 2006, p. 433) or that the "criticisms, which reject the claim of a positive relationship, have been acknowledged by Hagerty and Veenhoven to be correct" (Easterlin and McVey, 2010, p. 22464) and therefore the claim still holds that there is no positive effect of economic growth on average life-satisfaction.

Another strand of literature is on objective measures of well-being. Prominently, Wilkinson et al. (2010) have examined the relationship between average income and several objective measures of welfare. They come to the conclusion that "[n]ot only have measures of wellbeing and happiness ceased to rise with economic growth but, as affluent societies have grown richer, there have been long-term rises in rates of anxiety, depression and numerous other social problems" (p. 5 – 6).

Second, within high-income countries, individuals with higher income experience higher subjective well-being (SWB) than people with lower income: "There is an overwhelming amount of evidence that shows a positive relationship between income and SWB within countries" (Diener, 2009, p. 26). This is a very different issue, however, and must not be confused with the effects of average growth in income.

Third, factors other than economic growth contribute significantly to higher well-being in high-income countries. Diener and Seligman (2004) divide them into four categories: Other economic factors than income (i.e., inflation, unemployment rate, income inequality), social capital (i.e., divorce rates, membership in voluntary organizations, levels of trust), governance (i.e., human rights, extent of democracy, low corruption, effective rule of law) and religion (belief, church attendance). Dolan et al. (2008) in particular stress the point that unemployment has a strong negative effect on well-being. Wilkinson et al. (2010) highlight the role of income inequality for a set of objective welfare indicators and come to the conclusion that "the prevalence of poor health and social problems in whole societies really is related to inequality rather than to average living standards" (Wilkinson et al., 2010, p. 20). A negative relation between economic inequalities and welfare is also found in the subjective well-being literature (Alesina et al., 2004; Oishi et al., 2011).

2.1.3.3 Theoretical Explanations

Explanations for the three empirical issues are discussed in turn. There are three major theoretical arguments to explain the missing link between economic growth and social welfare. (1) *Diminishing marginal utility of consumption* makes additional income above a certain level irrelevant. (2) Due to a *"hedonic treadmill"* (Brickman and Campbell, 1971), every increase in consumption and income increases the perception of what level of income is satisfactory. Hence, the positive effect of an increase in material wealth quickly loses its positive effect on utility (Binswanger, 2006b). (3) *Societal norms* determine an individuals' perception of his or her own income. Therefore "[r]aising the incomes of all does not increase the happiness of all, because the positive effect of higher income on subjective well-being is offset by the negative effect of higher living level norms brought about by the growth in incomes generally" (Easterlin, 1995, p. 36).

There is one central argument concerning the fact that income and well-being are correlated *within* countries: The term *relative income* refers to the relationship that consumption is (above a certain level) primarily positional (e.g., Duesenberry (1949); Hirsch (2005); Alpizar et al. (2005); Diener (2009)): "Satisfaction is derived from relative position alone, of being in front, or from others being behind" (Hirsch, 2005, p. 19). Binswanger calls this the "positional treadmill" and argues that it (and other mechanisms) "seem to be inherent in modern economic development and help to turn economic growth in developed countries into a rat race, where the pursuit of happiness of all individuals becomes a zerosumgame on aggregate" (Binswanger, 2006b, p. 367).

There are two theoretical explanations for a correlation between low inequalities and high social welfare. (1) Due to diminishing marginal utility from income, distributing from people with higher incomes to people with lower incomes takes away less welfare from the former than it gives to the later (Pigou, 1932). (2) Wilkinson et al. (2010) argue that people at the bottom of the income distribution experience more social and health problems than others but that this is less the case for societies with lower inequality.

2.1.3.4 Implications for Economies Without Growth

The results from this section represent major motivations for investigating sustainable economies without growth. First, zero growth per se does not need to be in contradiction with high levels of social welfare.[6] Second, effects of zero growth, however, can still impede welfare. A central issue is the negative effect of unemployment on well-being.[7] Third, the discussion suggests that lower levels of economic inequalities lead to higher levels of social welfare.[8]

2.2 Economic Growth and the Environment

The relationship between economic growth and the environment is one important, if not the central motivation for discussions on economies without growth. Also, it is crucial to understand this relationship in order to analyse under which circumstances economies without growth generate fewer environmental problems than growing economies.

[6] This is reflected in the research subquestion 1.

[7] Unemployment and other instabilities are covered by subquestion 4.

[8] Subquestion 3 focuses on this issue.

This section starts with a short presentation of the most pressing environmental issues, using the framework of environmental sources and sinks (2.2.1). Next, two different perspectives on the topic are considered. Section 2.2.2 introduces the view of environmental economics, which often takes an optimistic position regarding the compatibility of economic growth and environmental sustainability. This is followed by an explanation of the central insights from ecological economics, whose contributors argue that economic growth and environmental goals are not compatible (2.2.3). Based upon these analyses, the prominent discussion on the feasibility of decoupling economic growth from environmental issues is laid out (2.2.5).

2.2.1 Issues: Sources and Sinks

Environmental and ecological economists commonly explain the relation between the economy and the environment by referring to sources and sinks. The basic logic is as follows: On the one hand, economic activities require natural resources as inputs. The question here focuses on the point in time when certain *sources* will be depleted or become too expensive and whether this constitutes a limit to economic growth. On the other hand, economic activities generate solid, liquid and gaseous materials as outflows. The sizes of *sinks* determine nature's ability to absorb such outflows.

2.2.1.1 Limits and Peaks

The discussion on sources became prominent in the 1970s after the publication of the famous *The limits to growth* report (Meadows et al., 1972). It models the use of various natural resources and comes to the conclusion that several of them become unavailable on a global scale, in case the existing trends continue. Major criticisms of the report have been the exact timing it predicted and the question whether the effect of increasing prices of scarce resources would induce incentives to use less of them and thereby solve the problem (Victor, 2008).

The next prominent debate refers to what was first coined *Hubbert's peak* and later *peak oil* and *peak everything*. The peaks set a maximum level of the production of a non-renewable natural resource. The fundamental logic is always the same. Discoveries of resources have to be made before exploitation of such resources can take place. Exploitation is modelled as dependent on the total amount of discovered resources. The development of discoveries therefore allows us to predict with some accuracy at what point production will need to decline (Hunt and Evans, 2011).

According to Victor (2008) "few now question the idea of peak oil. The real debate is about timing" (p. 60). Drawing on Campbell (2005), Victor argues that peak oil probably took place in the last decade and that "total production from conventional oil, natural gas, natural gas liquids, heavy oil, non-conventional gas, and from polar and deep water sources [...] peak" in the 2010s (p. 60).

2.2.1.2 Climate Change and Planetary Boundaries

Climate change is the most prominent example when it comes to sinks. Many economic activities (in particular the burning of fossil fuels) emit climate gases, which leads to global warming. According to Pachauri et al. (2014), human action is the main driver of climate change. Concerning the feasibility of mitigation, the most recent report by the Intergovernmental Panel on Climate Change (IPCC) states:

> There are multiple mitigation pathways that are likely to limit warming to below 2 °C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century (Pachauri et al., 2014, p. 20).

They further argue that "[i]mplementing such reductions poses substantial technological, economic, social and institutional challenges" (p. 20). One major obstacle is foregoing the exploitation of a high percentage of the fossil fuels that have already been discovered: "[A] third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2 °C" (McGlade and Ekins, 2015, p. 187). Klein (2014) argues that this poses a great challenge, as strong economic interests are associated with exploiting natural resources.

Another prominent conceptual approach to sinks are planetary boundaries (Rockstrom, J. et al., 2009; Steffen et al., 2015). It is argued that there are nine human-nature relations that are of great importance. According to Steffen et al. (2015), four of them have already been crossed. Two of these – climate change and biosphere integrity – have been identified as "core boundaries [...] each of which has the potential on its own to drive the Earth System into a new state should they be substantially and persistently transgressed" (p. 1).

2.2.1.3 Implications for Economies Without Growth

The central message from this section concerning subsequent discussions is therefore that sinks and not sources are the pressing environmental issues. As climate change and other planetary boundaries are being transgressed, the issue of limited fossil fuels becomes less urgent. As McGlade and Ekins (2015) put it:

> [A] stark transformation in our understanding of fossil fuel availability is necessary. Although there have previously been fears over the scarcity of fossil fuels, in a climate-constrained world this is no longer a relevant concern: large portions of the reserve base and an even greater proportion of the resource base should not be produced if the temperature rise is to remain below 2 °C (p. 190).

2.2.2 Environmental Economics

The field of environmental economics is broad and diverse. It entails multiple analyses and views on the relationship between economic growth and environmental sustainability. The following section is therefore limited to some very specific aspects of the field. First, an analytical framework is laid out that is often referred to and serves as a reference point for following discussions. Second, central mechanisms concerning the relation between economic growth and the level of pollutants are summarized. Finally, the debate around the Environmental Kuznets Curve is depicted.

2.2.2.1 Scale, Composition and Technology

A common framework is to investigate the economy-environment relationship from three different perspectives: scale, composition and technology.[9] Emissions[10] (E) depend on the level of production (Y), the emission intensity per unit of production (Ω_i, which differs between sectors (i)) and the composition of outputs between sectors (γ_i denotes the different sector shares). Emissions are determined according to

$$E = \sum_{i=1}^{n} \Omega_i \gamma_i Y, \quad \text{with} \quad \sum_{i=1}^{n} \gamma_i = 1. \tag{2.1}$$

Differentiating both sides with respect to time gives:

$$g_E = \sum_{i=1}^{n} \alpha_i (g_{\Omega_i} + g_{\gamma_i}) + g_Y, \quad \text{with} \quad \alpha_i = \frac{E_i}{E}. \tag{2.2}$$

According to Brock and Taylor (2005) "[c]hanges in aggregate emissions can arise from three sources" (p. 7). First, the scale effect is determined by holding the emission intensities and the composition between sectors constant. In this case, emissions change in the same direction and with the same speed as output:

9 The following representation is based on Brock and Taylor (2005).

10 According to Xepapadeas (2005) the argument on emissions as developed below can also be applied to issues of natural resources.

$$g_E = g_Y. \tag{2.3}$$

Economically, this implies that economic growth increases emissions.

Second, the effect of changing output composition is derived by holding the emissions intensities and the scale constant. The composition effect depends on the speed of the sectoral change g_{γ_i} and the differences between the emission intensities of the sectors (α_i):

$$g_E = \sum_{i=1}^{n} \alpha_i g_{\gamma_i}. \tag{2.4}$$

In economic terms, "[e]missions fall via the pure composition effect if an economy moves towards producing a set of goods that are cleaner on average than the set they produced before" (Brock and Taylor, 2005, p. 7).

Finally, the technology effect is illustrated by holding scale and composition constant. Here, emissions depend on the rate of change of emission intensities of the different sectors (g_{Ω_i}) and on the differences between emission intensities (α_i):

$$g_E = \sum_{i=1}^{n} \alpha_i g_{\Omega_i}. \tag{2.5}$$

Economically speaking, emissions fall when emissions intensities fall. The same percental fall in dirty sectors has a stronger impact than in clean sectors.

Two aspects concerning these effects are important to keep in mind for the following discussions. First, the technology effect incorporates two different types of effects. On the one hand, technology determines the composition of production factors for a given state of technology. In other words: Technology determines the relative amounts of labour, physical capital and natural resources used in production at a certain point in time. Emissions can be decreased due to *substitution* of natural resources by other production factors. On the other hand, technological change alters the state of technology and thereby the composition of and substitutability between production factors. In neoclassical theories, technological change is commonly modelled in the form of factor augmentation. This implies that technological change increases the effectiveness of one or several production factors.

The second aspect concerns the interrelatedness of scale, composition and technology effects. Brock and Taylor (2005) point out that the three effects are interlinked in various ways. Hence, it is important to take into account the influence on the other effects when analysing how emissions can be reduced due to one of the effects.

2.2.2.2 Reconciling Economic Growth and Environmental Sustainability

The framework of scale, composition and technology is a definitional framework. Hence, it does not provide indications whether (sufficient) decoupling is plausible or not. Prominent contributors to environmental economics point out several reasons for technology and composition effects to decrease emissions per unit of production. It appears that overall environmental economists are more optimistic than ecological economists on the feasibility of sufficient decoupling (Turner et al., 1995).

According to Prato (1998), there are four reasons for neoclassical environmental economists to be optimistic concerning decoupling. First, technological change increases the productivity of natural resources. Second, when the price of a resource or of polluting increases, this triggers the development of substitutes. Third, with rising average income, population growth declines. Fourth, environmental policies can further decrease emissions. In a similar vein, Ekins (2000) argues that environmental taxation is of major importance to facilitate decoupling.

On a more theoretical base, economic growth and decreasing environmental aspects can be reconciled in two manners. The first is that there is sufficient substitution between physical capital and natural resources, so that production can increase despite fewer inputs of natural resources. The second is that the productivity of natural resources increases faster than its input decreases, due to limited availability or in order to achieve environmental goals (Groth, 2007). Both manners are related to technological change. These issues are discussed in more detail in section 2.2.5.[11]

2.2.2.3 The Environmental Kuznets Curve

The Environmental Kuznets Curve (EKC) is a reference framework often used for debates concerning the compatibility of economic growth and environmental sustainability within environmental economics. It received increasing attention in the 1990s, based on several empirical studies[12] that found a U-shaped relation between economic growth and several environmental pollutants. According to Smulders et al. (2014) by now "[t]he empirical literature on the EKC [...] is huge and far from unambiguous" (p. 440).

Several explanations have been brought forward for this relationship.

[11] These issues are also discussed in chapter 8 with reference to neoclassical growth theories with environmental aspects.

[12] For example Selden and Song (1994) and Grossman and Krueger (1995), for a summary see Yandle et al. (2002).

The first directly refers to Kuznets' (Kuznets, 1955) explanation of a supposedly existing U-shaped relation between income inequality and economic growth due to a sectoral change from an agrarian to an industrial and finally to a service-based economy. The idea is that emissions are low in agrarian economies, rise in the process of industrialization and decline again due to the transformation to a service-based economy (Arrow et al., 1996).

Second, according to Dinda (2004), "[t]he most common explanation for the shape of an EKC is the notion that when a country achieves a sufficiently high standard of living, people attach increasing value to environmental amenities" (p. 435). Hence, people are willing to spend more of their income for cleaner products.

Dinda (2004) further points out that the Environmental Kuznets Curve can also be explained by using the framework of scale, composition and technology effects from the previous section. Emissions increase due to the scale effect. At the same time, the shift from an agrarian to an industrial to a service-based economy is a composition effect, as the composition of products changes. Finally, economies with higher average income are willing to spend more on research in clean development (which is a similar argument as the willingness-to-spend argument above), representing the technology effect.[13]

More recent contributions on the Environmental Kuznets Curve are critical concerning the applicability of it, in particular concerning crucial global environmental issues. Stern (2004) comes to the conclusion that "the statistical analysis on which the environmental Kuznets curve is based is not robust" (p. 1435). Caviglia-Harris et al. (2009) show that the curve does not hold for overall measures of environmental pollution, in particular the environmental footprint. According to (Markandya et al., 2002), "while it has been observed for pollutants whose effect is felt locally and currently, it tends not to be observed for transboundary pollutants, or those whose effect will be felt in the future." (p. 122).

If the Environmental Kuznets Curve was in place regarding the relevant environmental problems – the planetary boundaries – there would be no reason to argue for economies without growth. But the literature comes to the conclusion that the curve does not apply to the most relevant issues – in particular climate change. Hence, the mechanisms related to the Kuznets curve to do not reconcile economic growth with pressing environmental issues; other solutions have to be investigated.

[13] These have been the major explanations of the Environmental Kuznets Curve, for a more elaborate summary of the arguments see Dinda (2004, pp. 434 – 440)

2.2.2.4 Implications for Economies Without Growth

Many environmental economists come to the conclusion that economic growth is reconcilable with achieving environmental goals. Ekins (2000) argues[14] that even when the Environmental Kuznets Curve has not taken place in the past, emissions would decline under the proper environmental policies. These would not only bring about reductions in emissions but also increases in labour productivity and therefore reconcile environmental goals with economic growth:

> The environmental policy induces technical change that both contributes to environmental sustainability and increases labour productivity at least to the same extent as would have occurred without the policy (Ekins, 2000, p. 318).

There are also several insights to be taken concerning economies without growth from environmental economics. As will be seen below, the different strategies for decreasing environmental impacts in the literature on economies without growth refer to the four effects (scale, composition, substitution and factor augmentation). The scenarios developed in parts II – IV are also based on these. The central strategies from environmental economics – technological change, increasing prices on natural resources and emissions and environmental policies – also apply to economies without growth and can be applied to decrease emissions.

2.2.3 Ecological Economics

Referring to Schumpeter's concept of a "preanalytic vision" (1986) and Kuhn's concept of a "paradigm" (1970), Daly (1991) argues that there is a preanalytic vision, which precedes scientific investigations:

> [P]rior to analytic thought there must be a basic vision of the shape and nature of the total reality to be analysed and some feeling for where natural joints and seams lie, and for the way in which the whole to be analysed fits into the totality of things. Our basic definitions arise out of this preanalytic vision, which limits the style and direction of our thinking (Daly, 1991, p. 14).

The preanalytic vision of ecological economics is fundamentally different from that of neoclassically oriented environmental economics. In this section, several major aspects of ecological economics are explained, which are essential for discussions on economies without growth. These are the

[14] Similar arguments can be found throughout the literature, see for example Aghion et al. (2009), Brock and Taylor (2010), Ekins and Speck (2011), Eriksson (2013), Fücks (2013).

entropy laws of economic processes, analytical frameworks by Georgescu-Roegen and Herman Daly and recent investigations on the relationship between energy use and economic growth.

2.2.3.1 Entropy Laws

In the seminal book *The entropy law and the economic process*, Georgescu-Roegen (1971) developed a way of applying the laws of entropy to economic processes. Georgescu-Roegen explains the essence of the entropy laws as follows: “in an isolated system, the amount of energy remains constant (the first law), while the available energy continuously and irrevocably degrades into unavailable states (the second law)” (Georgescu-Roegen, 1986, p. 3). The significance regarding the economy is that the energy on earth is limited and that the entropy of the existing energy increases over time.

Additionally the concept of “available and unavailable energy” (Georgescu-Roegen, 1986, p. 3) is important. Available energy can be used for the economic process while unavailable energy cannot. Available energy has low entropy and unavailable energy has high entropy. In the economic process, the entropy of energy rises, transforming available energy into unavailable energy. When the limited amount of available energy decreases due to economic activities, available energy has to deplete at some point in time.

This would be the case if the earth was an isolated system. But solar energy constantly enters the earth’s atmosphere, and thereby increases the amount of energy. This leads to discussions on whether solar energy can solve the problem of limited available energy. While Georgescu-Roegen (1986) does not deny this possibility, he gives arguments why it is unlikely to be feasible. Essentially, the low concentration of solar energy poses a limit to its usefulness, as high amounts of material are necessary in order to harvest it.

It should also be noted that Georgescu-Roegen’s analysis regarding certain time periods, for example the next hundred years, remains unclear. The fact that available energy is limited in general says little about the point in time when it will become scarce.

2.2.3.2 Major Analytical Frameworks

Georgescu-Roegen (1971) develops a framework using the four categories of stocks, flows, funds and services. Stocks are reserves of non-renewable resources and when they are used (for economic production) they become flows. Funds are (physical) capital, labour and renewable resources and can also be used for production. Services are the goods and services resulting from the use of stocks and funds. To give an example: The stock of oil can be used (the concrete oil being used is the flow) in combination with a car (the fund physical capital) and a driver (the fund labour) in order to produce the service of travelling. It should be noted that Georgescu-Roegen's framework does not entail a concept of value measured in monetary terms, such as GDP. Therefore, it does not lead to clear statements concerning the feasibility of decoupling flows from GDP growth.

Daly slightly changes and simplifies Georgescu-Roegen's preanalytic vision. He uses the three categories of throughput, stocks and services. Throughput is on the one hand the input of renewable and non-renewable resources and on the other hand the output of waste. The usage of these resources facilitates the generation of stocks. Stocks entail what is commonly called physical capital (both productive capital as well as durable consumer goods as houses or cars), human beings and inventories of natural resources (Daly gives the example of petrol in a tank). These stocks are used to generate services, which is the "final benefit of economic activity" (Daly, 1991, p. 36). Examples for services are mobility, food and shelter.

Based on this argument he develops the following equation:[15]

$$\frac{services}{stock}\frac{stock}{throughput} = \frac{services}{throughput}. \tag{2.6}$$

The equation is to be read in the following manner: First, the ratio of services per stocks can vary based on how efficient the stocks are being used to fulfil humans' needs and wants. Second, the ratio of stocks per throughput can vary according to how efficient throughput is being used in order to build up and maintain the stocks. These two ratios together determine how efficient throughput can be translated into services.

As Georgescu-Roegen's framework, Daly's categories do not entail economic growth – as measured in GDP. Therefore, it does also not lead to direct implications concerning the issue of decoupling emissions (or throughput) from GDP growth.[16]

2.2.3.3 Energy and Growth in Labour Productivity

Recent publications within ecological economics have investigated, both theoretically and empirically, the role energy (as the most important flow/throughput) has played for economic growth in the past and whether continued growth is possible with decreases in energy inputs in the future.

The central finding is that rising energy inputs have been the driving force behind increases in labour productivity throughout the 20th century.

[15] The equation is taken from Daly (1991, p. 36).

[16] This is also the major reason for the unclear statements on whether economic growth can be positive in steady state economies, see section 3.1.

It is argued that neoclassical theories underestimate the role of energy, because they assume that “the economic weight of a production factor, which is called the output elasticity of that factor, should always be equal to the factor’s share in total factor cost” (Kümmel and Lindenberger, 2014, p. 1).[17]

Kümmel and Lindenberger (2014) therefore develop an alternative approach to measure the output elasticities of production factors. They start with a general production function, “a state function” (p. 5), where production is determined by the levels of capital (K), labour (L), energy (E) and time (t):

$$Y = (K, L, E; t). \tag{2.7}$$

Totally differentiating gives the growth rate of output ($\frac{dY}{Y}$), which depends on the growth in the levels of the production factors capital ($\frac{dK}{K}$), labour ($\frac{dL}{L}$) and energy ($\frac{dE}{E}$) and the change in time:

$$\frac{dY}{Y} = \alpha\frac{dK}{K} + \beta\frac{dL}{L} + \gamma\frac{dE}{E} + \delta\frac{dt}{t - t_0}, \quad \text{with} \quad \delta = \frac{t - t_0}{Y}\frac{\partial Y}{\partial t}, \tag{2.8}$$

with the output elasticities

$$\alpha = \frac{K}{Y}\frac{\partial Y}{\partial K} \quad , \quad \beta = \frac{L}{Y}\frac{\partial Y}{\partial L} \quad \text{and} \quad \gamma = \frac{E}{Y}\frac{\partial Y}{\partial E}. \tag{2.9}$$

The production function is fitted to past observations concerning output levels and the levels of the production factors for the countries Germany, Japan and the USA in the second half of the 20th century. It is further investigated how well the resulting production function with concrete values for the output elasticities fits the observations. The “adjusted coefficient of determination”, representing the fit between production function and data is between 0.96 and 0.99, which Kümmel and Lindenberger (2014) argue to be “quite good” (p. 13).

The most important result for the issue at hand is that output elasticities of energy are estimated to be much larger than is the case in neoclassical production functions. Additionally, it is pointed out that large changes in energy prices in the past (in particular during the oil crises of the 1970s) have not led to a strong decrease in its use. Kümmel (2011) argues that higher energy prices do not lead to a significant substitution of energy by other production factors.

[17] Compare to the explanation of neoclassical production functions and output elasticities in section 6.1.

Ayres (2003) and Ayres and van den Bergh (2005) come to very similar results. They also point out that the increasing use of energy has been a crucial prerequisite for increases in labour productivity. They further distinguish the use of "raw energy" and "useful work"[18], and is shows that economic growth can be empirically explained when using the latter concept.

2.2.3.4 Implications for Economies Without Growth

Georgescu-Roegen's work on the relationship between the entropy laws and the economy, combined with his and Daly's analytical framework constitute the key foundations for ecological economics. The analytical frameworks point out that economic activities depend on the input of natural resources, namely stocks (in Georgescu-Roegen' view) or throughput (in Daly's view). The entropy laws indicate that the supply of these resources is limited. The conceptual and empirical works by Ayres, Kümmel, Warr and others have further elaborated on the point that the input of energy has played a central role for economic growth in the past. Because the substitutability between physical capital and energy is argued to be low, and because the feasibility of harvesting sufficient renewable energy is restricted by the amount of necessary infrastructures needed, ecological economists often take a more pessimistic stand concerning the feasibility of sufficient decoupling.

2.2.4 Major Differences

Environmental and ecological economics start with different preanalytic visions of the relationship between the economy and the environment. The former regards natural resources as one production factor, next to labour and physical capital. Based on the way production functions are constituted, the production factors tend to be treated as having similar features. In particular, they are argued to be substitutable. Additionally, all three can be augmented due to technological change. These two strategies allow for a reconciliation of economic growth and environmental goals under the right set of policies.

Ecological economics on the other hand starts from the preanalytical vision that economic activities take place within an ecosystem that has limited capacities to supply resources and absorb emissions. This approach emphasizes specific characteristics that differ between the dif-

[18] Useful work is a physical concept that relates to the concept of available energy, developed above. Useful work describes all physical work (including electrical energy but also work done by animals) conducted in an economy (Ayres, 2003). The great majority of useful work requires the use of available energy (Ayres, 2003).

ferent production factors. The production factors are therefore regarded as very different in nature. In particular, fossil fuels are argued to be unique it their ability to deliver useful work in a concentrated form. The specific characteristics lead to a pessimistic view on the substitutability between the factors. This concerns both the substitution for a given state of technology as well as the feasibility of developing new technologies with strongly altered relations between the production factors.[19]

As a result, environmental economics are more optimistic regarding the feasibility of decoupling economic growth and environmental aspects. In the following section, these theoretical considerations are combined with empirical scenarios to discuss the issue of decoupling.

2.2.5 The Crucial Question: Decoupling and Green Growth

Decoupling is probably the most debated issue concerning the question whether economies should grow in the future. There are different types of decoupling. Relative decoupling takes place when the environmental impact per unit of output decreases. Absolute decoupling means that the total environmental impact declines over time, while the economy grows. The crucial question concerning environmental sustainability, however, is whether economic growth and its environmental impact can *sufficiently be decoupled*, so that environmental goals can be achieved (Santarius, 2015b).

The concept of decoupling is therefore closely related to green growth. Growth can be green, that is, environmentally sustainable, when a sufficient decoupling takes place: “Green growth means that environmental and economic objectives can be combined by decoupling environmental pressures from aggregate output at a sufficiently rapid pace” (Antal and van den Bergh, 2016, pp. 1 – 2).

The issue of decoupling is in the following discussed using the concepts and insights of the last three sections on sources & sinks, analytical frameworks and qualitative relations. First, some findings on necessary decoupling rates are summarized and put into relation with past experiences. Second, the analytical frameworks and qualitative relations from sections 2.2.2 – 2.2.4 are used to discuss technical strategies and obstacles to decoupling. Finally, the implications for economies without growth are described.

2.2.5.1 Necessary Rates of Decoupling

In section 2.2.1, several crucial environmental issues have been pointed out. In the following, the case of climate change is discussed, “as this is

[19] The neoclassical theories in part II are closely related to environmental economics. The Marxian theories in part IV are clearly connected to ecological economics. For the Keynesian theories in part III it is less clear.

perhaps the most important as well as the most difficult-to-solve environmental problem, meaning that it may imply the most severe limit to growth – if there are any such limits" (Antal and van den Bergh, 2016, p. 2). Two studies calculate the necessary decoupling rates of economic growth and climate emissions rates in coherent manners. Jackson (2009a) calculates them for four scenarios with different assumptions concerning the developments of population and per capita growth. The second contribution is conducted by Antal and van den Bergh (2016), who calculate only two scenarios with different growth rates. Here the latter results are used, because their calculations are more recent and use the insights from the IPCC as foundation.

Antal and van den Bergh (2016) calculate the necessary changes in emissions per unit of GDP, in order to reach the 2 °C target "with a probability of more than 66%" (p. 2). If per capita income increases on average by 1.5% per year, emissions intensity needs to decline by 81% between 2013 and 2050, which implies an annual decrease of 4.4%. If average per capita income stays constant, emissions intensity has to decline by 67%, which means a 2.9% decrease per year.

Antal and van den Bergh (2016) point out that annual reductions of 4.4% would represent a strong change compared to past experiences. Average reductions between 1970 and 2013 have only been 1.5% and the rate of 4.4% has not been reached in any year in that period. Additionally, they give several reasons why these reductions probably do not even suffice (see Antal and van den Bergh (2016, p. 3)).

These calculations refer to the global scale. Many argue though that early industrialized countries have a higher responsibility to decrease their emissions than other countries. The reason is that they have emitted more over the past two centuries and still have higher levels of per capita emissions. Also, it is argued that economic growth in countries with lower incomes can still contribute to well-being, while it does not in high-income countries (Victor, 2008). As consequence, the rates of decoupling in high incomes countries would have to be even above 4.4%.

2.2.5.2 Strategies and Obstacles

So much for the numbers. The subsequent question is what the theoretical insights from sections 2.2.2 – 2.2.4 can contribute to analysing the feasibility of achieving sufficient decoupling. In the framework of *scale, composition and technology*, reductions are separated into three types of effects. Additionally, it has been argued that the technology effect can be divided into a substitution and a factor-augmenting effect. The feasibility of each of the three effects due to composition, substitution and factor augmentation are discussed in turn.

a Composition of outputs
The analysis that a change in composition of outputs can decrease average emission intensity has already been formulated in the first wave of discussions on economic growth and environmental aspects in the 1970s: "[O]ne of the ways in which other inputs can be effectively substituted for nonrenewable resources is by a change in the composition of real output to include fewer resource-intensive goods and more of other goods" (Solow, 1978, p. 6).

The argument from environmental economists is as follows: When an increasing share of production takes place in the form of clean rather than dirty production, emissions decline. As increases in labour productivity are mainly due to more efficient technologies, labour productivity can increase in clean sectors as it does in dirty sectors.

The major reason why this does not work from the perspective of ecological economics refers to the discussions on the role of energy. Changing the composition from dirty towards clean sectors would in fact decrease emissions only once. In the (hypothetical) resulting economy, consisting of (almost) only clean sectors, these clean sectors would have to grow in order to generate overall growth. From the perspective of ecological economics, there are two possible outcomes of this situation. Either it is not possible to increase labour productivity in these sectors, due to the type of economic activity performed (Jackson and Victor, 2011). Or it is possible by using increasing levels of energy in the sector, which would lead to economic growth but also increase emissions (Wölfl, 2003). The reason is that increases in labour productivity always depend on the additional use of energy.

An insightful way of investigating this issue is by looking at ecological economists' analysis of historical developments. Kümmel (2011) argues that the sectoral switch from industrial to service sectors throughout the 20th century was primarily a switch concerning monetary GDP and employment, accompanied by a rise of the energy used in the industrial sector. The process constitutes a substitution of labour by energy in the industrial sector, while the spare labour has been employed in the service sector. This shift of labour has enabled the service sector to grow. From this point of view, a sectoral change towards the (cleaner) service sector, combined with a strong reduction in energy use in the industrial and agrarian sectors, would therefore entail a strong shrinkage of the industrial sector and only mild growth in the service sector (Kümmel, 2011).

b Substitution of production factors
The second decoupling strategy of is to use fewer natural resources and instead rely on other production factors. The feasibility of facilitating

economic growth in this manner is discussed for the other two production factors – physical capital and labour – in turn.

Environmental economists argue that a sufficient increase in prices of natural resources would lead to a substitution of natural resources by other production factors. The major candidate for substitution is physical capital (Groth, 2007). The reason is that increasing the amount of labour does not facilitate continuous per capita growth.

Several mechanisms counteract the substitution of natural resources by physical capital from the perspective of ecological economics. First, physical capital consists per definition of natural resources (Daly, 2011).[20] Second, natural resources are used in the production process of physical capital (Daly, 2011). These two mechanisms imply that increasing the amount of physical capital also tends to increase the use of natural resources. Third (and most importantly), the application of physical capital is in most cases dependent on the use of energy and the production of energy involves the use of natural resources. Generally speaking, physical capital is not primarily a substitute, but a complement of natural resource use: the "substitutability is trivial compared to the overwhelming complementarity that must necessarily exist between that being transformed (resource) and the agent of transformation (capital)" (Daly, 1990, p. 3).

Facilitating economic growth by substituting natural resources with labour is even less plausible within the framework of ecological economics. According to Braverman (1998), technological change in the past was marked by a substitution of labour with a combination of physical capital and natural resources (in particular energy). The fact that such a substitution has proved to be feasible in the past suggests that it might be feasible to reverse the process, that is, to use more labour and fewer natural resources and physical capital in the future. This would, however, imply a *decrease* in labour productivity. Hence, it would not facilitate economic growth per capita, but just the opposite, decreasing production per capita (assumed that labour per capita does not change significantly).

A slightly different argument refers to the substitution of some natural resources by others. For example, coal has been substituted by oil, and more recently biofuels have partly substituted fossil fuels. Though such substitutions often lead to new environmental problems: "Efforts to relieve one environmental pressure may create or strengthen another. For exam-

20 According to Zinn (2015), this is why there are only two production factors, namely labour and natural resources. Physical capital is an outcome of applying the two.

ple, trying to reduce GHG [greenhouse gas] emissions through biofuels can contribute to biodiversity loss" (Antal and van den Bergh, 2016).[21]

The issue of renewable energy is of special importance. Ekins (2000) argues that renewable energy can solve the issue of climate change by substituting fossil energy. The use of renewable energy also makes sense within the perspective of ecological economics, as one form of energy (fossil energy) is substituted by another form (renewable). At the same time, there are also counterarguments from ecological economists on whether this effect can facilitate sufficient decoupling. This strategy represents the idea discussed above, in which physical capital replaces natural resources. But the construction of such physical capital (windmills, solar panels etc.) requires both material inputs and energy (Paech, 2012). This is why the relation between energy necessary to put in and the energy received (the "Energy Return to Energy Invested" (Santarius, 2015b, p. 83)) is lower for renewable than for fossil energies. Whether the implementation of renewables is able to lead to sufficient absolute decoupling remains an open question.

c Augmentation of production factors

A central concept in neoclassical theories is that the productivity of a production factor can be increased – or augmented – due to technological change. As result, production takes place due to the same production function, only that the contribution of the same amount of the augmented factor counts as if its amount had increased (see part II and in particular sections 6.1 and 8.1).

Many neoclassical theories explain a large part of the increases in labour productivity due to labour-augmenting technological change (see chapters 6 and 7). But also the feasibility of green growth depends on resource-augmenting technological change (see chapter 8). Augmentation of production factors constitutes an important reason for an optimistic view regarding decoupling.

Factor-augmenting technological change therefore leads to two manners how economic growth can be reconciled with decreasing use of natural resources. Both are related to the aforementioned issue of substitutability. First, labour-augmenting technological change implies a higher supply of effective labour and therefore increases in production. Depending on the size of augmentation and the substitutability between labour and natural resources, the usage of natural resources can be decreased.[22] Second, resource-augmenting technological change can reconcile economic growth with strong decreases in the use of natural resources even when substi-

21 See also (Victor, 2008, pp. 107 – 111).

22 This logic is represented in scenario II in chapter 9.

tutability is low. The augmentation of natural resources increases their effective supply, so that their supply in material units can be decreased despite growing production.[23]

Ecological economists on the other hand argue that the feasibility to have such factor-augmenting technological change is very limited. Per capita economic growth of the past is explained by increases in energy inputs, or more precise, by useful work. It is therefore not possible to increase the output of goods and at the same time decrease the input of useful work. It is possible, however, to improve the "conversion efficiency" (Ayres and Warr, 2005, p. 198) of exergy inputs into useful work. These types of increases are limited in two aspects. It is principally limited when conversion efficiency approaches one, meaning that the full potential useful work of an exergy input is converted into useful work. On a more practical base, there are many technical obstacles that need to be overcome, in order to increase the conversion efficiency to such a degree (Ayres and Warr, 2010). A further argument refers to the common economic idea of low hanging fruits: "efficiency follows a law of diminishing returns: the first gains in efficiency are usually cheap, but every further incremental gain tends to cost more, until further gains become prohibitively expensive" (Heinberg, 2011, p. 11), see also (Antal and van den Bergh, 2016, p. 4). Both technically as well as politically, the easiest changes are undertaken first, making reductions in emission-intensities of the scale necessary unlikely.

d Social-political considerations

It is noteworthy that the discussion on decoupling also takes into account non-technical issues on the feasibility of decoupling. Three aspects seem most critical. First, it is argued that strong economic and political interests oppose the necessary changes for strong decoupling (Santarius, 2015b). The second argument is related: There are inertia and lock-in effects, most importantly investments in infrastructure. "Early retirement or retrofit of existing infrastructures on a large scale" (Antal and van den Bergh, 2016, p. 4) are needed, which goes against investors' interests and implies major social struggles, for example due to job losses.[24] Third, strong behavioural change by both consumers and producers is needed, but these groups do not always respond rationally to price incentives. Therefore, strong environmental policies based on market principles may not be enough to trigger the necessary behavioural changes (Antal and van den Bergh, 2016). It is important to note, though, that the same

[23] This logic is represented in scenario III in chapter 9.

[24] See section 3.6.2 for further elaboration on the issue of disinvestments.

obstacles (and maybe even more so) also apply to the introduction of economies without growth.[25]

2.2.5.3 Implications for Economies Without Growth

It has been shown that the necessary rates of decreases in emission intensities to achieve internationally accepted climate goals are far higher than those experienced in the past. The debate on whether such rates of decoupling are feasible is ongoing, with contrary perspectives and arguments from environmental and ecological economics. A decisive question concerns the extent to which renewables energies are able to substitute fossil fuels and whether the application of renewables leads to other environmental problems. Regarding the size of the challenge and the controversy of the debate, the conclusion of Antal and van den Bergh (2016) seems appropriate:

> Our analysis does not prove that green growth will surely be infeasible. The conclusion is that key climate targets are unlikely to be reached if economic growth continues on a global scale. Therefore, even a minimal consideration of the precautionary principle requires being open to stringent climate policies that may result in low or even negative growth (Antal and van den Bergh, 2016, p. 7).

But even when economies do not grow, large reductions in emission intensities are necessary to achieve environmental goals (as argued above). Therefore, all the strategies and policies put forward by environmental and ecological economics to decrease emissions per unit of production are also relevant for economies without growth.

2.3 Stationary State and Secular Stagnation

In public debates, ongoing exponential growth is usually regarded as normal: “Everything less than exponential growth often seems interpreted as a fairly bad outcome and associated with economic stagnation” (Groth et al., 2009, p. 215). The same is true for the economics profession: “Mainstream macroeconomic theory is profoundly oriented towards an assumption of continuous, exponential GDP growth” (Pirgmaier et al., 2010, p. 1). Contrary to this view, high growth rates of per capita income is a historical exception however, as we have seen above.

Discussions on automatic ends to economic growth have come in waves. Classical economists analysed that economic growth is a historically tem-

[25] This issue is discussed in detail in parts IV and V.

porary phenomenon and will therefore come to an end (2.3.1).[26] Another wave of discussions took place under the label *secular stagnation* after the Great Depression in the 1930s. After the recent Great Recession following the Financial Crisis in 2007/2008, these discussions have gained renewed attention. At the same time, there are also various authors who have written on the subject independent from these crises. The arguments are categorized into two sections with arguments relating to the supply side (2.3.2) and the demand side (2.3.3).[27]

2.3.1 Classical Theories

Remarkably, all major classical economists have some notion of the stationary state. In the literature the sole debate is on whether they saw an end to economic growth as inevitable and when it was going to happen. There are differences in emphasis though: Smith focusses on the role of the division of labour (2.3.1.1), Malthus on population (2.3.1.2) and Ricardo on distributional aspects (2.3.1.3). While they draw a negative picture of the end of economic growth, Mill argues that certain policy measures can lead to high social welfare in the stationary state (2.3.1.4). The section concludes with a discussion on the relevance of their contributions for economies without growth (2.3.1.5).

2.3.1.1 Smith

Adam Smith is considered to be one of the most important early thinkers of modern economics (Samuels et al., 2003). Although Smith did not use the terminology of economic growth, he wrote extensively on the subject. According to Johnson (1997) “Smith could very well be called the first growth theorist” (p. 1). He also wrote on the stationary state of the economy and considered it to be problematic (Luks, 2013). First his growth theory and then his analysis of the stationary state are explained here.

Smith was one of the first who developed a comprehensive analysis of the flows of goods and money in an economy. Based on this economic understanding, he developed a theory on what determines the size of production and its growth (Samuels et al., 2003). Krelle and Coenen (1988) argue that in modern terms, Smith’s determinants of the size of production are labour productivity ($\frac{Y}{L}$) and the labour force participation rate

26 Marx, also considered a classical economist, is not included here but rather in part IV.

27 Keynes’ analysis on long-term stagnation is not included here but rather in chapter 10.

($\frac{L}{B}$). Y is total production, L is the number of workers and B is the total population. Hence, total production can be depicted by the equation

$$Y = \frac{Y}{L}\frac{L}{B}B. \tag{2.10}$$

Per capita income depends primarily on labour productivity and the labour force participation rate. For Smith, the growing division of labour is the main reason for increases in labour productivity: “The greatest improvement in the productive powers of labour [...] seem to have been the effects of the division of labour” (Smith, 1998, p. 17). Capital accumulation facilitates a higher degree of division of labour: “As the accumulation of stock must, in the nature of things, be previous to the division of labour, so labour can be more and more subdivided in proportion only as stock [of capital] is previously more and more accumulated” (Smith, 1998, p. 361). Capital accumulation is also necessary to increase the labour force participation rate. More physical capital needs more workers and hence increases the number of workers (L) (Samuels et al., 2003). In addition to capital accumulation, market size plays an important role. With increasing market size, a higher degree of division of labour and labour productivity can be attained (Kurz and Salvadori, 2003).

Smith argues that average income can and should increase in the medium and short term and that this leads to increases in living standards for the majority of people. The central argument is as follows: Firms accumulate capital to increase their production (to make profits). This increases the demand for workers who are needed to operate the physical capital. Higher demand for workers increases wages, which decreases profits and hampers capital accumulation. At the same time, the higher wages lead to population growth. The lower capital accumulation and growing population leads to lower demand and higher supply of labour and therefore to a reduction in wages. This once again increases profits, which starts a new round of fast capital accumulation and the cycle of events starts anew (Reuter, 2000).

In the long run, economic growth will come to an end in Smith’s analysis:[28]

[28] There is a debate on whether Smith argued for the necessity of an arrival at a stationary state or not. There are also passages in his work that can be interpreted in the opposite direction. According to Luks (2013), Smith’s analysis suggests that economic growth is a temporary state that can last for a long time but will come to an end at some point. Other authors come to the conclusion that “[t]here are no clear and obvious limits to growth” (Kurz and Salvadori, 2003, p. 6) in Smith’s analysis.

> In a country which had acquired that full complement of riches which the nature of its soil and climate, and its situation with respect to other countries, allowed it to acquire; which could, therefore, advance no further, and which was not going backwards, both the wages of labour and the profits of stock would probably be very low. In a country fully peopled in proportion to what either its territory could maintain or its stock employ, the competition for employment would necessarily be so great as to reduce the wages of labour to what was barely sufficient to keep up the number of labourers, and, the country being already fully peopled, that number could never be augmented. In a country fully stocked in proportion to all the business it had to transact, as great a quantity of stock would be employed in every particular branch as the nature and extent of the trade would admit. The competition, therefore, would everywhere be as great, and consequently the ordinary profit as low as possible" (Smith, 1998, p. 136).

Three arguments are central in Smith's analysis on how economies enter into a stationary state: First, the "soil and climate" is a limiting factor to production. Second, economic forces are responsible for the end of growth. Increases in productivity are due to division of labour. But the possibility of continued division of labour seems limited (Luks, 2013). When each sector of the economy ("every particular branch") has reached the highest capital stock and the highest degree of division of labour possible, productivity increases come to an end. In current terminology, one would say that productivity growth is technologically restricted. Finally, the "nature of its [the country's] laws and institutions" such as the relation to other countries and property rights determine the level of the "full complement of riches" (Smith, 1998, p. 136).

The stationary state is marked by low profits, low wages and high rents. With increasing production, investments become less profitable and profits decrease. Assuming there is a surplus supply of workers in the long run, this leads to a worsening bargaining position for workers and decreasing wages. The land owners obtain an increasing share of income (Smith, 1998).

Economic growth per capita is hence primarily limited because of the limits to increases in the division of labour and hence labour productivity ($\frac{Y}{L}$). Population (B) growth is limited because at some point a country is *fully peopled* due to territorial boundaries. And the labour force participation rate is limited if only because it cannot be higher than 1. In conclusion, Smith's analysis of the stationary state depicts a technological optimism in the short and medium run but a technological scepticism in the long run.

2.3.1.2 Malthus

The prominent contribution of Malthus' work does not regard growth theory but rather his analysis on the relationship between economic growth and population growth. The main argument states that the production of food grows in principle linearly (arithmetically) while population grows exponentially (geometrically): "Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio" (Malthus, 1872, p. 4). This means that any increase in production will not lead to higher income per capita but to population growth.

Population is limited by the availability of food. According to Malthus (1872), this is due to two mechanisms: (1) The foresight of limited food supply leads people to have fewer children. (2) If there are more people than can be fed, the mortality rate rises. In the first version of Malthus' *Essay*, he argued that prospects of preventive checks were very low (Luks, 2013). According to Gilbert (1993), in the later versions, Malthus became more optimistic regarding this issue and the pessimistic view was "replaced by shades of cautious hopefulness" (p. xviii).

According to Hollander (1997), Malthus' work entails passages supporting the view that he argued for continuous economic growth (and in case of successful population control also continuous per capita growth), but also passages leading to the opposite conclusion. On the one hand Malthus writes that "[n]o limits whatever are placed to the productions of the earth; they may increase for ever and be greater than any assignable quantity" (Malthus, 1872, p. 8). The linear growth of production can continue infinitely. On the other hand, there is the "notion that, as population density rises, so per-capita output and real wage fall, ultimately leading to stationariness of population" (Hollander, 1997, pp. 27 – 28). In this view, there are diminishing returns to labour on a limited amount of land. This is why per capita output decreases and the population that can be sustained by production is limited.

2.3.1.3 Ricardo

While Smith's prominent topic is the explanation of economic growth (due to division of labour) and Malthus' primary subject is the role of population growth, Ricardo's emphasis is on the role of factor income distribution: "To determine the laws which regulate this distribution, is the principal problem in Political Economy" (Ricardo, 1821, paragraph F.3). His argument is a combination of Smith's and Malthus' theories, with an emphasis and rigorous analysis of the role of distribution combined with limited access of land (Kurz and Salvadori, 2003).

Income is distributed among the three production factors capital (profits), labour (wages) and land (rents). Apart from temporary fluctuations, wages are constantly at the subsistence level: “The natural price of labour is that price which is necessary to enable the labourers, one with another, to subsist” (Ricardo, 1821, paragraph 5.1). If wages are above subsistence level, population growth leads to an increase in labour supply and a decrease in wages (similar to the arguments by Smith and Malthus).

Ricardo (1821) assumes that different areas of land can be used with different productivity. The rents for the land depend on how productive it can be used. The productivity of the least fertile land is the reference point. The owners of the more fertile land receive the difference in production as rent. Therefore, with increasing levels of production and population in a country, the rent share (of national income) increases. With a given level of real wages and an increasing rent share, profits necessarily have to decrease over time.

Ricardo also regards capital accumulation as the prime reason for increases in production (Luks, 2013). With decreasing profit rates, capital accumulation needs to slow down and eventually come to a halt. In this stationary state, wages are at a subsistence level, profits are small and rents are high: “[A]lmost the whole produce of the country, after paying the labourers, will be the property of the owners of land and the receivers of tithes and taxes” (Ricardo, 1821, paragraph 6.29).

2.3.1.4 Mill

Mill (2004) used a similar analytical framework as his predecessors, extended the analysis by various aspects (in particular on technology, innovation and investments) (Samuels et al., 2003) and is often regarded to have finalized the classical framework of economics (Reuter, 2000). As with the other classical economists, Mill argues that the growth of national income must come to an end due to the mechanisms related to decreasing returns to land use and population growth (Reuter, 2000).

Contrary to the other classical authors, Mill (2004) develops a positive perspective on the stationary state however. He argues that under certain conditions, the stationary state can be marked by high levels of welfare. Two conditions are central: decreasing population growth and low inequality (Joelsohn, 1952). In Mill’s words: “[W]hat is economically needed is a better distribution, of which one indispensable means is a stricter restraint on population” (Mill, 2004, p. 190). The reasoning behind the two claims is rather simple: If total production is restricted due to natural limitations, a lower number of people and a relatively equal distribution will lead to high material welfare for a large majority of the population.

According to Mill, population control does not require strict governmental controls or altruistic behaviour. Instead, it can be the outcome of behaviour due to personal interests, while societal institutions are important for shaping the incentives to have many or few children (Mill, 2004). Low inequality can be achieved by various political measures, most importantly progressive taxation and social spending for the poor (Joelsohn, 1952).

With these quite heavy but at the same time simple political measures, Mill transforms Ricardo's negative perspective on the stationary state (with low incomes for the vast majority of people and high inequality) to a positive vision (with high incomes for the majority people and low inequality). He even goes further and argues that in this state people can move their attention from the economic struggles towards other – more enjoyable – activities in their lives. His overall very positive perspective is depicted well in the following quote:

> Under this twofold influence [population control and low inequality], society would exhibit these leading features: a well-paid and affluent body of labourers; no enormous fortunes, except what were earned and accumulated during a single lifetime; but a much larger body of persons than at present, not only exempt from the coarser toils, but with sufficient leisure, both physical and mental, from mechanical details, to cultivate freely the graces of life, and afford examples of them to the classes less favourably circumstanced for their growth. This condition of society, so greatly preferable to the present, is not only perfectly compatible with the stationary state, but, it would seem, more naturally allied with that state than with any other (Mill, 2004, p. 190).

2.3.1.5 Implications for Economies Without Growth

It is striking that all prominent classical economists predict an end to economic growth, i.e., the occurrence of a stationary state. They also present arguments why this stationary state is supposed to happen. At the same time, one gets the impression that the necessity of the occurrence of a stationary state barely needs justification. For example, Mill writes: "It must always have been seen, more or less distinctly, by political economists, that the increase of wealth is not boundless: that at the end of what they term the progressive state lies the stationary state, that all progress in wealth is but a postponement of this, and that each step in advance is an approach to it" (Mill, 2004, p. 188).

There are two major reasons why classical economists predicted the stationary state and underestimated the feasibilities to increase production. First, their thinking was shaped and deeply anchored by how agricultural economies function. As the absolute limitation of the amount of land limits production in the agricultural, but less so in the industrial and service sector, classical economists underestimated possible growth potentials (Luks, 2013). Second, the effect of technological change was also underestimated. According to Reuter (2000), these points of criticism have discredited the classical analysis, so that their major line of reasoning has been rejected.

At the same time, various arguments and aspects of the classical views are to be found in more recent contributions to the debate on economies without growth. The argument for limits to growth due to limited land supply is similar to the recent discussions on peak oil and peak everything (see section 2.2.1). The argument that at some point every branch of industry is fully equipped with capital and no further increases in productivity will be possible is similar to recent debates on limitations to technological progress (see section 2.3.2). Finally, recent debates on how to shape a desirable post-growth or degrowth economy take up Mill's central arguments for a desirable stationary state: population control, redistribution and working time reduction (see chapter 3). In sum, classical economists have already discussed many of the ideas and concepts of current debates on sustainable economies without growth.

2.3.2 Supply Side Explanations

In supply side theories, the level of production depends on the availability of different production factors. Usually four factors are taken into account: The amount of physical capital (K), the amount of labour (L) and the amount of natural resources (R). Additionally, the factor technology (T) is added. It determines the productivity of the production factors. Production is determined according to the following general production function:

$$Y = F(T, K, L, R). \tag{2.11}$$

In the following, the arguments on secular stagnation from the literature are discussed along the lines of these factors. The discussion does not include natural resources, as there are almost no references to environmental issues in this literature.

2.3.2.1 Technological Change

Technological change is often seen as the most important determinant of economic growth per capita. In section 2.2 it was argued that increases in labour productivity due to technological change depend on increasing energy inputs. The following debate is not placed within such an analysis (of ecological economics) but instead argues for increases in labour productivity purely based on technological change (neoclassical economics). The most important argument is that recent innovations bring about fewer increases in labour productivity than the innovations of the past (a). Additionally, there are arguments on limited economies of scale (b) and decreasing productivity gains from research and learning-by-doing (c).

a Innovations

The central argument for decreasing growth rates regarding the role of technology is that recent innovations have not increased labour productivity as much as previous ones and that innovations in the near future will not do so either. Gordon (2012, 2014a,b) is a prominent advocate of this position. He argues that innovations in the capitalist process can be divided into three industrial revolutions:

> The first (IR #1) with its main inventions between 1750 and 1830 created steam engines, cotton spinning, and railroads. The second (IR #2) was the most important, with its three central inventions of electricity, the internal combustion engine, and running water with indoor plumbing, in the relatively short interval of 1870 to 1900. [...] The computer and Internet revolution (IR #3) began around 1960 and reached its climax in the dot.com era of the late 1990s (Gordon, 2012, pp. 1 – 2).

Gordon (2012) argues that the inventions made in IR #1 and #2 increased productivity much more than those of IR #3. This is due to the nature of inventions made. Those of IR #1 and #2 changed the functionings of the economy, the society and personal life more profoundly than those of IR #3. For example, in the production sphere the application of combustion engines increased labour productivity immensely. In the societal sphere, new modes of transportation (railroad, automobiles etc.) and new technologies associated with urbanization (sewage system, tower buildings with elevators) facilitated an entirely different and more productive organization of society. On an individual level, technologies such as the washing machine, central heating and refrigerators decreased the amount of household work and made it possible to increase average working hours in the sectors measured by GDP.

Two important arguments are brought forward, why IR #3 has increased productivity less. First, computers are only a small share of total capital goods (Sichel, 2001, p. 78). Second, product-innovations replaced existing products instead of adding new products to the consumer basket (Gordon, 2014b).

Gordon (2014a) argues further that future prospects of technological innovations are relatively predictable. Based on historic documents, he points out that past innovations have been foreseen (over several decades) and that therefore the predictions concerning future technological change can be taken as good measures as well. When examining the prospects of such innovations, he comes to the conclusion that they are unlikely to bring about high levels of labour productivity growth. Chancel et al. (2014) summarizes this point as follows: "The new information and communication technologies (NICTs) with their growth potential are harbingers of hope. However, despite the radical changes they have brought to our daily lives, their effect on economic activity is hardly visible in the statistics" (p. 2).

Gordon's view has been criticized by various authors (most prominently by Eichengreen (2014), Mokyr (2014) and Brynjolfsson and McAfee (2014)). They argue that high increases of productivity are likely to take place in the coming decades due to technological innovations – often related to the digital revolution or medical advances. For example, according to Eichengreen (2014), "[l]ooking ahead, it seems clear that the productive potential of robotics and the human genome, for example, have only begun to be realised. Evidence that we are learning how to use intelligent machines to replace first unskilled and eventually skilled labour suggests that we have a distribution problem, not a growth problem" (p. 42). Whether Gordon or his opponents are correct concerning future developments can of course not be answered.

b Economies of scale

Economies of scale are an important driver of economic growth (e.g., Krugman et al. (2009)). At the firm level, productivity can be increased due to fixed capital costs. Research into new production methods becomes profitable at higher production levels. But economies of scale also exist on the macro level. There are multiple efficiency gains from specialization on the production of certain goods for the world market (e.g., infrastructure, knowledge spill overs, learning-by-doing effects, etc.). Chancel et al. (2013) argue that economies of scale are limited, though: "[G]rowth rates have slowed down due to the exhaustion of the scale economies that were facilitated by the globalisation of trade from the 1980s and 1990s onwards" (p. 14).

c Research and learning by doing

Groth et al. (2009) take a closer look at the conditions under which new growth theories lead to *regular*, that is non-exponential growth. They point out two possible mechanisms in particular. First, research and development can lead to regular growth if the assumption (as often made in growth theories) of constant returns to human capital is dropped and instead decreasing returns are assumed. Second, learning by doing can generate regular economic growth under certain assumptions regarding the its effects and regarding and population growth. This is related to the argument of decreasing returns to education, see below.

2.3.2.2 Physical Capital

There are three major reasons why the accumulation of physical capital has slowed down over the past decades. These are the phasing out of reconstruction (a) and catching up (b) and decreases in investments due to demographic changes and government policies (c).

a Reconstruction

One important reason for the high growth rates of European countries after World War II has been reconstruction. At the end of the war, the levels of the capital stocks had fallen significantly and subsequent reconstruction was fast: "It is, thus, quite safe to place the end of the first phase of reconstruction and the beginning of a new era in the history of European economic growth in 1950." (Crafts and Toniolo, 1996b, p. 3). Maddison (2006) argues that its absence in subsequent decades was a major reason for declining growth rates.

b Catching up

Another central reason for high growth rates after the Second World War was a catching up to the technological state of the USA by European countries. This catching up went along with high investments in physical and human capital (Crafts and Toniolo, 1996a). Catching up has been one of the major causes for the high growth rates in the "golden age" (Maddison, 2006, p. 131) from 1950-1973 (see also Eichengreen (2008); Cohen (2009); Chancel et al. (2013)). The end of catching up is accordingly one of the reasons for lower economic growth after 1973: "It was inevitable that West European productivity growth would decelerate. In 1950–73, once–for–all opportunities for catch–up on the United States were available and were seized, and the rate of technical progress in the lead country (the United States) was then much faster than it has been since 1973" (Maddison, 2006, p. 131).

c Fewer investments

Hansen (1939) has prominently put forward the concept that a change of demographics also effects investments. As Hansen (1939) and more recently Krugman (2014) argue, there are two central effects. (1) An increasing population leads to increasing investments in order to build up the physical capital needed for the population's employment. (2) A stagnating and ageing population decreases the share of demand for housing because a sufficient number of houses already exists and because working-age people tend to build houses while older people do not. The housing sector and other goods demanded by working-aged people are more capital-intense than the products demanded by older people (in particular services in health and care). Due to these two effects, investments decline in ageing populations. Hansen (1939) argues that the only possible countervail could be a capital-deepening of production.

In recent debates, two additional arguments have been put forward. Eichengreen (2014) points out that investments in infrastructure – in particular by the government – have been low in the USA. According to Summers (2014a), the Great Recession has not only led to low growth rates in the short term but has brought the economy on a lower long-term growth path: "supply potential may eventually decline to the level of demand when enough investment is discouraged in physical capital, work effort, and new product innovation" (Summers, 2014a, p. 37).

2.3.2.3 Labour

Regarding the production function above, the more labour is supplied, the more goods are produced. Here the focus is on labour per person. There are two relevant aspects. First, the average working hours have changed and are predicted to do so in the future (a). Second, increases in the *quality* of labour are diminishing (b).

a Average working hours

Four developments have been important concerning the changes in average working hours, since the World War II. First, average working hours per worker have decreased. This effect has been much higher in Europe than in the USA (Maddison, 2006). Second, unemployment rates have risen significantly after 1973, leading to a lower labour participation rate (Maddison, 2006). Third, the participation rates of women have increased. According to den Dulk (2009), "[a]ll European countries are characterized by growing female activity rates" (p. 451) between 1975 and 2005. Fourth, the fractions of the population in working age have first increased and then started decreasing (Maddison, 2006).

The overall effect was that the hours worked per head of population have decreased in Western European countries from 1950 to 1998 significantly from 904 to 657 hours on average. In the Western Offshoots (USA, Canada, Australia), they stayed roughly the same, somewhere between 700 and 800 hours. Particularly in Europe, this trend is predicted to proceed, mainly due to an ageing population: "OECD potential growth rates moderate over the long term mainly for demographic reasons" (OECD, 2012, p. 199).

The driving force regarding future developments is the dependency ratio. Table 2.5 depicts its development for high-income OECD countries since 1960. It decreased continuously from the 1960s to the 2000s and started increasing only in the 2010s.

This development is predicted to continue. Johansson et al. (2012) forecast that the dependency ratio will be smaller for almost all OECD high-

Table 2.5: Dependency Ratios for High-Income OECD Countries 1960-2013

Time	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2013
Depend. ratio	60	57	51	49	49	51

Dependency ratio: Ratio of working to total population. Source: (World Bank, 2014), own calculations.

income countries in 2030 (compared to 2011) and in all of them in 2060. They come to the conclusion that "[p]opulation ageing, due to the decline in fertility rates and generalized gains in longevity, has a potentially negative effect on trend [economic] growth as it leads to a declining share of the working age population as currently defined (15-64 years)" (Johansson et al., 2012, p. 13).

The decrease of the share of the working population could be balanced out by one of the other factors mentioned. Unemployment is a possibility given the consistently high unemployment rates in Europe (Maddison, 2006). The participation rate of women is still below that of men in all countries and could therefore be another possible factor. At the same time, it is questionable whether it is possible, let alone desirable, to increase the average working hours of working-age people. The reason is that somebody also has to do the *reproductive work* – household work, caring for children and the elderly and various other activities outside the market (Netzwerk Vorsorgendes Wirtschaften, 2013). Therefore, in order to further increase the participation rate of women, either the participation rate of men or the average working hours per worker would have to decline. Both would not increase the average working hours. Therefore, the ageing of the populations of almost all countries relevant here is the driving factor concerning labour supply that makes economic per capita growth in the coming decades less likely.

b Education

Another aspect related to labour concerns education. As recent growth theories emphasize (see section 7.1), the quality of education of the working-population is of major importance for its productivity. Gordon (2014b) argues that the big effect of educating large shares of the population in high schools, universities etc. has been exhausted and no such (big) effects are to be expected in the future. Eichengreen (2014) points out that investments in education, mainly by the government, have been too low over the past decades and that this is the reason for less increases in productivity. A third argument states that economic circumstances for unemployed people are such that people who loose their jobs in a recession are unlikely to regain jobs in an economic recovery and stay unemployed persistently (Glaeser, 2014).

2.3.2.4 Implications for Economies Without Growth

In this section, several explanations for low growth rates in the recent past have been presented. The important result is that most of the reasons for low growth in the past, it is argued, will continue to exist in the future. Technological change is predicted to remain slow, labour supply to decrease, and there are no reasons to believe that investments or gains from education will rise. Hence, low growth should continue in future decades. These conditions are included in the analysis in part V.

2.3.3 Demand Side Explanations

Arguments relating limits to growth to the demand side concern mainly the size and structure of goods and services consumed. In demand side theories, the size of production primarily depends on the amount of goods and services demanded in an economy. Aggregate demand (Y) consists of three components: Consumption (C), investments (I) and government spending (G):

$$Y = C + I + G. \tag{2.12}$$

There are three important reasons why economic growth is expected to decline from a demand side point of view: Due to satisfied markets, increases in demand slow down (2.3.3.1); increasing inequality hampers consumption demand (2.3.3.2); and a shift of consumption towards goods from sectors with low productivity growth decreases economic growth (2.3.3.3).

2.3.3.1 Satisfaction of Needs

A central argument for limits to growth from a demand side perspective are the satisfaction of needs and a subsequent slow down or end of consumption growth. As argued in section 2.1.3, consumption is motivated by utility gains. When there are diminishing returns to consumption, these gains come to an end.

One central question is whether needs are finite or infinite. In traditional welfare economics, needs are unlimited, because once a desire is satisfied a new desire appears: "the tendency of an individual act of want satisfaction is to initiate a process of fulfilment which in turn seeks higher fulfilment or satisfaction, *ad infinitum*" (Swanson, 1956, p. 296). In a detailed discussion on the issue, Reuter (2000) argues for the opposite. Based on Maslow's famous theory on the hierarchy of needs (Maslow, 1943) he points out that it is plausible that needs are finite.[29]

Once basic needs are fulfilled, people have the possibility to choose against consumption and in favour of leisure or savings (Reuter, 2000). There are four arguments that are important for whether this possibility takes place or not. First, it is not possible to separate basic needs from other needs on a neutral basis, as needs always depend on the social context (Gronemeyer, 1988). Similarly, Leiss (1988) argues that "scarcity is a socially created condition that arises out of a particular organization of productive activity" (p. 29). In other words: Over time, luxurious consumption becomes standard and then a necessity (Scitovsky, 1992). Second, behavioural habits and time constraints additionally limit the ability to continuously increase consumption (Reuter, 2000). Third, conspicuous consumption can countervail a tendency to consume less (Veblen, 2007). Finally, commercials and marketing can induce people to consume more (Heller, 1984). According to Zinn (1989) the consumption rate is higher with commercials than it would be without.

In sum, the fulfilment of basic needs and continuous increases in consumption open up the possibility of an end to consumption growth and generates considerable reasons for it. At the same time, several countervailing mechanisms have been pointed out. The cumulative outcome depends on the combination of factors.

2.3.3.2 Increasing Inequalities

In the recent discussion on secular stagnation, several authors (e.g., Chancel et al. (2013), Krugman (2014) and (Summers, 2014b)) point out that increasing economic inequalities are one reason for low growth rates. The argument is based on Keynes' theory (see section 11.1). Higher levels of income inequality lead to a lower propensity to consume, because people with lower income consume a higher proportion than people with higher income.

A particular role (related to discussions in the USA) is attributed to debt-based consumption. Krugman (2014) argues that consumption will be lower in the coming years because consumer-loans are allocated less generously as an effect of the financial crisis of 2007/2008. Eggertsson and Mehrotra (2014) additionally point out that with increasing inequality, a decreasing share of people are able to acquire consumption loans.

[29] Original quote in German: "Mit Blick auf die Ergebnisse der Maslowschen Bedürfnistheorie erhält die These, daß der menschliche Bedürfniskosmos begrenzt ist, eine hohe Plausibilität" (Reuter, 2000, p. 378).

2.3.3.3 Tertiatisation

A related issue is the process of tertiatisation. This process describes the phenomenon that an increasing share of production takes place in the service sector (as opposed to the agricultural and the manufactured sectors). As the service sector depicts lower growth rates in productivity, this shift is associated with low growth expectations for the future (Chancel et al., 2013). The shift is usually explained by demand factors: “the growth of services’ real output shares has been mainly attributed to shifts in private domestic consumption, which is in turn claimed to be mainly sustained by a positive income effect” (Savona and Lorentz, 2006, p. 2).

Baumol (1967) and more recently Rowthorn and Ramaswamy (1997) argue that the slower increase in productivity in the service sector was the reason behind its increasing share in production in the first place. They point out that the consumption shares of products from the agricultural, industrial and service sectors are relatively constant, and labour productivity increases more slowly in the service sector than in the other two sectors. The increases in labour productivity led to decreasing prices of industrial goods. Due to the techniques of GDP calculation (see section 2.1.1), industrial goods therefore made up a declining portion of GDP. Therefore, “at constant prices (in contrast to its steeply falling current-price share), the share in GDP of value added by manufacturing in the advanced economies was roughly unchanged between 1970 and 1994” (Rowthorn and Ramaswamy, 1997, p. 3). Kümmel (2011) argues further that increases in labour productivity in the industrial sector have been facilitated by a substitution of labour by energy (compare section 2.2.3.3).

New studies differentiate between those parts of the service sector with high and those with low productivity increases (Wölfl, 2003). It is argued that future prospects for economic growth depend on which of these sectors is likely to increase. Service sectors with the potential to generate increases in labour productivity are argued to be also associated with high resource use, however. Hence, if they are to be regarded as a promising cause for future economic growth, they are likely to be problematic from an environmental point of view (Greenpeace (2014).

The explanation of low growth relating to tertiatisation can be summarized as follows: Due to technological change that facilitated a substitution of labour by energy inputs, labour productivity rose sharply in the agricultural and industrial sectors and far less in the service sector. With relatively constant shares of consumption, employment gradually shifted into the service sector. Due to the way GDP is measured, the decreasing prices in the agricultural and industrial sectors led to its decreasing relative value in GDP terms. Based on this reasoning, as long as consumption patterns do not change and the ability to substitute labour by energy in the service sector does not increase, economic growth rates will decrease further in the future.

2.3.3.4 Implications for Economies Without Growth

Major demand side reasons for the declining growth rates are satisfied needs, high economic inequalities and the process of tertiatisation. As for the supply side reasons, the respective authors predicted that these developments will persist in the future. One exception may be economic inequalities, which could be altered by appropriate economic policies (Cornia, 2003). These developments are also taken into account and discussed in part V.

Chapter 3

Existing Concepts on Economies Without Growth

Tim Jackson sometimes tells the following story in his speeches: His book *Prosperity without growth* was almost simultaneously published with Peter Victor's book *Managing without growth*. As they were apparently the only two economists working on the issue, they decided to collaborate in future research. Only later did they become aware that similar discussions were taking place under the label *degrowth* in Southern Europe and *Postwachstum* in German-speaking countries. A similar observation can be made in the German-speaking debate. There, only recently has the term degrowth become familiar. The comparatively independent developments of these discourses until recently is why Anglophone, Southern European and German-speaking discussions on the issue are treated separately.

Among the four concepts discussed here, the historically earliest concept on economies without growth[1] is the *steady state economy*. This emerged out of the first wave of discussions on limits to growth in the 1970s. Therefore, first this concept is discussed (section 3.1), followed by degrowth (section 3.2), the Anglophone contributions (section 3.3) and then the German-speaking discussions (section 3.4). It is important to note that the contributions within these concepts are very heterogeneous. The following descriptions attempt to give an overview of the dominant features of each concept, while not accounting for all their diversities. Also due to their diversity, it is not possible to depict a coherent set of conditions – neither for the single concepts nor for the literature on economies without growth in general – on how the resulting economies (and societies) would look like.[2] Consequently, section 3.6 entails a very heterogeneous collection of conditions for economies without growth.

1 This refers to *economies without growth* without the term *sustainable*. This is because the term sustainable has been defined in a very specific manner above. The following concepts nevertheless pursue similar goals as the ones outlined above.

2 The concepts steady state economy is an exception. It mainly has been formulated by one person, Herman Daly, which is why it is less heterogeneous.

3.1 Steady State Economies

The concept of steady state economies is closely associated with Herman Daly, as he has developed and written most extensively on the subject (Daly, 1974, 1987, 1990, 1991; Daly et al., 1994; Czech and Daly, 2004; Daly, 2005, 2008, 2011, 2014). While Daly defines the steady state economy slightly differently in various publications, the low and constant level of throughput is always essential. The steady state economy is defined "as an economy with constant population and constant stock of capital, maintained by a low rate of throughput that is within the regenerative and assimilative capacities of the ecosystem" (Daly, 2008, p. 3).

In the following, first the origins and central motivations of the steady state economy are outlined (3.1.1). Next, the relation between the steady state economy and economic growth is explained (3.1.2) and then the analysis of economic growth by steady state advocates is examined (3.1.3).

3.1.1 Origins and Motivations

The origins of discussions on steady state economies are closely related to the emergence of ecological economics. As the relation between economic activities and the environment has already been laid out in section 2.2, it is not repeated here.

In addition to environmentally motivated origins, various works criticize how the existing social and economic system impacts human well-being or other desirable features of human life. The argument of Veblen (2007) (see section 2.1.3) concerning conspicuous consumption has been taken up as a strong reason why further economic growth is at most a zero sum game. Research in social psychology (e.g., Fromm and Stein (1976)) argues on a fundamental level why the prevailing materialist nature of society is detrimental to human beings. Mishan (1975) and others point out that the negative effects of economic growth on social welfare now outweigh the benefits, most importantly due to negative externalities. Illich (1979) makes a strong case that the negative effects of central social institutions and technologies associated with the industrial society have overtaken the benefits from modern developments. Schumacher (1973) argues for an economic system without growth that is more appropriate for fulfilling (true) human needs. While this list is certainly not exhaustive, it illustrates the broad range of sources, feeding the emergence of ecological economics and the concept of a steady state economy.

Daly (1987) argues for environmental, ethicosocial and economic limits to economic growth. He gives four reasons for "ethicosocial limits" (p. 327): (1) Growth uses up resources that are subsequently not available to future generations, (2) growth leads to the decrease of biodiversity and the extinction of species, (3) growth becomes less desirable because welfare effects cancel each other out and (4) the "desirability of growth is limited by the corrosive effects on moral standards" (p. 328).

Daly (1991) further develops the concept of an "*economic* limit to growth" (p. 28). Based on the argument concerning the limited benefits of growth for humans, increases in stocks[3] (e.g., physical capital) have decreasing marginal benefits. On the other hand, growing stocks have increasing marginal costs on the environmental side. Therefore, at some point, the costs will exceed the benefits – even if benefits are still positive or natural resources are available. At this point, it is rational for a society to stop increasing stocks and transform the growth-economy into a steady state economy.

3.1.2 Relation to Economic Growth

The central attribute of the steady state economy is maintaining the amount of throughput at a sustainable level below the carrying capacity of the earth and stays approximately constant.

Daly's position concerning economic growth in the steady state economy is closely related to his perspective on the economy and the environment in general. In his preanalytic vision, there are stocks, throughput and services. Throughput needs to stay constant, the growth of stocks is very limited (as they need to be sustained by a constant flow of throughputs) and services can change in size. The whole concept of economic growth as measured in GDP is not part of this perspective on the economy. Throughput is a purely material concept. Stocks are people, physical capital and inventories and are therefore a physical concept as well. Services may be somewhat similar to GDP as both entail goods that lead to human utility. But the concepts are also very different, as Daly argues that economic activities can have negative services (in the case of environmental destruction) and services can be outside the realm of GDP (as all non-market activities). In sum, in Daly's analytical framework, GDP simply does not exist.

Daly argues that "we can define growth as increase in throughput" (Daly, 1996, p. 69) and "[d]evelopment can be defined as an increase in service" (p. 69). Growth hence refers to the physical concept of throughput, development to the quality and amount of services generated by the use of throughput. Economic growth from his point of view is a concept that measures a combination of growth and development and therefore complicates a fruitful analysis: " 'Economic growth,' growth in GNP, is a conflation of these two processes" (p. 69).

3 See section 2.2.3 for a definition of Daly's analytical framework including concepts of stocks, throughput and services.

This is why, Daly makes rather vague statements concerning the possibility to have positive economic growth (in GDP) in a steady state economy. First, he points out that the concept of a steady state economy does not talk about GDP: "Note that an SSE is not defined in terms of gross national product. It is not to be thought of as 'zero growth in GNP' " (Daly, 1996, p. 32). It seems that economic growth may be possible to some extent, but it is rather limited. At another point, he asks the question whether GDP may grow in a steady state economy and comes to the conclusion that "I think this [economic growth due to dematerialisation] should be pushed as far as it will go, but how far that is likely to be?" (Daly, 2008, p. 5). He then argues that growth is limited because even service sectors are bound to some material base.

Additionally, it is important to note that Daly sees the sustainable level of throughput far lower than its current level in the USA and other high-income countries. Therefore, "[w]hat is needed in the first instance are reduced levels of consumption" (Daly, 1996, p. 14). Combined with his scepticism concerning technological solutions, it makes it very unlikely that GDP can or should grow in these countries.

3.1.3 Explanations of Economic Growth

Daly (1987) argues that labour productivity has been able to grow due to an increasing energy coefficient. When this is prevented due to environmental reasons, growth comes to an end (Czech, 2013). This mechanism is argued to be based on the externalization of costs. The large use of natural resources is caused by its low market price, which in turn is due to excluding various social and environmental costs associated to it. If these were internalized, the use of natural resources would be limited to a sustainable level (Daly, 1991).

Authors who write about steady state economies do not explicitly point out the economic mechanisms that lead to economic growth. The availability of energy inputs is therefore a *prerequisite* for economic growth. But the *causes* (or in other words, *why* the possibility to substitute labour by natural resources has been utilized to expand production) for growth in production are not explained in a comprehensive manner. Instead, it is argued that economic growth is the central policy goal and is therefore pursued by governments: "Economic growth is currently the major goal of both capitalist and socialist countries" (Daly, 1991, p. 183). Daly points out that "[e]conomic growth is held to be the cure for poverty, unemployment, debt repayment, inflation, balance of payment deficits, pollution, depletion, the population explosion, crime, divorce and drug addiction". He calls this "growthmania" (p. 183). According to Daly (1991), the reason for the belief in economic growth is that mainstream economic theory does not take into account the material and environmental aspects of economic activity.

Therefore, it seems that the feasibility of growth due to the cheap availability of natural resources, combined with a belief in economic growth by economists and the pursuit of economic growth by policy makers is the explanation for economic growth itself.[4]

3.2 Degrowth

> Degrowth defies a single definition. Like freedom or justice, degrowth expresses an aspiration which cannot be pinned down to a simple sentence. Degrowth is a frame, where different lines of thought, imaginaries, or courses of action come together. We see this versatility as a strength (D'Alisa et al., 2014, p. xxi).

The term degrowth relates to three things: a type of analysis, a social movement and a political agenda. (1) "'Degrowth' became an interpretative frame for a new (and old) social movement where numerous streams of critical ideas and political actions converge" (Demaria et al., 2013, p. 191). This frame has been outlined in the former section by explaining the different sources of degrowth. In addition to being a frame, (2) "[d]écroissance has established itself in Southern Europe as a significant and heterogeneous societal movement" (Muraca, 2013, p. 147). The third important aspect of degrowth is that it is (3) "a potent political vision that can be socially transformative" (Kallis, 2011, p. 873).

3.2.1 Origins and Motivations

The "term décroissance appeared in the political and cultural arena of France in the early 1970s" (Muraca, 2013, p. 148). After experiencing some recognition in France in the 1970s and '80s, the term was used less in the '90s. It experienced increasing prominence in France again starting in 2001 (Demaria et al., 2013). In the following years, it soon spread throughout Southern European countries, in particular Spain and Italy. The discussions have been connected to English-speaking debates on *prosperity or managing without growth* some years later and to German-speaking discussions on *Postwachstum* in recent years.

There are several articles listing different intellectual sources of degrowth by now (Flipo, 2009; Martínez-Alier et al., 2010; Bayon et al.,

[4] In the introduction of this present study has been argued that there are few macroeconomic analyses within the literature on economies without growth that make use of traditional macroeconomic frameworks. This is true for steady state economies, as they refer to Daly's analytical framework (or more generally speaking to ecological economics).

2011; Muraca, 2013; Demaria et al., 2013). The following list of five central intellectual sources builds on the contributions by Flipo (2009) and Demaria et al. (2013):

(1) Ecology and bioeconomics: The idea that economic growth is compatible by decoupling it from environmental destruction is rejected. "Degrowth is therefore a possible path to preserve ecosystems by the reduction of human pressure over ecosystems and nature" (Demaria et al., 2013, p. 196). Furthermore, it is argued that ecosystems have value in themselves and that the most promising way to organize the use and maintenance of ecosystems is by the "*res communis* approach", meaning that ecosystems are "commonly cared for and shared so that appropriation by a single individual is avoided" (p. 196). These analyses build upon insights from ecological economics and bioeconomics.

(2) Development critique: In particular within economics, economic growth is often regarded as closely related or even synonymous to development. While many have criticized this view (e.g., Sen (1988b)), authors within the degrowth literature, most prominently Latouche (2009), build on other criticisms of development and go one step further: "The failure of development in the South and the loss of any sense of direction in the North led these thinkers [in particular Ivan Illich and Cornelius Castoriadis] to call into question the consumer society and its imaginary bases, namely progress, science and technology. This critique led to the search for a 'post-development"' (Latouche, 2009, p. 14).

(3) Well-being: There is a variety of reasonings why the current societal growth-orientation is detrimental for human well-being. Of central importance are the arguments that needs are satisfied in high-income countries and that the organization of modern economies hinders the development of having "meaning in life" (Demaria et al., 2013, p. 197).

(4) Democracy: Degrowth authors argue that current political systems have a low degree of democracy and that the necessary social-ecological transformation can only be achieved by extending democratic institutions (Muraca, 2014). A central intellectual figure is Castoriadis (1984) who "defended the ideas of 'self-institutionalising society' and of autonomy, meant as an entity that governs itself with its own laws" (Demaria et al., 2013, p. 199).

(5) Justice: Finally, it is argued that certain institutions are needed to decrease inequalities both within societies as well as between societies on a global scale. Decreasing inequality would improve well-being, facilitate a more egalitarian democracy (because power is more evenly distributed) and is necessary to give environmental space for development in the Global South (Demaria et al., 2013).

In sum, the intellectual sources of degrowth overlap with those of the steady state economy. At the same time, they are broader because aspects such as development critique or democracy are included.

Similarly, the motivations go beyond those of the steady state economy. Four aspects appear to be crucial. (1) Concerning the environmental dimension, the goal is not only to sustain ecosystems in order to facilitate human life for the future. Additionally, the preservation of environment (including animals) is regarded as an end in itself and a different human-nature relation is seen as the goal (Demaria et al., 2013). (2) Similarly, the understandings of human welfare differ. While the steady state economy often stays within the traditional economic analyses of welfare (income, employment, etc.), degrowth authors focus on aspects difficult to measure, such as social relations, human-nature relations or convivial work and living (e.g., Illich (1979) and Latouche (2009)). The degrowth literature also entails two additional goals. (3) Regarding societies of the Global North, it aims for a deepening of democracy (Muraca, 2013). (4) Looking at global aspects, it is argued that the Western model is not to be imposed upon other societies and that instead a multiplicity of cultures and institutions should be facilitated (Latouche, 2009).

3.2.2 Relation to Economic Growth

Degrowth implies an "equitable downscaling of production and consumption" (Schneider et al., 2010, p. 511). Economic shrinkage is a consequence of degrowth, it is not the goal: "The goal of sustainable degrowth is not to degrow GDP. GDP will inevitably decline as an outcome of sustainable degrowth, but the question is whether this can happen in a socially and environmentally sustainable way" (Kallis, 2011, p. 874).

There is some discussion on the question whether the term *a-growth* would be preferable over the term *degrowth* (van den Bergh and Kallis, 2012). The central argument in favour of a-growth is that economic growth should be seen as irrelevant. Instead, it is important to implement the necessary measures for environmental sustainability regardless of their impact on economic growth. Focusing on a downscaling of production and consumption instead of focusing on the environmental aspect could be cumbersome to achieve environmental sustainability (van den Bergh, 2011). Degrowth proponents on the other hand argue that a transformation towards environmental sustainability necessarily includes such a downscaling and that one should not avoid "calling things by their name" (van den Bergh and Kallis, 2012, p. 915).

The focus is thus not on shrinkage of GDP, but on a different organization of the economy (and the society) that also brings about a shrinkage of GDP (Kallis, 2015a). The question whether GDP will grow or shrink after this initial downscaling is not a vital question either. Based on the lines of argument of degrowth proponents and their strong references to bio- and ecological economics, it is plausible that the economy will also stay approximately constant after the downscaling.

3.2.3 Explanations of Economic Growth

To the best of my knowledge, there are very few analyses using macroeconomic reasonings within the degrowth literature on why the economy grows. Latouche (2009) touches upon the issue in his seminal book *Farewell to growth*. He says that societies are depicted by an "addiction to growth" and shortly refers to Karl Marx's theory of accumulation. He argues further that advertisements, credit creation and planned obsolescence play central roles for increasing consumption despite satisfied needs.

Bonaiuti (2014) discusses reasons for economic growth in a similar manner. As with Latouche, he refers to Marx's analysis and to the fact that companies retain profits for investments: "[P]art of the profits made by enterprises should be reinvested, thus increasing their endowment of capital, which then becomes the basis on which to make new products and hence new profits, [this] is the fundamental trait of the modern economy" (Bonaiuti, 2014, p. 23). He additionally criticizes neoclassical approaches and argues for different phases in capitalist development.

Kallis (2015a) further refers to the new debate on secular stagnation (see section 2.3) and in particular point out limits to growth due to environmental constraints. In the same book, Victor (2015) wrote a section on "Growth" (p. 109). He mentions Smith's emphasis of labour specialization (see section 2.3.1.1), Keynes analysis of aggregate demand (see section 11.1) and the contributions of Solow (see section 6.2) and endogenous growth theories (see chapter 7). Additionally, he points to the work of Ayres (see section 2.2). Victor (2015) does not explain these relations in detail though.[5]

3.3 Prosperity and Managing Without Growth

Several works from Anglophone countries are summarized here. The two most prominent authors are Tim Jackson and Peter Victor. Neither give an exact name to the economy they envision, nor do they define it precisely. Jackson's (2009a) positive concept is the "Cinderella economy" (p. 133), which does not require growth and instead focusses on "resilience [...] equality [...] work [... and] ecological limits" (p. 194). Victor (2008)

[5] As with the literature on steady state economies, contributions in the degrowth literature are seldom thoroughly based on traditional macroeconomic frameworks. There are some exceptions, which are discussed in the introductions of parts II – IV.

lays emphasis on facilitating happiness, staying within ecological limits, generating employment and decreasing poverty. Additional authors included here are Robert Skidelsky and Juliet Schor. These authors have collaborated in several instances on developing concepts for economies without growth (e.g.,Coote et al. (2013), Jackson et al. (2014)).

3.3.1 Origins and Motivations

Two origins and associated motivations are dominant within this literature, which are rooted within ecological and welfare economics. The issue that is put forward and discussed most often is that economic growth is incompatible with environmental sustainability. Jackson's (2009a) argument that the necessary increases in resource efficiency are implausible is cited by many authors. The second central aspect is the connection between economic growth and social welfare, referring to the arguments as lined out in section 2.1.3. Both such arguments are presented throughout the literature (e.g., Victor (2008); Jackson (2009a); Schor and White (2010); Skidelsky and Skidelsky (2012); Chancel et al. (2013)).

A third (less dominant) argument is that economic growth does not match up to its promises. It is argued that economic growth is usually seen as a means for decreasing poverty, reducing inequalities, improving environmental quality, preventing unemployment and/or increasing happiness or well-being. These goals are barely or only partly achieved however (Victor, 2008; Jackson, 2009a; Skidelsky and Skidelsky, 2012).

3.3.2 Relation to Economic Growth

The contributions from Anglophone authors suggest that sustainable economies should operate with zero or low rates of economic growth. Jackson (2009a) and Victor (2008) both argue that it is necessary to manage or create prosperity *without growth*. Victor argues for very low growth in the Canadian economy. Jackson starts his explanation of a positive vision for a future economy by saying "[l]et's forget for a moment about growth" (p. 194). He further argues that in this economy little or no increases in labour productivity would take place. This implies an economy with zero or low rates of economic growth. Skidelsky and Skidelsky (2012), on the other hand, take the a-growth perspective that "for the wealthy nations of the world, GDP should be treated as a by-product of policies aimed at realizing the good life. Only experience will show whether the GDP outcome is positive, negative or stationary" (p. 4).

3.3.3 Explanations of Economic Growth

The most explicit and elaborated theories on economic growth that have been put forward within the Anglophone literature on economies without growth have been developed by Jackson and Victor. In Victor's (2007; 2008) model, economic growth is determined by aggregate demand, consisting of consumption, investments and government expenditures. Increases in labour productivity are exogenously given. Changes in the components of aggregate demand are due to a mixture of endogenous mechanisms and exogenously given parameters. While Victor therefore bases his analysis on Keynesian analyses, his theoretical framework is rather simple (while his model is quite complex).

Jackson (2009a) argues that economic growth is the outcome of two distinct logics, one on the business and one on the consumer level. Businesses have a "profit motive: the need to increase the difference between revenues from sales and the costs associated with the so-called factor inputs: capital, labour and material resources" (Jackson, 2009b, p. 62). Jackson points out that companies invest in order to reduce costs and stay competitive. He further argues that "[e]fficiency drives growth forwards. By reducing labour (and resource) inputs, efficiency brings down the cost of goods over time. This has the effect of stimulating demand and promoting growth" (Jackson, 2009b, p. 62). How the reduction in consumer goods prices precisely stimulates demand and how this relates to a potentially decreasing wage income due to less employment is not explained however.

On the consumer side, an "iron cage of consumerism" (Jackson, 2009a, p. 102) spurs consumption. Individuals are inclined to increase consumption primarily due to "distinction", "social comparison" and "emulation" (Jackson, 2009b, p. 64). These mechanisms make sure that consumption demand goes hand in hand with increases in supply. Jackson thus develops a sophisticated theoretical framework by making use of primarily Keynesian and Marxian theoretical ingredients.[6]

3.4 "Postwachstum"

In German-speaking countries, there is an increasing debate on post-growth economies (Postwachstumsökonomien) and post-growth societies (Postwachstumsgesellschaften). Schmelzer (2015a) distinguishes between five different approaches within the German-speaking discourse: conservative, social-reformist, sufficiency-oriented, critical of capitalism and feminist.

[6] While their analyses use many arguments from these schools of thought, they are neither explicitly integrated into a macroeconomic theory. In fact, Jackson and Victor themselves repeatedly point out the lack of a good ecological macroeconomic framework and they work on developing one (Jackson et al., 2014).

Paech (2010) gives a clear definition of the post-growth economy. For him, a post-growth economy is one without growth in GDP which is characterized by stable supply systems that are accompanied by reduced levels of consumption.[7] Schmelzer and Passadakis (2011), on the other hand, put a stronger emphasis on social and democratic aspects. They define a post-growth economy based on solidarity as a steadfast social-ecological transformation of the modes of production and living, including a democratically organized reduction in production and consumption.[8] Seidl and Zahrnt (2012a) further argue for three central features of post-growth societies: (1) No policies are implemented that are intended to increase economic growth. (2) Areas, institutions and structures that are either dependent on or foster economic growth are transformed, so that they are no longer dependent on it. (3) Growth in the use of energy and resources is stopped and reduced to a sustainable level.[9]

In the following, the motivations (3.4.1), the relation to (3.4.2) and explanation of (3.4.3) economic growth are laid out. In the literature on post-growth, there is additionally a unique discussion on growth imperatives (3.4.4).

3.4.1 Origins and Motivations

The central motivations for German-speaking authors on Postwachstum are very similar as those in the Anglophone contributions. Their origins also lie primarily within ecological and welfare economic considerations.

Most important is again the incompatibility of further economic growth with environmental goals. Authors often refer to Jackson's calculations concerning necessary increases in efficiency (e.g., Schmelzer and Pas-

[7] Original quote in German: “Als ‘Postwachstumsökonomie’ wird eine Wirtschaft bezeichnet, die ohne Wachstum des Bruttoinlandsprodukts über stabile, wenngleich mit einem vergleichsweise reduzierten Konsumniveau einhergehende Versorgungsstrukturen verfügt” (Paech, 2010, p. 1).

[8] Original quote in German: “Eine solidarische Postwachstumsökonomie bedeutet eine konsequente sozial-ökologische Transformation der Produktions- und Lebensweise und eine demokratisch organisierte Reduktion von Produktion und Konsum” (Schmelzer and Passadakis, 2011, p. 67).

[9] Original quote in German: “Leitlinien für eine Postwachstumsgesellschaft: 1. Es findet keine Politik zur Erhöhung des Wirtschaftswachstums statt. 2. Wachs-
tumsabhängige und -treibende Bereiche, Institutionen und Strukturen werden umgebaut, so dass sie vom Wirtschaftswachstum unabhängig werden. 3. Das Wachstum des Energie- und Ressourcenverbrauchs wird gestoppt und der Verbrauch entsprechend den Nachhaltigkeitszielen zurückgefahren” (Seidl and Zahrnt, 2012a, p. 114)

sadakis (2011)). Paech (2005) argues on a theoretical basis, why the necessary level of decoupling economic growth from environmental aspects does not work. The second argument is again that economic growth does not foster well-being in high-income countries (e.g., Seidl and Zahrnt (2010b); Schmelzer and Passadakis (2011); Paech (2012); Schneidewind and Zahrnt (2013); Alexander (2014)). Also the third argument already familiar from the section on Anglophone contributions is once again brought forward. Seidl and Zahrnt (2010b) and Schmelzer and Passadakis (2011) point out that central goals associated with economic growth are not achieved within growth economies. These are, in particular, full employment, emission reductions, increasing social welfare and raising incomes of people at the lower end of the income distribution.

Authors on Postwachstum additionally point to many of the origins and motivations that steady state and degrowth proponents refer to. For example, Hanke (2012) engages in the discussion on (post-) development, progress and economic growth. Schmelzer and Passadakis (2011), von Braunmühl (2010) and Muraca (2014) discuss the role of democracy. Möhring-Hesse (2010), Schmelzer and Passadakis (2011) and Muraca (2014) take issues of justice into account. According to Brand (2014), questions of power and its distribution are seldom analysed however. In general, these issues are far less prevalent than the three mentioned before.

3.4.2 Relation to Economic Growth

There are different understandings on the relation between Postwachstum and economic growth within the literature, which resemble to some degree the discussion on degrowth vs. a-growth, laid out above. On the one hand, there are proponents who argue that economic growth rates have declined over the past and political discussions and policies should deal with the question of how the necessary social transformation can be managed based on low growth (Reuter, 2002).

Seidl and Zahrnt (2012a) also come to a conclusion along the lines of a-growth, namely that economic growth should neither be pushed nor prevented. Instead, in a post-growth economy, the dependence on economic growth is removed.[10] Their line of argument is different to Reuter's: Economic and social systems need to be made independent from economic growth, so that strong environmental policies become politically feasible

[10] Original quote in German: "In einer Postwachstumsgesellschaft wird die Abhängigkeit von Wachstum abgebaut. Das bedeutet auch, es gibt weder ein Wachstumsverbot noch ein Wachstumsgebot" (Seidl and Zahrnt, 2012a, p. 114).

and socially acceptable. The underlying assumption seems to be that such strong environmental policies reduce economic growth.

On the other hand, there are authors who argue that post-growth economies must entail zero or negative economic growth. Schmelzer and Passadakis (2011) point out that the economies of the Global North need to shrink out of environmental reasons. They combine this economic shrinkage with a gradual and fundamental change in the modes of production and way of life.[11] Similarly, Paech (2012) argues that a post-growth economy would result in a drastic reduction of industrial production.[12] He regards this as a chance to increase social welfare, as many activities that would disappear rather harm than serve welfare. Muraca (2014) states that economic shrinkage is unpreventable and that it must be reshaped.

3.4.3 Explanations of Economic Growth

Within the literature on Postwachstum, there is a diverse discussion on the causes for economic growth. Here, the discussion is categorized into five groups.

Similar to Jackson's argument, several authors analyse the role of competition and profit-making. Schmelzer and Passadakis (2011) argue that companies aim is to maximize profits and they do so by cost minimization, which often goes hand in hand with investments. Another reason for economic growth is that companies need to reinvest their profits in order to stay competitive. Exner and Lauk (2011), Schmelzer and Passadakis (2011) and Lange (2013) point out that companies are therefore forced to invest in cost reductions, as otherwise they are pushed out of the market by competitors. Both profit-making and competition therefore lead to high investments and subsequently to economic growth.

It is additionally argued that internal reasons induce firms to pursue an expansion of production. According to Posse (2015), larger companies have several advantages over smaller firms. First, average costs per unit are smaller for larger production when there are fixed costs (economies of scale). Second, larger companies have a reputation and can guarantee supply more securely, which makes them more attractive for costumers. Third, large companies acquire the ability to exercise power over suppliers of intermediate goods and political actors, so that they can improve their market conditions. Fourth, internationally acting companies can exploit

[11] Original quote in German: "[E]ine schrittweise grundlegende Veränderung der Produktions- und Lebensweise" (Schmelzer and Passadakis, 2011, p. 45).

[12] Original quote in German: "[Eine] Postwachstumsökonomie würde [...] auf eine drastische Reduktion der industriellen Produktion hinauslaufen" (Paech, 2012, p. 11).

differences in wage levels, taxes, environmental regulations, etc. between countries in order to lower their costs. Finally, both managers and employees may have monetary and social incentives for their company to grow.[13] All these aspects represent incentives for companies to expand their production level.

Increasing consumption is seen as a driving force of economic growth, and some even argue that it is the central cause (Røpke, 2010). As the argument goes, increasing consumption generates high company revenues, and the companies are therefore inclined to expand production. There are several arguments on why people continuously increase consumption, despite high levels of material well-being in high-income countries. In general, the idea that consumption increases utility due to the use of the product itself is criticized (Paech, 2012). It is often argued that people consume due to status considerations (e.g., Paech (2012), see also section 2.1.3) and because consumer aspirations rise with the experience of increasing consumption (Røpke, 2010).

Ax and Hinterberger (2013) point out that not only household consumption but also government expenditures constitute a part of consumption, with the same effects on profits, investments and economic growth. They argue that government expenditures only generate economic growth when they are financed by government debt and not higher taxes, as the latter reduce consumption by households and/or investments by firms.[14] [15]

3.4.4 Growth Imperatives

The literature on post-growth entails a unique discussion on growth imperatives. Growth imperatives are economic circumstances that bring about some highly undesirable outcome if the economy does not grow. Three of

13 For a good summary of the literature and several additional reasons for companies to grow see Posse (2015, pp. 36 – 54).

14 It should be pointed out that there are also various non-economic explanations. Several authors argue that economic growth is deeply embedded into social, psychological and political systems. According to Rosa (2009), social acceleration is tightly entangled with economic growth. Welzer (2011) introduces the concept of "mental infrastructures" and argues that the current mental infrastructures follow the same logic as economic growth. Deutschmann (2014) develops a complex sociological explanation of economic growth that combines market mechanisms as well as certain human attitudes and class and social struggles.

15 These explanations of economic growth are characterized by the same features as those from the prior three sections. While they entail many relevant arguments, they do not take place within comprehensive macroeconomic frameworks.

such relations are prominent in the literature. They refer to the monetary system, social stability and social systems.

The monetary, credit-based system is argued to function only properly in the case of continuously expanding money creation and accompanying economic growth. The basic argument is that companies need to pay back loans with interest. The additional necessary money is said to depend on additional money creation (Peukert, 2010; Loehr, 2012; Farley et al., 2013). Several authors in recent contributions point out, however, that money creation is not needed when there is sufficient consumption out of profits and/or wealth (Wenzlaff et al., 2014; Cahen-Fourot and Lavoie, 2013; Jackson and Victor, 2015; Richters and Simoneit, 2017).

Paech (2012) combines the argument of a growth imperative due to positive interest rates with an analysis of increasing global division of labour. Due to the division of a production process, the number of firms who take out loans increases and therefore the need to grow (in order to pay back the loans) does too.[16]

A second common argument is that social stability in the current political system rests on economic growth, because growth facilitates increases in income of some, without necessary decreases of others.[17] While many authors see this connection between economic growth and social peace as a challenge for post-growth economies, most argue for a redistribution despite potential political conflicts (Victor, 2008; Möhring-Hesse, 2010; Schmelzer and Passadakis, 2011; Muraca, 2014).[18]

Third, it is pointed out that various social systems are currently based on economic growth. According to Seidl and Zahrnt (2012a), these are the health sector, the pension system, the labour market, consumption, distributional justice, companies – in particular shareholder-driven business types, banking and financial systems and public finances.[19] As argued above, there are various proposals on how these systems can be adjusted in non-growing economies.

[16] To the best of my knowledge, there has been no further contribution on this argument yet.

[17] Original quote in German: "Wenn der Kuchen immer größer wird, ist dessen Verteilung weniger problematisch und konfliktreich: Man muss niemandem etwas wegnehmen, um es anderen zu geben" (Muraca, 2014, p. 8)

[18] Muraca (2014) additionally points out that economic growth may have prevented a (desirable) political debate on the societal conditions.

[19] Original quote in German: "[D]ie Systeme Gesundheitswesen, Alterssicherung, Arbeitsmarkt, Konsum, Verteilungsgerechtigkeit, Unternehmen, vor allem börsennotierte Aktiengesellschaften, Banken und Finanzmärkte sowie Staatsfinanzen." (Seidl and Zahrnt, 2012a, p. 112).

3.5 Comparison and Implications

Due to the diversity of the contributions to each of the four concepts, a detailed comparison of them is not feasible here. Hence, the analysis is restricted to the points that refer to the following discussions. It focuses on the three topics *origins and motivations*, *relations* and *explanations of economic growth*.

There are numerous origins and motivations among the four concepts. Three stand out because they are important in all four concepts: environmental sustainability, low economic inequalities and economic stability (in the sense that economic systems are not characterized by crises and entail a good way of dealing with the issue of (un-)employment). These three motivations correspond to research question 2 – 4.

Concerning the relation to economic growth, there is also a great diversity among authors. In particular, some argue for shrinkage, while others seem in favour of stabilizing production at the current levels. While this may not apply to all authors, many either explicitly or implicitly argue for a relatively stable level of production over time, once a (more) sustainable level of emissions is reached. This aspect is represented in research question 1.

Finally, the explanations of economic growth also vary between the four concepts. Arguments from ecological, Keynesian and Marxian economics are used. Typical neoclassical arguments are almost absent. The analyses are seldom explicitly based within a macroeconomic framework, however. This is why the proposals for conditions from these concepts (of the next section) are often not explicitly linked to analyses of economic growth. This reaffirms the research gap pointed out in section 1.2.3.

3.6 Macroeconomic Conditions in Existing Concepts

The four concepts of the last section have led to the development of a vast diversity of proposals for conditions of economies without growth. These conditions stem from many different authors and are usually not analysed together. An exception are the conditions for steady state economies. Daly has developed a coherent set of conditions. It includes a distributional (min-max incomes and wealth), an environmental (cap-and-trade systems for all major natural resources) and a population[20] (birth licences) institution. In recent years, his conditions for a steady state economy have also been extended.

[20] The issue of population is not included here, as it plays only a minor role in the latter three concepts and as it is not excluded from the analysis throughout the present work.

In the following, the proposals for conditions that relate to macroeconomic analyses have been compiled. Other aspects of economies without growth – e.g., societal, psychological or individual aspects – have not been included. The proposed macroeconomic conditions are grouped into seven areas: environmental regulation, investments and capital depreciation, business types, consumption, employment, distribution and the monetary system.

3.6.1 Environmental Regulation

A central strategy to decrease material use and emissions is to increase their price. The general idea is that higher prices lead to a substitution of natural resources by labour and resource-saving technological change (see section 2.2). In Daly's steady state economy, one of three central institutions is a cap-and-trade system ("depletion quotas" (Daly, 1991, p. 61)) for all major natural resources, both renewables and non-renewables. The government sells licences for the extraction of the resources according to the politically defined sustainable level of extraction. In this manner, the goal is to reach a sustainable level of throughput. The natural resources are distributed efficiently, namely to the companies that have the greatest need for them. Daly argues that it makes more sense to cap the extraction of resources instead of emissions, as extraction is relatively centralized compared to decentralized emission. Such cap-and-trade systems are proposed in various manners by a large number of authors (Alcott, 2010; Douthwaite, 2012; Kallis and Martinez-Alier, 2010; Jackson, 2009a; Victor, 2008)

Other types of environmental regulation are also brought forward: environmental taxation (Daly, 2008), environmental regulation and prohibitions (Schmelzer and Passadakis, 2011), taxation of physical capital (Lorenz, 2010) and the abolishment of environmentally harmful subsidies, in particular for the fossil industries (Paech, 2012).

According to Kallis (2011), the issue of environmental regulation plays a less important role in the degrowth discourse than in steady state and post-growth discussions, for three main reasons. First, there is scepticism concerning market-based solutions to environmental problems. Second, environmental regulation is argued to lead to increases in prices, which can generate problems for people with low incomes. (3) It is doubtful whether sufficient environmental regulation is feasible to be implemented within the current political system.

3.6.2 Investments and Capital Depreciation

Investments and disinvestments play an important role in the concepts (though with little reference by the contributions on steady state economy). The central argument is that some sectors of the economy need to shrink. These are "high-speed transport infrastructures, space missions for tourists, new airports, or factories producing unnecessary gadgets, faster cars or better televisions". On the other hand others need to grow: "We may still need more renewable energy infrastructures, better social (education, and health) services, more public squares or theatres, and localised organic food production and retailing centres" (Kallis, 2011, p. 875). Kallis calls this a "selective downscaling of man-made capital" (p. 875); and while those sectors that are supposed to grow seem to have a lower capital coefficient, they still need a certain level of gross investments.

Passadakis and Schmelzer (2011) argue that the sectors that need to shrink make up a large part of the global economy and that shrinking these sectors implies dismantling production sides that have not yet amortized. Paech (2012) gives some concrete examples of capital that should be dismantled in post-growth economies: industrial plants, motorways, car parks and airports.[21]

3.6.3 Business Types

How to organize production and consumption at the company level is particularly prevalent in discussions on degrowth, Postwachstum and Anglophone discussions (e.g., Cattaneo and Gavaldà (2010), Paech (2012), Schor and White (2010)). The central idea is that alternative types of business entities (as compared to shareholder value-driven large companies) have fewer incentives and pressures to expand production. Additionally, such alternative business types pursue various goals associated with economies without growth – such as low inequalities, environmentally sustainable production, resilient structures, cooperation and strong social ties (Konzeptwerk Neue Ökonomie, 2014).

There is a range of different concepts on how production can be organized at the company level. Johanisova et al. (2013) argue that cooperatives are appropriate, as they have collective ownership and decision structures. Another prominent concept is to organize production and consumption via the principles of commons (Helfrich and Bollier, 2015). Concrete examples often refer to urban gardening (Anguelovski, 2015), innovative models of living (Cattaneo and Gavaldà, 2010; Lietaert, 2010; Kallis et al., 2012) and community-supported agriculture (Infante-Amate and González de Molina, 2013).

The majority of authors argue that businesses need to be smaller, more democratic and produce for a more regional market (Schor and White,

21 Original quote in German: "Industrieanlagen, Autobahnen, Parkplätze und Flughäfen" (Paech, 2012, p. 137).

2010; Paech, 2012; Reichel, 2013; Konzeptwerk Neue Ökonomie, 2014; Lange, 2014a; Gebauer and Sagebiel, 2015; Posse, 2015). Posse (2015) gives an overview over prominent positions concerning firms (pp. 59 – 66). Of central importance are networks of small enterprises, preferably on a regional scale. Reichel (2013) points out that shareholder-driven companies contain incentives to invest and expand production. Cooperatives, business types where profit-based payments are prohibited and foundations are compatible with post-growth economies. Lange (2014b) further argues that a shift towards smaller and more democratic businesses would also help to solve the *globalization paradox* with globally active corporations on the one hand and governments that can only enact economic policies at the national level on the other.

A special feature of post-growth discussions is the concept of prosumers ("Prosumenten" (Paech, 2013, p. 271))[22]. The concept states that the roles of people are not clearly separated into (1) producers of one good and (2) consumers of a great variety of goods that are produced by others. Instead, there are increasing examples in which people consume a product and at the same time take part in their production in some shape or form (Reichel, 2013).

3.6.4 Consumption

Economies without growth also imply an end to consumption growth. The contributions on consumption from the different concepts reflects their diverging perspective on whether the economy needs to shrink before it reaches an environmentally sustainable level. Degrowth and Postwachstum proponents argue that consumption needs to shrink (Schneider et al., 2010; Røpke, 2010; Stengel, 2011; Paech, 2012). Steady state and Anglophone contributors on the other hand argue for an end to consumption growth (O'Neill et al., 2010; Victor, 2008) and a switch towards other products, such as services (Jackson and Victor, 2011).

In texts on degrowth, the question is not primarily under what circumstances people consume less or more environmentally friendly goods. Instead, a transformation of society is envisioned that also implies lower levels of consumption (compare e.g., Kallis (2015a)). Degrowth authors are particularly sceptical on the transformational perspective that people simply need to change their consumption pattern in order to achieve sustainability. The reason is that

> "[o]ur lifestyle decisions, especially our consumption decisions, are not made in a vacuum. Instead, they are made within social, economic, and political structures of constraint, and those structures make some

22 Habermann (2012) develops the similar concept "Ecommony" (p. 43).

> lifestyle decisions easy or necessary and other lifestyle decisions difficult or impossible. Change the social, economic, and political structures, however, and different consumption practices would or could emerge" (Alexander, 2012a, p. 2).

For Postwachstum analysts, a reduction of consumption is usually not seen as negative to individual and social welfare. Instead it improves well-being (Røpke, 2010; Stengel, 2011; Paech, 2012).

The analysis on how a change in consumption can be achieved takes into account structural obstacles but also individuals' capacity to act. Jackson (2009a) coins the term "iron cage of consumerism" (p. 102). Consumption is induced due to a strong personal identification with material aspects, status consumption and a desire for novel goods. At the same time Paech (2012) attributes a significant role to personal choices in reducing consumption. Victor (2008) is a good example for the combination of individual agency with structural aspects. He argues that "[c]onsumption is one area where people can take action as individuals to effect change in the economy and society. [...] Changed behaviour becomes much more powerful, however, if we act as a group, and the tax system can help" (pp. 220 – 221).

A particularly important role in reducing the pressure to consume is attributed to advertising, which is argued to increase consumption (Skidelsky and Skidelsky, 2012). Therefore, it is proposed to regulate commercials, for example by making it more expensive (Skidelsky and Skidelsky, 2012) or strengthening public compared to commercial media (Jackson, 2009a). Paech (2012) even argues for restricting or prohibiting commercials in certain instances.[23]

3.6.5 Employment

A central argument against economies without growth is that it would lead to rising unemployment, due to increases in labour productivity (Victor, 2008). There are multiple proposals under what conditions the problems associated with unemployment do not take place. The most widespread concept is to reduce average working hours and distribute them more evenly among the population (Victor, 2008; Jackson, 2009a; Reuter, 2010; O'Neill et al., 2010; Schmelzer and Passadakis, 2011; Paech, 2012; Skidelsky and Skidelsky, 2012; Kallis et al., 2012, 2013; Asara et al., 2013; Schor, 2015). These are not only necessary to prevent economic growth, but also facilitate time for care work (Biesecker et al., 2012), the pursue of "the

[23] Original quote in German: "Einschränkungen oder (punktuelle) Verbote von Werbung" (p. 139).

good life" (Skidelsky and Skidelsky, 2012, p. 145) and more democratic participation (Wittmann, 2014).

The second possible condition is that technological change in economies without growth is not characterized by increasing labour productivity. Daly (1991) has already argued that high resource prices, caused by the cap-and-trade systems, lead to a substitution of natural resources by labour. Therefore, a given level of production needs more employment (see also Røpke (2011)). Sorman and Giampietro (2013) make a strong case that reductions in working hours are not feasible in degrowth economies. They build on the argument that the increases in labour productivity of the past have only been possible due to the continuous increase in energy use (section 2.2.3). If energy use is reduced substantially in a degrowth society, labour productivity will decrease. Both within the paid as well as in the unpaid sector, more work will be needed per unit of production. Additionally, the dependency ratio is predicted to increase in the future. In sum, "it is very unlikely that in the future the work load of adults will be reduced neither in the paid work category or the unpaid work category" (Sorman and Giampietro, 2013, p. 92).

Third, Anglophone and German-speaking authors point out that sectoral change from industrial to service sectors can prevent unemployment. They argue that service sectors have a higher labour and a lower resource coefficient. A change from one to the other sector can therefore support the level of employment and at the same time decrease material throughput (Victor, 2008; Reuter, 2010; Jackson and Victor, 2011; Reuter, 2014; Jackson et al., 2014). Victor (2008) additionally points out that this is not true for all service sectors. It does not suffice to argue for a shift from industrial to service sectors, but a closer look to the labour and resource coefficients of each sector is necessary to know which sectors should grow.

It is also noteworthy that there are very different perspectives on the concept of work in the four concepts. Steady state and Anglophone authors argue mainly within the logic of wage labour, implying that the main focus is on providing a sufficient number of jobs in economies without growth. Degrowth and Postwachstum authors, on the other hand, entail a different vision for work. An increasing part of production takes place outside the market (Gómez-Baggethun, 2015) and is organized neither based on the logic of competition nor by the state (Helfrich and Bollier, 2015). Different forms than wage labour are encouraged (Fournier, 2008) and the role of household and care work receive a greater recognition (Haug, 2011; Biesecker et al., 2012; Nierling, 2012; D'Alisa and Cattaneo, 2013; D'Alisa et al., 2015).

3.6.6 Distribution

The great majority of contributions argues for a more equal distribution in economies without growth than is currently the case. Low economic inequalities are seen as an end in itself. But they are also regarded as a precondition for other changes in economies without growth. Small differences in income and wealth are necessary to make the price increases due to environmental regulation socially acceptable (Kallis, 2011) and to decrease differences in power (Asara et al., 2013).

Daly (1991) has already proposed concrete measures that decrease income and wealth inequalities. First, he argues in favour of setting a minimum income level, made possible by a negative income tax for low incomes. Second, a maximum income level should be introduced, by increasing marginal taxation up to 100%. Third, he argues for a maximum wealth level, because wealth is interchangeable with income and because too high concentrations of wealth impede democratic institutions.

Similar and additional proposals are brought forward throughout the literature. These "include revised income tax structures, minimum and maximum income levels, improved access to good quality education, anti-discrimination legislation, anti-crime measures and improving the local environment in deprived areas" (Jackson, 2009a, p. 181). Additionally, basic income is an increasingly discussed concept Schneider et al. (2010); Kallis (2011); Schmelzer and Passadakis (2011); Paech (2012); Schuster (2012); Alexander (2015); Demaria et al. (2013); Kallis (2015a). Less central are proposals on a debt audit (Cutillas et al., 2015) and the abolishment of the ability to inherit (Alexander, 2012b).

3.6.7 Monetary System

Throughout the literature it is often argued that the currently existing monetary system is not compatible with economies without growth. The common arguments relate to the fractional reserve system (e.g., Mellor (2015)) and/or positive interest rates (e.g., Loehr (2012); Douthwaite (2012))[24]. It is argued that a monetary system with these features can only be stable when the economy grows (e.g., Daly (1993)). There are diverging proposals for the concrete conditions for the monetary system to be compatible with zero growth.

Perhaps the most common condition proposed is to replace the fractional reserve system by a full reserve system (Daly, 2008; O'Neill et al., 2010; Peukert, 2010; Paech, 2012; Seidl and Zahrnt, 2012b; Peukert, 2013; Bernholt, 2014): "the SSE could benefit from a move away from our frac-

24 The issue of the compatibility of positive interest rates and non-growing economies is discussed in more detail in chapter 12.

tional reserve banking system toward 100% reserve requirements" (Daly, 2008, p. 9). The full reserve system is supposed to counter the necessity to grow, lead to a more stable (in terms of fluctuations in GDP) economy and provide the government with additional latitude for fiscal policies such as the job guarantee (O'Neill et al., 2010). However, some authors are critical of this. Cahen-Fourot and Lavoie (2013), Richters and Simoneit (2017) and Jackson and Victor (2015) argue that the current monetary system is compatible with zero growth (under certain conditions). Dittmer (2015) argues that there are additional negative aspects of full reserve banking, as it grants additional power to the state and because it is argued to be politically difficult to achieve. Jackson (2009a) and Schmelzer and Passadakis (2011), on the other hand, point out that monetary institutions need to be characterized by a higher degree of democratic control.

Several authors also propose other regulations and reforms of the banking and financial systems. The measures include a Tobin tax and higher reserve fractions of central banks (Jackson, 2009a), prohibition of financial instruments that do not serve a purpose to the real economy and a regulation of rating agencies (von Braunmühl, 2010), an overall shrinkage of the financial sector (Passadakis and Schmelzer, 2011) and a closure of tax havens and shadow banking systems (Schmelzer and Passadakis, 2011).

Additionally local/complementary currencies have been argued to be supportive for the necessary economic transition (Latouche, 2009; O'Neill et al., 2010; Pennekamp, 2011; Schuster, 2012; Paech, 2012; Douthwaite, 2012) or are seen as part of the degrowth movement (Martinez-Alier et al., 2011; Demaria et al., 2013). According to Dittmer (2013) alternative currencies can have positive effects on alternative living, ecological consumption and localization, but the extent of their impacts is very limited both in practice and in theory.

Chapter 4
Intermediate Results

High economic growth rates are a historical novelty of the capitalist period since the industrial revolution. Since World War II, growth rates have been declining in early industrialized countries. The resulting secular stagnation is due to a variety of factors, including supply side and demand side considerations.

Early industrialized countries today are characterized by high levels of average income, a high diversity of degrees of economic inequality and unsustainable levels of emissions per capita. A transformation towards sustainable economies without growth is born out of this situation.

The four concepts of economies without growth – steady state economies, degrowth, prosperity/managing without growth and Postwachstum – have been introduced. Building on a diversity of origins and motivations, they share the goals of (1) organizing economies without growth in an (2) environmentally sustainable manner with (3) low economic inequalities and with (4) economic stability. These concepts have different views on whether and the extent to which the economy needs to shrink in order to reach a sustainable level. In this way, they share the view that the economy needs to be depicted by a relatively stable level of production.

The literature on the four concepts comprises a bouquet of proposals for macroeconomic conditions. These are sometimes contradicting, but more often they are complementary. The conditions can be summarized as follows:

Economies without growth are characterized by an end of consumption growth. Economic activities switch from dirty towards clean production, which requires disinvestments in dirty and investments in clean activities. Environmental regulation, which limits the use of natural resources and the emission of pollutants, supports this switch in production. At a business level, economic activities are characterized by small companies that produce for local markets and are marked by a higher degree of democratic participation. Low levels of economic inequalities facilitate a sufficient level of material welfare also for people at the lower end of the income distribution. The monetary system is adjusted so that it functions properly without growth and its institutions are more democratically controlled. Unemployment is prevented by reductions in average working hours and/or due to a redirection of technological change from decreasing the labour coefficient towards decreasing the resource coefficient.

The interplay between technological change, employment and resource use is of particular interest concerning the work at hand. The reason is that many of the theories applied in the next three parts, can be connected to these issues. Also, this interplay seems to depict a dissent within the literature on economies without growth. On the one hand, reductions in working hours is one of the most commonly proposed condition. On the other hand, a reduction in working hours contradicts one of the central statements of ecological economics, namely that increases in labour productivity are based on increasing energy use.

The analysis of the four concepts yields three distinct scenarios on this interplay between technology, employment and the environment:

Scenario 1. ***Technological change with increasing labour productivity:*** *Technological change (still) leads to increases in labour productivity. This results in decreasing labour demand when the economies do not grow. Reductions in average working hours are implemented to prevent unemployment (e.g., O'Neill et al. (2010), Kallis et al. (2012), Paech (2012)).*

Scenario 2. ***Technological change with constant or declining labour productivity:*** *The type of technological change is redirected, so that it does not increase labour productivity. Instead it is directed towards emission reductions and reduced use of natural resources. Such technological change goes hand in hand with constant or even increasing employment (e.g., Daly (1991), Sorman and Giampietro (2013) and Røpke (2011)).*

Scenario 3. ***Technological change with increasing labour productivity and sectoral change:*** *Production is shifted towards sectors with lower labour productivity. The resulting increase in employment compensates the decrease in employment due to technological change (e.g., Jackson and Victor (2011)).*

These three scenarios, as well as the wider range of macroeconomic conditions, are investigated further in the following parts. In particular, they are discussed based on the insights from neoclassical, Keynesian and Marxian theories in chapters 9, 14 and 19, respectively. In part V, the macroeconomic conditions and scenarios from this section and the three schools of thought are compared and synthesized.

Part II

Neoclassical Theories

Chapter 5
Introduction

Thus far, arguments for economies without growth and concepts of how they could look like have been discussed. At the same time, economic growth is a central policy goal worldwide (Schmelzer, 2015b). Policy-makers as well as their advisors often have a neoclassical background from their education or their current research (Steurer, 2001). This suggests a connection between neoclassical thought and the great importance attributed to economic growth by policy-makers and within the economics profession. This makes one of the central findings of the following chapter interesting and surprising: Zero growth economies do not fundamentally conflict with the neoclassical paradigm.

The Agenda of Neoclassical Theories

Historically, neoclassical theories continued on the classical theories of section 2.3.1. In the 19th century several authors applied mathematical tools to economic issues. Many fundamental aspects of economics, such as productivity, utility and costs, were no longer investigated with respect to their averages but rather their marginal values. The basic idea was that every input has a diminishing marginal return: decreasing marginal utility from consumption and diminishing marginal productivity from labour and capital. Along with the marginal revolution, the thematic focus of economics also changed. The classical theories had been centred on the development of macroeconomic aspects, such as production, population or the functional income distribution. In neoclassical theories, the main focus became the allocation of scarce resources. Alongside the question of how resources are distributed, there is also the determination of the price of a factor or a good. The price is determined by the interplay of supply and demand. This is why prices, supply and demand are often seen as the central concepts of neoclassical theories (Medema and Samuels, 2003).

Determining the level of production and its growth were therefore not at the centre of this theory at the beginning. Later on, neoclassical theories were developed that specifically focus on determining the level of production and its growth. In general, the level of production (and its development) is due to the amount of production factors. The issue of growth therefore comes down to the question of what determines the number of workers and their working hours, the amount of capital and later on the amount of human capital and the state of technology. By now, there are countless neoclassical theories and models which deliver explanations for the speed of economic growth.

State of Research on Economies Without Growth

The issue of zero growth economies has barely been discussed in neoclassical economics. To the best of my knowledge, there are only three contributions that explicitly discuss the question of zero or negative growth within neoclassical frameworks.

Irmen (2011) investigates whether economic growth is inherent to the market economic system. First, he argues the historical observation that market economies grow is not sufficient to argue that economic growth is inherent to the system. A pure correlation does not constitute a causation. Second he looks at theoretical considerations with a focus on neoclassical theories.[1] He argues that in certain neoclassical growth theories the growth rate per capita is zero in the long run. The reason is that capital has diminishing marginal productivity and there is no technological change. When technological change is included, its rate needs to be higher than the reduction of natural resource use, in order to facilitate economic growth[2]. However, this establishes the condition for economic growth and is not an inherent mechanism for it. Irmen (2011) comes to the conclusion that from the point of view of neoclassical theories economic growth is not inherent to the economic system; it can even work fine when it shrinks.[3]

Bilancini and D'Alessandro (2012) develop a neoclassical model with three types of externalities. First, increases of consumption of one person have a negative externality on aggregate utility. This is because consumption is relative. Second, leisure has a positive externality since "the accumulation of social ties depends on the average leisure time" (p. 196) – and social ties have a positive effect on utility. Third, there are positive production externalities due to spill-over effects from one economic activity to the other (compare chapter 7). Based on these externalities Bilancini and D'Alessandro (2012) develop a neoclassical model and compare three scenarios: one "dezentralized" scenario without a social planner that leads to relatively high economic growth; one scenario with a social planner who

1 He also discusses Binswanger's theory shortly, see section 12.3.

2 It is assumed that the supply of natural resources is exogenously reduced, for example by the government. This approach is also followed in several of the theories covered in chapter 8.

3 Original quote in German: "Aus neoklassischer Perspektive ist also eine Marktwirtschaft mit funktionierendem Kreditmarkt ohne Wirtschaftswachstum denkbar. Sie kann sogar schrumpfen. Wirtschaftswachstum ist in diesem Sinne nicht systemimmanent" (Irmen, 2011, p. 12).

does not take into account the externalities; and one scenario in which the social planner includes them in his calculation. Bilancini and D'Alessandro (2012) argue that certain conditions lead to "happy degrowth" (p. 200) with declining production and increasing social welfare. The main reason is that it is "optimal to have an average level of leisure that is dramatically higher than that emerging in any of the first two regimes" (p. 202).

Heikkinen (2015) shows that changes in household preferences can lead to stable zero or negative growth rates in a neoclassical general equilibrium model. A central mechanism are households that decide to decrease labour supply, which decreases the growth rate of the balanced growth path. He argues that such a shift in preferences can be depicted as "voluntary simplicity" (p. 331) – this concepts originates from the degrowth literature. Furthermore, Heikkinen (2015) points out that the reduction in consumption, working hours and economic growth can lead to increases in social welfare. The central reason is the existence of "conspicuous consumption" (p. 337). Therefore, consumption has a negative externality, which implies that reductions in consumption by a group of households or of all households increases aggregate welfare.

In sum: All three contributions consider zero or negative economic growth to be compatible with economic stability. The major reasons why growth declines is either a change in households' preferences (for more leisure) or due to the actions of a social planner. Zero or negative growth is compatible with high social welfare when certain externalities are assumed.

Outline

The following chapter 6 discusses fundamental neoclassical theories. They represent an older generation of neoclassical (growth) theories, are characterized by exogenous technological change and do not integrate environmental concerns. The first of these limitations is lifted in chapter 7, describing endogenous growth theories. Here, technological change takes place due to endogenous mechanisms. Chapter 8 covers theories which integrate environmental concerns, both into the fundamental as well as endogenous theories. Finally, chapter 9 summarizes the results and develops three neoclassical scenarios for economies without growth. Note that chapter 9 entails a table (9.1) with an overview of the results from each of the neoclassical theories.

Chapter 6
Fundamentals

This chapter covers some fundamental neoclassical theories. These explain the foundations of the neoclassical analysis on how the macroeconomy works and what determines its level of production and economic growth. The subsequent chapters build on these foundations. First, the Basic Macroeconomic Model is developed and discussed. This model gives an understanding of the determinants of the level of production. Second, the Solow Model integrates continuous capital accumulation and therefore the concept of long-term economic growth into the neoclassical framework. Third, this analysis is extended by microfoundations in the Neoclassical Growth Model, which allows the dynamics of economic growth to be explained based on the behaviour of households and firms.

6.1 Basic Macroeconomic Model: Neoclassical Foundations

In the Basic Macroeconomic Model the behaviour of two central groups of agents, combined with the state of technology, determine macroeconomic variables. Firms produce goods in such a manner that their profits are maximized. They buy labour and capital for production and sell their products. As all firms face the same production function, they can be modelled as one representative firm. The second group of economic agents are households. They receive labour and capital income, depending upon how much they work and how much capital they save. Contrary to the firms they have a choice: They can choose (1) how much of their time they dedicate to work and (2) how much of their income they consume. This choice is modelled based on a utility function.[1]

[1] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The neoclassical understanding of the macroeconomy is described similarly though slightly differently in numerous papers, books and textbooks. The following illustration is based on Felderer and Homburg (2005). The model in section 6.1.1 is a reproduction of the existing model. The application of the model to zero growth in section 6.1.2 includes rearranging and recombining the equations of the existing model.

6.1.1 The Theory

6.1.1.1 Firms

Firms produce one good. The level of production depends on the level of the production factors capital (K) and labour (L):

$$Y = F(K, L). \tag{6.1}$$

Output positively depends on both production factors ($\frac{\partial F(K,L)}{\partial K} > 0$; $\frac{\partial F(K,L)}{\partial L} > 0$), with diminishing marginal returns ($\frac{\partial^2 F(K,L)}{\partial K^2} < 0, \frac{\partial^2 F(K,L)}{\partial L^2} < 0$). Firms maximize their profits (Π). Profits are determined by the total revenue and expenditures on capital and labour:

$$\Pi = PF(K, L) - wL^d - iB^s, \tag{6.2}$$

where P is the price of the good, w is the wage rate, L^d is the demand for labour, i is the interest rate and B^s is the amount of bonds sold by the firm in that period. This amount is equal to the bonds it possesses from the past plus the money needed for new investments: $B_t^s = B_{t-1} + P(K_t - K_{t-1})$. B_{t-1} is the debt from the past, K is the current amount of capital, K_{t-1} is the amount of capital in the past. As there is no shortage of demand, the firms employ capital and labour as long as marginal products are higher than marginal costs. The marginal products of capital and labour are determined by the production function, the marginal costs by the wage level and the interest rate. Marginal revenues minus marginal costs are equal to zero when

$$P\frac{\partial F(K,L)}{\partial K} = iP \quad \text{and} \quad P\frac{\partial F(K,L)}{\partial L} = w. \tag{6.3}$$

As result, the level of production is negatively related to the amount of the interest rate and the wage rate. Also, it means that the demand for labour is negatively related to the wage level and the demand for investment is negatively related to the interest rate. Hence, the general demand function for labour is

$$L^d = L^d(\frac{w}{P}), \quad \text{with} \quad \frac{\partial L^d(\frac{w}{P})}{\partial \frac{w}{P}} < 0, \tag{6.4}$$

and the general demand function for investments is

$$I = I(i), \quad \text{with} \quad \frac{\partial I(i)}{\partial i} < 0. \tag{6.5}$$

6.1.1.2 Households

Households decide how much they want to work and accordingly how much leisure time they have. Additionally, they control what portions of their income they consume and save. In this case, a representative household is assumed. The households' income (PY) is determined by its labour income (wL^d), its capital income (iB^d) and its income from profits (Π):

$$PY = wL^d + iB^d + \Pi. \tag{6.6}$$

The level of wages and the interest rate play a crucial role in determining households' income. This is why they play important roles in households' decisions concerning how much labour they offer and what proportion of their income they save. Each decision is examined in turn.

The first decision of households concerns how much of their time they dedicate to labour (and how much to leisure time). Neoclassical theories do not only assume marginal productivity in production but also with regard to consumption. Due to the diminishing marginal utility of consumption, the marginal utility of income also diminishes. Work is assumed to have negative utility (or one could say that leisure has positive utility). Therefore, households decide whether the additional utility they get from consumption (enabled by income) outweighs the negative utility they encounter due to more labour time. The higher the wage, the more consumption an individual can realize by working one additional hour. Therefore, the labour supply is positively related to the wage rate (the underlying assumptions that lead to this conclusion are discussed below).

$$L^s = L^s(\frac{w}{P}), \quad \text{with} \quad \frac{\partial L^s(\frac{w}{P})}{\partial \frac{w}{P}} > 0. \tag{6.7}$$

Second, households decide how much of their income they consume and how much they save. Neoclassical theories assume that households prefer current consumption over future consumption. Without an interest rate, they would consume their entire income and save nothing. Because of the interest rate, saving today facilitates consumption tomorrow that is higher than today's consumption that is then forfeited. Based on this reasoning, savings are positively related to the interest rate

$$S = S(i), \quad \text{with} \quad \frac{\partial S(i)}{\partial i} > 0. \tag{6.8}$$

6.1.1.3 Labour Market

The labour market is at the core of the model. The interplay between demand and supply of labour determines the production level and plays an important part concerning the functional income distribution. As argued above, demand and supply of labour both depend on the real wage. Combining equations 6.4 and 6.7, the equilibrium in the labour market is derived:

$$L^d(\frac{w}{P}) = L^s(\frac{w}{P}). \tag{6.9}$$

In neoclassical theories, there is no unemployment, as the labour market clears due to an adjustment of the wage (w).[2] On the one hand, workers offer labour dependent on their preferences and the wage. On the other hand, firms demand labour dependent on its productivity (which in turn depends on technology) and the wage. When demand for labour exceeds supply, the wage level rises, which results in a higher labour supply while less labour is demanded, and vice versa when supply exceeds demand.

6.1.1.4 Capital Market

On the capital market, demand and supply of capital determine the interest rate. As in the case of the labour market, demand is determined by firms and supply by households. By combining equations 6.5 and 6.8, the equilibrium condition for the capital market is derived:

$$I(i) = S(i). \tag{6.10}$$

The interest rate brings demand and supply into equilibrium. As with the labour market, the underlying factors are to be found in the determinants of the demand and supply functions. Capital demand is determined by the current capital stock and the state of technology (as was labour demand), whereas capital supply is determined by the preferences of the households. If demand exceeds supply, that is, if investment demand is higher than the supply of savings, the interest rate rises. This lowers investment demand and increases the supply of savings, so that the two come into equilibrium. If demand is lower than supply, the mechanism works in the opposite direction.

6.1.1.5 Goods and Money Markets

The goods market is in equilibrium when there are equilibria on the labour and the capital markets. As technological change does not occur in the ba-

2 See section 11.1 for a critique of this argument and an alternative analysis.

sic set up of the model, production is solely dependent upon the amount of labour and capital employed. These are determined according to equations 6.9 and 6.10. Applying the resulting amounts to the production function (equation 6.1) yields the level of production in the goods market. It is therefore determined by two elements: the preferences of households and the state of technology.

The money market has no impact on the level of production, the amount of labour and capital employed, the state of technology or any other aspect of the macroeconomy discussed so far. It solely determines the price level. The reason is that money is a secondary phenomenon in neoclassical theories. The price level is determined based on the Fisher equation:

$$PY = VM, \tag{6.11}$$

with the price level P, production Y, the velocity of money V and money supply M. It is assumed that the level of production is determined as explained above and the velocity of money is given. Hence, a change of the money supply only affects the absolute price level while the relations between prices of labour, capital and final goods remain constant.

6.1.2 The Theory and Economies Without Growth

6.1.2.1 Zero Growth Without Technological Change

Within the model's understanding of the macroeconomy, there is nothing that needs to change for the economy to generate zero growth when the state of technology does not change. The condition for a zero growth economy is in this case simply that households' preferences do not change over time. Even if they change, the level of production only alters once however. There are therefore no macroeconomic problems or imbalances. There is also no unemployment, firms cannot go bankrupt, and inequality plays no role, as there is a representative household.

6.1.2.2 Zero Growth With Technological Change

In the long run, technological change can alter the productivities of the production factors. In order to generate a zero growth economy, this would need to be countervailed by changes in the levels of the two production factors, which primarily depend on households' preferences.

Households preferences' play important roles in two aspects. First, the amount of labour applied in production depends on households' labour supply $L^s()$, which depends on the real wage (see equation 6.7) but also on households' preferences. The preferences determine how people divide their time between labour and leisure. As labour is seen as means to an end (i.e., consumption), the central choice is between consumption and leisure. The more important the next unit of consumption is compared to the next unit of leisure, the more people work and the higher is the output level. Additionally, a greater labour supply makes further use of capital profitable, as its marginal productivity rises. A higher labour supply therefore leads to additional application of both production factors, labour and capital.

Second, households' preferences have a strong influence on the level of capital applied, as capital depends on savings (in this model). The less an individual prefers consumption today over consumption in the future, the more she will save. Higher savings lead to higher investments ($I^s()$) and a higher capital stock. The higher capital stock increases the marginal productivity of labour, as more capital is being supplied per unit of labour. This leads to an increase of the wage rate and to a higher labour supply. Therefore, the amounts of both production factors and the level of production are higher for such preferences.

Technological change is not part of this model. But it is possible to compare situations with different states of technology. The necessary adjustments in households' preferences depend on the *type* of technological change. Barro and Sala-i Martin (2004) distinguish three types of technological change.

1. Hicks-neutral technological change does not alter the proportion of the marginal productivities of capital and labour. It is depicted as

$$Y_t = T_t F(K_t, L_t). \tag{6.12}$$

   If this type of technological change takes place and *increases* both factor productivities, labour supply and capital supply (due to household preferences in equations 6.7 and 6.8) need to *decrease* in order to generate zero growth. In other words: Households need to value consumption today higher and prefer additional leisure over additional consumption. On the other hand, if the technological change leads to *decreasing* productivities, the supplies need to *increase*.
2. Harrod-neutral or labour-augmenting technological change takes place when new technologies increase the productivity of labour. It is depicted as

$$Y_t = F(K_t, T_t L_t). \tag{6.13}$$

   In this case, a reduction in labour supply facilitates a constant level of production. Intuitively speaking, when households prefer increases in leisure over additional consumption, increases in labour productivity are translated into shorter working hours instead of higher income. Decreases in capital supply could also countervail the effect of labour-augmenting technological change. This would lead to a different capital-labour ratio, however, and it would necessitate strong preferences not to save, as the interest rate would continue to increase.

3. Solow-neutral or capital-augmenting technological change has the opposite effect. It is depicted as

$$Y_t = F(T_t K_t, L_t). \tag{6.14}$$

It increases the productivity of capital but not of labour. Hence, a decrease of capital supply with an equivalent effect on the level of capital would countervail its effect and lead to constant production. Households need to increase their time preference for consumption today. Again, also a decrease of labour supply could balance out the effect of capital-augmenting technological change, but it would increase the capital-labour ratio, and it is less likely because the wage would continuously rise.

The central condition for a zero growth economy with technological change is thus that a change of one of the three determinants of production (the levels of labour, capital and state of technology) needs to be countervailed by an opposite change of one or both other factors.

6.2 Solow Model: Savings and Capital Accumulation

Solow's article *A Contribution to the Theory of Economic Growth* (1956) demarcates the beginning of the ascendancy of neoclassical growth theory. It is part of most current textbooks on economic growth and while the demonstrations of the model differ slightly from author to author, the central mechanisms stay the same.[3]

The Solow Model argues within the same paradigmatic framework as the Basic Neoclassical Model, and most mechanisms stay the same. The central difference is that capital accumulation changes the capital stock over time. The intuition of the model is as follows: A given portion of pro-

[3] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following illustration is based Solow's original article and to its description and extension in Acemoglu (2009). The model in section 6.2.1 is a reproduction of the existing model. The application of the model to zero growth in section 6.2.2 includes rearranging and recombining the equations of the existing model.

duction is not used for consumption but saved and used for investments. Investments (or capital accumulation) lead to an increasing capital stock over time. Capital has decreasing marginal productivity, and it depreciates at a given and constant rate. Therefore, at low levels of capital stock, capital will accumulate as its marginal productivity is higher than the rate of depreciation. But with increasing levels of the capital stock, the difference melts away until the marginal productivity of capital is equal to the rate of capital depreciation. Further capital accumulation does not take place. Apart from capital, labour is the second important production factor. The more people work, the more products are produced. The amount of work can change due to several reasons: Workers can work more or less, and the share of people who work can change. Finally, the technological state of the art affects the level of production. It determines the productivity of labour and capital.

The process of capital accumulation and economic growth comes to an end in the original Solow Model. Capital accumulation is limited due to depreciation, and labour per capita is limited as people can only work a limited amount of hours per day and the share of people working in a society is also confined. This is why technological progress is the most important explanatory variable for long-term economic growth. Extensions of the original Solow Model, usually assume labour-augmenting technological change. This type of technological change increases the productivity of labour. The effect can also be interpreted as increasing the effective amount of labour. More supply of effective labour increases the marginal productivity of capital. Hence, additional capital accumulation becomes profitable again. In this manner, continuous *labour-augmenting* technological change facilitates the profitability of continuous capital accumulation and leads to continuous economic growth (Acemoglu, 2009).

6.2.1 The Theory

It is assumed (as in previous models) that only one good is produced by many firms. As firms are all identical, the production function of a single firm is equal to the production function of all firms. Production (Y_t) is determined by the amount of capital (K_t), labour (L_t) and the state of technological state (T_t), where t refers to time:

$$Y_t = F(T_t, K_t, L_t). \tag{6.15}$$

The production function has constant returns to scale, positive and diminishing returns to private inputs and the Inada conditions need to be satisfied.[4] A specific commonly used production function is the Cobb-Douglas function:

$$F(T_t, K_t, L_t) = T_t K_t^{\alpha} L_t^{(1-\alpha)}. \tag{6.16}$$

The change of the stock of capital is determined by net investments. Net investments depend on the savings rate (s), the level of production ($F[K_t, L_t, T_t]$), the depreciation rate (δ) and the capital stock (K):

$$\dot{K} = I_t - \delta K_t = sF[K_t, L_t, T_t] - \delta K_t. \tag{6.17}$$

The change in labour is determined by the factor g_L, which often stands for population growth. Here and throughout this work, it is interpreted as a parameter that incorporates all factors affecting the amount of labour. These are in particular the share of workers to total population and average working hours[5]:

$$L_t = (1 + g_L)^t. \tag{6.18}$$

6.2.1.1 Growth Without Technological Change

In the Solow Model without technological change the production function is simplified to

$$F(K_t, L_t) = K_t^{\alpha} L_t^{(1-\alpha)}. \tag{6.19}$$

The amount of capital and labour in period t are given. Using equation 6.17 and 6.18, production in period $t+1$ is determined by

$$F(K_{t+1}, L_{t+1}) = (K_t + sY_t - \delta K_t)^{\alpha}(1 + g_L)L_t^{(1-\alpha)}. \tag{6.20}$$

Growth therefore depends on the savings rate, depreciation, the change in average working hours, the level of production factors and the exact nature of the production function.

4 The Inada conditions imply that "the marginal product of capital (or labor) approaches infinity as capital (or labor) goes to 0 and approaches 0 as capital (or labor) goes to infinity" (Barro and Sala-i Martin, 2004, p. 27).

5 As mentioned in the introduction, matters of changes in the size of overall population are left out of this investigation.

6.2.1.2 Growth With Technological Change

In many models the production function from equation 6.19 is extended by the state of technology (T):

$$F(K_t, L_t) = T_t K_t^{\alpha} L_t^{(1-\alpha)}. \tag{6.21}$$

Production changes due to capital accumulation and the change in the amount of labour as before. Additionally, the production factor technology increases by a certain percentage g_T. It is assumed that the productivity of the technology applied exogenously increases in each period by this percentage. Production in period $t+1$ is therefore determined by

$$F(K_{t+1}, L_{t+1}, T_{t+1}) = (1+g_T)T_t(K_t + sY_t - \delta K_t)^{\alpha}(1+g_L)L_t^{(1-\alpha)}. \tag{6.22}$$

Compared to the case without technological change, growth is additionally influenced by both the state of technology and the rate of technological change.

6.2.2 The Theory and Economies Without Growth

Capital accumulation, rising labour supply and more efficient technologies lead to growth. Consequently, a constant capital stock, constant labour supply and a constant state of technology lead to zero growth. In this case, the economy does not grow if the different factors determining whether each of the three aspects grows or shrinks exactly cancel each other out. The capital stock stays constant when net capital accumulation due to savings is equal to capital depreciation. Labour supply is constant when changes in average working hours and the workers share of population balance out one another. The technologically determined productivity of the production factors needs to stay the same.

When one of the three has a positive effect on growth, it can be cancelled out by a negative effect of the other factor. Continuously more productive technologies, combined with decreasing stocks of capital and labour, can lead to constant production. Various other combinations are possible. In the next sections the possible combinations of the developments of technology, capital and labour are specified.

6.2.2.1 Zero Growth Without Technological Change

In order to investigate the conditions of zero growth economies, production in period $t+1$ needs to equal production in period t:

$$F(K_t + 1, L_t + 1) = F(K_t, L_t). \tag{6.23}$$

By combining equations 6.19, 6.20 and 6.23 the following relation is derived:

$$sY_t = (\frac{1}{(1+g_L)^{(\frac{1}{\alpha}-1)}} - 1)K_t + \delta K_t. \tag{6.24}$$

Condition 6.24 shows that investments (sY_t) need to equal the depreciation of the capital stock (δK_t) and a term dependent upon the change in labour supply and the capital stock ($(\frac{1}{(1+g_L)^{(\frac{1}{\alpha}-1)}} - 1)K_t$). The extreme cases are investigated, in which either depreciation is zero or the labour supply does not change.

When depreciation is equal to zero, equation 6.24 reduces to

$$sY_t = (\frac{1}{(1+g_L)^{(\frac{1}{\alpha}-1)}} - 1)K_t. \tag{6.25}$$

In this case, changes in labour supply and capital accumulation have to balance out one another. For the equation to hold, there are three potential scenarios: (1) If there is no change in labour supply ($g_L = 0$), the savings rate must be equal to zero ($s = 0$). In this case, the economy does not change over time. There is no depreciation, no changes in labour, no changes in the capital stock. (2) If there is positive change in labour ($g_L > 0$), the savings rate must be negative ($s < 0$). Intuitively: If one production factor increases (labour), the other production factor must decrease (capital). (3) If there is negative change in labour ($g_L < 0$), the savings rate must be positive ($s > 0$). If labour decreases, the capital stock must rise in order to compensate for it. The exact relation depends on the capital intensity of the economy ($\frac{K_t}{Y_t}$) and the output elasticities of capital and labour (depending on α). The higher the capital intensity and/or the output elasticity of capital, the higher the savings rate has to be.

The second relationship concerns the condition under which capital depreciation equals net investments. To examine this relation, constant labour is assumed, so that equation 6.24 reduces to

$$sY_t = \delta K_t. \tag{6.26}$$

Here, capital accumulation and depreciation have to cancel each other out. As labour does not change, the capital stock needs to stay constant in order to generate stable production. The higher the depreciation rate, the higher the savings rate has to be. By reshaping the following relationship is derived: $\frac{K_0}{Y_0} = \frac{s}{\delta}$. The exact relation between savings rate and depreciation rate depends only on the capital intensity of the economy. If it increases, the savings needs to increase relative to depreciation. Assuming a constant depreciation rate, this implies that for higher levels of capital intensity, the savings rate needs to increase in order to establish constant production.

In conclusion, in the Solow Model without technological change there are three factors – savings, depreciation and change in labour – which determine economic growth, and these need to cancel each other out to establish the condition of a zero growth environment. Staying within the central assumptions that have been made, their impact on long-term growth is still limited however. Changes in labour can only occur to a certain degree, as population growth (or decline) have been assumed not to take place. The capital stock also can neither increase or decrease infinitely due to the assumption of decreasing marginal returns to capital. For very high levels of capital stock, further accumulation becomes impossible, as depreciation always eats up accumulation. For very low levels of the capital stock, capital is highly productive so that even small savings are enough to countervail depreciation.

6.2.2.2 Zero Growth With Technological Change

As listed above, production of period $t+1$ (equation 6.21) and t (equation 6.22) are set equal to get the condition for zero growth:

$$(\frac{1}{(1+g_T)^{(\frac{1}{\alpha})}(1+g_L)^{(\frac{1}{\alpha}-1)}} - 1)K_t + \delta K_t = sY_t. \tag{6.27}$$

This equation resembles equation 6.24, only that it includes an additional term that covers the role of technological change. Again, a look at different scenarios reveal the relationship between technological change and other determinants of production. In a first scenario, the relation between technological change and savings is investigated by setting depreciation and labour equal to zero:

$$(\frac{1}{(1+g_T)^{(\frac{1}{\alpha})}} - 1)K_t = sY_t. \tag{6.28}$$

If there is positive technological change ($g_T > 0$), the savings rate must be negative ($s < 0$). In other words: When the production factors capital and labour become more productive over time, they need to decrease in order for production to stay the same. If technological change decreases productivity ($g_T < 0$), the savings rate must be positive ($s > 0$). Less productive technology would need to be counteracted by capital accumulation. The exact relation depends again on the capital intensity and the output elasticities. The higher the capital intensity and/or the output elasticity of capital, the higher the savings need to be for a given speed of technological change (g_T).

Second, it can be examined under what circumstances technological change and depreciation would cancel each other out – by setting the savings rate and the change in labour equal to zero:

$$-(\frac{1}{(1+g_T)^{(\frac{1}{\alpha})}} - 1) = \delta. \tag{6.29}$$

The higher the depreciation rate, the higher technological change needs to be (for the left hand side to become smaller). The exact relation in this case again depends on the output elasticities of capital and labour. The higher α, the higher δ needs to be. Therefore, a higher output elasticity of capital relative to the output elasticity of labour needs to accompany a higher depreciation rate.

Finally, by keeping the capital stock constant (zero savings and zero depreciation) the condition for technological change and labour cancelling each other out is examined:

$$\frac{1}{(1+g_L)^{(1-\alpha)}} - 1 = g_T. \tag{6.30}$$

If labour (g_L) increases, the numerator on the left hand side becomes larger so that the entire left hand side becomes negative. In this case, technological change (g_T) would need to be negative – productivity would have to decrease. On the other hand, increasing productivity would have to be accompanied by decreasing labour inputs.

The additional factor of technological change enriches the analysis. Technological change that increases productivity needs to be accompanied by decreasing amounts of capital (due to low savings and/or high depreciation rates) and/or decreasing amounts of labour. The other possibility is to change the technological path, so that the productivities of the production factors decline. The role of different types of technological change will be further discussed in various theories and in particular in chapter 9.

6.2.2.3 Two Sets of Conditions With and Without Technological Change

In the Basic Macroeconomic Model of section 6.1, the level of production is only determined for one period. The Solow Model has extended this analysis by allowing for capital accumulation and technological change. In both models, zero growth economies require an outbalancing of positive and negative effects from the developments of capital, labour and the state of technology. The Solow Model has contributed additional insights into the exact relationships: in particular, the proportions depend on the output elasticities of capital and labour, the capital intensity and on the levels of the production factors. Apart from these general results, the model has revealed a number of more detailed relations:

Two sets of conditions emerge from the different constellations discussed above. They are similar to the first two scenarios in existing concepts for economies without growth (see chapter 4). The first is to countervail the technological change by decreases in average working hours. This has been discussed above as the scenario in which the capital stock stays constant, technological change takes place and labour supply decreases. The second set of conditions includes the redirection of technological change, so that it does not increase labour productivity anymore. This new type of technological change would decrease environmental effects, which cannot be analysed by the Solow Model as it does not include an environmental aspect. Within the model, it would be represented by no labour-augmenting technological change, so that labour supply and the capital stock stay constant.

6.3 Neoclassical Growth Model: Microfoundations

The Neoclassical Growth Model[6] is to some extent a combination of the Basic Macroeconomic Model and the Solow Model. It takes the concepts of the utility maximizing household and the profit-maximizing firm from the Basic Model and combines it with the concepts of capital accumulation based on savings and exogenously given technological change from the Solow Model. The main differences from the Basic Macroeconomic Model are the inclusion of capital accumulation and technological change. The main difference from the Solow Model is that the savings rate is not exogenously given but rather explained by household behaviour. Another difference worth mentioning concerns the production factor labour. In the Basic Macroeconomic Model, it depends on household preferences and the wage level, and in the Solow Model it is determined by exogenous factors. In the Neoclassical Growth Model, it is usually given exogenously as well.[7]

6 The model is simply called Neoclassical Growth Model, as this is what many textbooks call it, see for example Acemoglu (2009, p. 317).

7 Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The Neoclassical Growth Model is part of basically all mainstream textbooks on growth theory, see for example, Acemoglu (2009), Aghion et al. (1998), Aghion and Howitt (2009) or Barro and Sala-i Martin (2004). The following representation is largely based on Barro and Sala-i Martin (2004). The model in section 6.3.1 is a reproduction of the exist-

6.3.1 The Theory

The basic set up of the model is similar to the Basic Macroeconomic Model. Its central constituents are households and firms. Their combined behaviour determines all macroeconomic outcomes, with the exclusion of technological change, which is exogenously given. Firms' behaviour cannot change, as they produce according to a production function, which is endogenously given – it is determined by technological change. Hence, the macroeconomic outcomes entirely depend on the preferences of households and on technological change.

6.3.1.1 Households

Households offer labour to firms and receive wage income (w) in return. They use the income either for consumption (c) or to save. The behaviour of households is entirely determined by their preferences, which are given. Consumption is the only determinant of utility and hence the sole driver of behaviour.[8] This is represented by the utility function $U = u(c_t)$. Consumption has positive but decreasing marginal returns $u'(c_t) > 0$, $u''(c_t) < 0$. If consumption is close to zero, marginal utility is infinite, if it is close to infinity, marginal utility is zero $\lim_{c\to 0} u'(c_t) = \infty$, $\lim_{c\to\infty} u'(c_t) = 0$. The following utility function entails these attributes and is used in the model:

$$u(c) = \frac{c^{1-\rho} - 1}{1-\theta}. \tag{6.31}$$

In addition to the level of consumption, the parameters ρ and θ determine the level of utility and households' behaviour. ρ represents the time preference of the households. The larger ρ is, the greater the households' preference to consume at an earlier point in time. The value of θ (it is assumed that $\theta > 0$) influences how fast the additional utility of consumption decreases. For high values of θ, additional consumption increases utility less. The important consequence is that households engage in consumption smoothing, i.e., are less willing to have different levels of consumption over time, which impacts the consumption-saving behaviour of households. Households maximize their utility over time based on the utility function and their time preference:

ing model. The application of the model to zero growth in section 6.3.2 includes rearranging and recombining the equations of the existing model.

[8] The households' behaviour is therefore similar but not the same as in the Basic Macroeconomic Model. There, households' utility was also determined by the amount of work and leisure time.

$$U = \int_0^\infty u(c_t)e^{(-p)t}. \tag{6.32}$$

In addition to the maximization behaviour of households, its income and its wealth are decisive for the level of consumption and savings. Income consists of wages (w) and interest payments, which are the product of the interest rate (i) and the amount of assets households hold (a). The assets of households change according to the income and expenditures of households. Assets develop according to

$$\dot{a} = w + ia - c. \tag{6.33}$$

At this point, the basic set up concerning households is complete and their consumption behaviour can be described. Change of consumption over time ($\frac{\dot{c}}{c}$) is determined by the interest rate (i), the time preference (ρ) and θ:[9]

$$\frac{\dot{c}}{c} = \frac{i - \rho}{\theta}. \tag{6.34}$$

Hence, if $i = \rho$, consumption stays constant over time; if $i > \rho$ consumption increases over time; and if $i < \rho$ consumption decreases. The value of θ determines how strong consumption changes over time for given values of i and ρ.

6.3.1.2 Firms

As in section 6.1, firms use labour and capital in order to produce a good according to a certain production function. The production function is also similar to the one in the Basic Macroeconomic Model (equation 6.1). The difference is that technological change is introduced. As it influences the firms' behaviour throughout, below all formulas are developed with and without technological change. Technological change is labour-augmenting. Therefore, the amount of labour (L) is multiplied by the state of technology (T). Effective labour is defined as $\hat{L} = LT$. Technological change takes place according to an exogenously given rate (g_T):

$$T = e^{g_T * t}. \tag{6.35}$$

The production function is (without and with technological change):

$$Y = F(K, L) \quad \text{and} \quad Y = F(K, \hat{L}). \tag{6.36}$$

[9] For the derivation see (Barro and Sala-i Martin, 2004, p. 26 – 40).

For the analysis, further efficiency units are introduced. $\hat{y}$ is the production per effective labour ($\hat{y} = \frac{Y}{\hat{L}}$), $\hat{k}$ is capital per effective labour ($\hat{k} = \frac{K}{\hat{L}} = ke^{-g_T * t}$) and $\hat{c}$ is consumption per effective labour ($\hat{c} = \frac{K}{\hat{L}} = ce^{-g_T * t}$).

Firms' profits equal their income minus their expenditures. Income is equal to production, while expenditures are the sum spent on interest for capital, capital depreciation and wages:

$$\Pi = F(K, L) - (i - \delta)K - wL \quad \text{and} \quad \Pi = F(K, \hat{L}) - (i - \delta)K - wL. \tag{6.37}$$

The derivation to capital gives the profit maximizing condition

$$f'(k) = i + \delta \quad \text{and} \quad f'(\hat{k}) = i + \delta. \tag{6.38}$$

The firm chooses the capital intensity, where the marginal productivity equals the marginal costs of capital. It can also be interpreted as the determination of the interest rate. The interest rate depends on the marginal productivity of capital and the depreciation rate:

$$i = f'(k) - \delta \quad \text{and} \quad i = f'(\hat{k}) - \delta. \tag{6.39}$$

Labour is also paid according to its marginal productivity, which is equal to:[10]

$$w = f(k) - kf'(k) \quad \text{and} \quad w = [f(\hat{k}) - \hat{k}f'(\hat{k})]e^{g_T * t}. \tag{6.40}$$

At this point, all components required for determining the developments of the capital stock and consumption have been laid out. The capital stock develops according to production per effective capital, effective consumption, the stock of effective capital, the rate of technological change and the depreciation rates:[11]

$$\dot{k} = f(k) - \delta k - c \quad \text{and} \quad \dot{\hat{k}} = f(\hat{k}) - (\delta + g_T)\hat{k} - \hat{c}. \tag{6.41}$$

[10] The following equation is deduced by derivating the production function to labour and combining it with equation 6.38.

[11] The following equation is derived by combining equations 6.33, 6.38 and 6.40.

Changes in consumption depend on the marginal productivity of capital, the depreciation rate, the time preference, the willingness for intertemporal substitution – and the rate of technological change[12]:

$$\frac{\dot{c}}{c} = \frac{f'(k) - \delta - \rho}{\theta} \quad \text{and} \quad \frac{\dot{\hat{c}}}{\hat{c}} = \frac{f'(\hat{k}) - \delta - \rho - \theta g_T}{\theta}. \tag{6.42}$$

Equations 6.41 and 6.42 together determine the development of consumption and capital over time. It is not possible to infer a constant rate of growth based on these two equations alone. But it is possible to determine a steady state rate of growth. This is the rate of growth within which capital, consumption and therefore also output grow at constant rates. As Barro and Sala-i Martin (2004) show, this is only the case if the variables $\hat{k}$, $\hat{c}$ and $\hat{y}$ do not grow over time. In this situation, physical capital, consumption and per capita income grow at the same rate, which is equal to the rate of technological change[13]:

$$\frac{\dot{k}}{k} = \frac{\dot{c}}{c} = \frac{\dot{y}}{y} = \frac{\dot{T}}{T} = g_T. \tag{6.43}$$

Exogenously given technological change was presented above as a central component of the Solow Model. Barro and Sala-i Martin (2004) also stress its importance:

> The main lesson to be learned from the neoclassical model is, in the long run, economic growth (that is, growth in per capita GDP) is driven by technological change. Without technological change, an economy can perhaps grow for a while by accumulating capital, but eventually growth will be come to an end due to the diminishing marginal productivity of capital. With technological change, however, growth can be sustained; and indeed the economy will converge to a steady state in which the rate of economic growth is exactly equal to the rate of (Harrod-neutral) technological progress (Barro and Sala-i Martin, 2004, p. 39).

The inability of capital accumulation or any other endogenous mechanism within the Neoclassical Growth Model to explain economic growth in the long run has led many to criticize it (e.g., Aghion et al. (1998)). It has

12 This equation is derived by combining equations 6.34 and 6.38.

13 For the case without technological change, there is no steady state rate of growth, as growth comes to an end when the capital stock has reached the level where the marginal productivity of capital is equal to the rate of capital depreciation. The steady state is therefore a state of zero growth. Its conditions are discussed below.

also contributed to the development of the so-called theories of endogenous growth, covered in chapter 7.

6.3.2 The Theory and Economies Without Growth

The Neoclassical Growth Model without technological change and the model with technological change are discussed in turn. In the model without technological change and constant labour, economic growth is determined by capital accumulation, given by equation 6.41. Setting this equation equal to zero, the condition for zero capital accumulation and zero growth is derived:

$$f(k) = \delta k + c. \tag{6.44}$$

Capital accumulation and economic growth come to an end once the entire sum of output is used for investments that replace capital depreciation and for consumption.

It can also be determined, at which combination of parameters this is the case. In this so-called steady state, not only capital but also all other variables – including consumption – do not change anymore. Setting equation 6.42 equal to zero yields

$$f'(k) = \delta + \rho. \tag{6.45}$$

The steady state and zero growth are existent when the marginal productivity of capital is equal to the depreciation rate plus the parameter ρ representing the time preference. This implies that accumulation stops at an earlier point, if the time preference is larger. The more important condition refers to the relationship between $f'(k)$ and δ however. For a given ρ, zero growth takes place at lower levels of production for higher depreciation rates.

Concerning technological change, there are three different sets of conditions for zero growth to take place in this case. The first is the simplest one. As argued above, growth of capital, consumption and output is determined by technological change in the long run. Therefore zero growth takes place when technological change is zero.

The second set of conditions is that technological change is countervailed by a decrease in labour supply. As technological change is labour-augmenting, its effect can directly be counteracted by reduced labour supply. In order to lead to zero growth, the decrease in labour supply needs to be the same size as the increase in effective labour due to technological change. As argued above, technological change increases effective labour according to the equation $\hat{L} = LT$. Combining this with equation 6.35 yields

$$\hat{L} = Le^{g_T \cdot t}. \tag{6.46}$$

Therefore, labour would have to change at the rate $-g_T$, so that

$$\hat{L} = LT = L\frac{1}{e^{g_T \cdot t}}e^{g_T \cdot t} = L. \tag{6.47}$$

As discussed in chapter 3, a reduction in average working hours is a central topic in the concepts of economies without growth and would also be reflected in this case. Here, the level of reduction in working hours can also be pointed out precisely: It has to be exactly the same percentage as the increase in labour productivity due to technological change. Other reasons for a reduction of labour could be a lower employment rate or a declining overall population.

The third set of conditions would be to have a decreasing amount of capital stock that countervails the increasing amount of effective labour due to technological change. In order to determine the exact rate of decrease, a concrete production function would be necessary. It is clear though that no steady state can be achieved in this situation, as per definition in a steady state situation all variables grow at the same speed. In this scenario, physical capital would decline, while output would stay the same. The reason could be a continuously declining savings rate, due to a high preference of consumption today over tomorrow. The other more likely reason is an increasing rate of capital depreciation, for example due to more natural catastrophes or dismantling industrial plants.

6.4 Results and Discussion

In this section, the insights from the investigation of the fundamental neoclassical theories are summarized and discussed. The first part of this section is a summary of the results. The question of stability is discussed first, followed by a discussion of different forms of technological change in zero growth economies. This leads to the development of possible zero growth scenarios. In the second part, the neoclassical theories are critically examined and it is discussed how this criticism influences the validity of the results.

6.4.1 Summary of Conditions

Within the neoclassical framework nothing essential needs to change in order to facilitate a zero growth economy in the short run. In the Basic

Macroeconomic Model, equilibrium implies zero growth. In the Solow Model and the Neoclassical Growth Model economic growth comes to an end automatically at a certain point, as long as no technological change takes place.

6.4.1.1 Stability

There is no mechanism that makes a zero growth economy unstable within the theories covered. As argued in the introduction (chapter 1), the existing literature on economies without growth entails several concerns on whether an economy can work without growth. These refer, in particular, to the problem of unemployment, whether positive interest rate is compatible with zero growth and whether production would collapse without growth. All these problems do not occur according to neoclassical theories covered in this chapter. Unemployment is not an issue, as it cannot exist. If unemployment occurs, wages fall, which induces people to work less and firms to employ more. The level of the interest rate depends on the supply of savings by households on the one hand and the demand for investments by firms on the other. If a zero growth economy is depicted by a relatively constant capital stock, investments are only necessary to the extent that depreciation of the existing capital stock takes place. This requires a low willingness to save and a low marginal productivity of capital. These two conditions would lead to a low but positive interest rate and would not imply any macroeconomic problems or instabilities. Finally, there is also no mechanism leading to a collapse or continuous shrinkage of the economy in case of zero growth. The most common argument for a collapse is that firms need to make a certain profit rate in order to have the incentive to keep producing. In the zero growth economy with a constant capital stock, firms make positive profits according to their capital stocks and the interest rate in case they own the capital themselves. In case they have to borrow the capital, they make zero profits but are still able to pay for all costs.

6.4.1.2 The Crucial Role of Technological Change

The central condition for a zero growth economy within the neoclassical framework is that the production capacity due to the available production factors does not change over time. In other words: The amount of effective capital and labour need to remain constant. This depends not only on the amount of capital and labour as measured in hours worked or the amount of machines[14] but on their productive capacity. There are various possible

[14] It is highly discussed whether physical capital can be counted in any meaningful manner. The related debates are called the Cambridge-Capital-Controversy, see for example Heine and Herr (2013).

sets of conditions of growth of one factor and shrinkage of another factor, as they can balance out each other due to the possibility of substitution. *Plausible*[15] combinations are limited within the neoclassical framework however. In the following, the conditions for a zero growth economy are discussed along the lines of different types of technological change, as for the Basic Macroeconomic Model.

a Harrod-neutral technological change

Usually labour-augmenting or Harrod-neutral technological change is assumed. In this case, the plausible condition for a zero growth economy are continuous reductions in average working hours. As shown in section 6.2, the labour-augmenting effect of technological change can best be countervailed by reducing labour itself. Within the neoclassical framework, the central explanation for working hours reductions is that people prefer more leisure over additional income. The central condition has been developed in section 6.3. The finding is that labour countervails the effect of technological change if it develops according to:

$$L_t = \frac{1}{e^{g_T t}} L_0. \tag{6.48}$$

The capital stock would stay constant in this scenario. Within a growing economy, the continuous increase of effective labour counteracts the effect of decreasing marginal returns to capital. Therefore, the marginal productivity of capital is kept above the depreciation rate and investments stay profitable. If labour decreases in a zero growth economy so that effective labour stays constant despite technological change, investments are only profitable to the extent that they balance out capital depreciation.[16]

b Solow-neutral technological change

Capital-augmenting or Solow-neutral technological change can be described as the opposite type of technological change. It increases the ef-

15 Other sets of conditions include the assumption that the supply of a production factor – labour or capital – *decreases* continuously, although its price continuously *increases*. This is regarded as *implausible*, as it contradicts the logic of neoclassical theories.

16 Harrod-neutral technological change can also be negative, so that it decreases effective labour. One explanation could be that the labour-augmenting technological change in the past has been due to increasing energy input and that decreasing energy input to achieve environmental sustainability would reverse this process and decrease the labour effectiveness Ayres and Warr (2005). In this case, the decreasing amount of effective labour would need to be compensated by higher average working hours, in order to generate zero growth.[17]

fectiveness of physical capital and keeps the effectiveness of labour constant. The condition for facilitating a plausible zero growth economy are a decreasing capital stock and therefore negative net investments. The reasoning behind this is essentially the same as before, only with opposite roles for labour and capital. The capital-augmenting technological change increases the amount of effective capital. Negative net investments would countervail this effect, meaning that investments are below capital depreciation. Possible reasons for investments to be very low are low marginal productivity of capital, high capital depreciation and/or little household savings. Combining equations 6.14, 6.17 and 6.35 yields

$$s\frac{F(TK,L)}{K} - \delta = \frac{1}{e^{g_T t}}. \tag{6.49}$$

The faster the technological change is, the lower the savings (s), the lower the marginal productivity of capital ($\frac{F(TK,L)}{K}$), and the higher the depreciation rate (δ) must be. Labour would stay constant over time. This goes along with constant preferences, as the amount of effective capital stays the same and therefore also the marginal productivity of labour is constant. Workers hence do not have a reason to either increase or decrease their labour supply and firms have no reason to change their labour demand.[18][19]

c Hicks-neutral technological change

Under Hicks-neutral technological change, the marginal productivities of the different production factors do not change due to technological change. In other words: The effectiveness of both capital and labour increases or decreases in the same proportion. If such technological change takes place, the most likely countermeasure is to have decreasing amounts of capital *and* labour. The mechanisms for such a development are a combination of those discussed above: low willingness to save concerning capital accumulation and a high preference for leisure time concerning labour. If only shrinkage of one of the production factors is to balance out the effect of technological change, its price (wage or interest rate) would rise continu-

18 Solow-neutral technological change with decreasing effectiveness of capital is also conceivable. In this case, capital accumulation would need to countervail the negative effect of technological change on economic growth.

19 The opposite (implausible) set of conditions is that the amount of capital stays constant and labour decreases. Such a development would increase wages continuously. Therefore, increasing wages would need to be accompanied by a large reduction in working hours and do so continuously. This requires continuously changing household preferences.

ously. This would lead to its higher supply, bringing its shrinkage to an end.[20]

6.4.1.3 Zero Growth Scenarios

All of the above and several other sets of conditions are conceivable from a theoretical standpoint. Another question is which of them are likely to take place in reality and are compatible with other concepts concerning economies without growth as outlined in chapter 3. Within the analyses of economies without growth, three scenarios have been developed (see chapter 4).

The combination of labour-augmenting (Harrod-neutral) technological change and reductions in average working hours is very similar to scenario I from chapter 4. In both, increases in labour productivity due to technological change are balanced out by a reduction in labour supply, so that overall production stays constant.

The combination of capital-augmenting (Solow-neutral) technological change and a decrease in the capital stock, as well as the combination of Hicks-neutral technological change and no change of the level of production factors could reflect the second scenario in chapter 4. There, it was argued that a redirection of technological change would stop the increase in labour productivity and instead increase resource productivity. Whether this goes along with a constant or decreasing level of capital has not been defined. This issue can be discussed in more detail in chapter 8, when natural resources are included as production factor.

6.4.2 Critical Assessment of the Fundamental Neoclassical Theories

The theories covered so far are models that constitute a great simplification of the macroeconomy. This simplicity has an advantage: On the one hand, such models are clear and stringent in their reasoning due to their mathematical nature[21] (Mankiw, 2006). They enable precise answers concerning economies without growth. In each model, several parameters need to be in a certain relation so that the economy generates zero growth. On the other hand, simple models have the disadvantage to cover only a very limited amount of aspects of the economy (Mankiw, 2006). For example, in the Solow Model capital accumulation is only determined by savings and the depreciation rate. In the real world, various other factors influence investments and capital accumulation, many of which will ap-

[20] Hicks-neutral technological change with negative effects on capital and labour effectivenesses would on the other hand need to be balanced out by continuous capital accumulation and more labour input.

[21] As compared to textual theories, see parts III and IV

pear in following chapters. Results of the preceding models therefore need to be interpreted accordingly: Each model depicts a very small number of mechanisms concerning for the determination of the level of production and its growth and hence each model can deliver only a very small number of insights concerning an zero growth economy. This is one reason for having chosen a pluralist approach as argued in section 1.3.

A more severe criticism of the theories of this chapter concerns the content and causal relations of the mechanisms themselves. It is argued in the following that many of the causations of the fundamental neoclassical theories are not accurate nor central in explaining what they intend to reveal. It is sometimes difficult to draw a clear-cut line between necessary simplifications to develop a model and a description of the economy that has very little to do with how it works in reality. As Mankiw (2006) puts it: "The line between simplifying and oversimplifying is often far from clear" (p. 4).

6.4.2.1 Investments, Capital Accumulation and the Interest Rate

In the fundamental neoclassical theories, a central determinant of investments and capital accumulation is the behaviour of households. Of special importance is their savings behaviour. In the Basic Macroeconomic Model, the preference of households to save is decisive in determining the level of the interest rate and subsequently the amount of investments. In the Solow Model, the exogenously given savings rate determines the speed of capital accumulation. Finally, in the Neoclassical Growth Model the time preference of households is important in deciding upon savings, which again determine investments[22].

This understanding of the determination of investments has been criticized by many authors (e.g., Keynes (2006), Heine and Herr (2013), Hein (2014)) and is one of the fundamental differences between neoclassical and other schools of economic thought, in particular the Keynesian theories (see part III). Keynesian authors argue that both the interest rate and investments are determined by other factors than savings and the state of technology, and that savings adjust to investments. While the savings behaviour can play some role, it is only of minor importance (this logic is laid out and discussed in more detail in part III). Overall, the argument

[22] It should be noted that the other important aspect determining the level of investments is the marginal productivity of capital. It increases the demand for money by firms, thereby raising the interest rate and savings. While it plays an important role, it is exogenously given however, so that the theories have little to say about why the marginal productivity of capital increases or decreases.

thus is that the central neoclassical mechanism to explain investments and capital accumulation does not cover any of the important determinants.

6.4.2.2 Labour, Working Time and Wages

Labour supply is either determined by households preferences and the wage level or by exogenously given factors such as average working hours. This reasoning has been criticized on several grounds. First, it assumes labour market clearing. This is clearly a stark and unrealistic assumption. The fact that unemployment exists often at high levels and for long time periods contradicts this assumption (Keen, 2002). Second, a strictly monotonic increasing labour supply function is assumed (in the Basic Macroeconomic Model), meaning that an increase in wage always leads to an increase in labour supply and that a decrease in wage has the opposite effect. It can be observed, however, that a decrease in the wage rate, for example, can lead to an increase in labour supply as people earn less and want to work more in order to keep their standard of living. Another example is that people with high wage levels start to decrease their labour supply, as they prefer leisure over additional income (Keen, 2002). The most important criticism is probably that people do not determine the amount they work according to their preference concerning income and leisure. Instead, it is argued that the amount of average working hours is primarily an outcome of social institutions, negotiations and struggles (see for example Hermann (2014) and also part IV). It is therefore questionable whether the mechanism of higher wages leading to higher labour supply is in fact the or at least one of the major determinants of average working hours.

6.4.2.3 The Speed and Type of Technological Change

Technological change is the central determinant of economic growth in neoclassical models and therefore also the most important aspect concerning conditions of economies without growth. It is exogenously given in the models covered so far. As it is unsatisfactory to have the central variable exogenously determined, the next chapter covers theories with endogenous technological change. The second critical aspect concerning technological change is that not only its speed of occurrence but also the type of technological change is assumed to have certain characteristics. In most cases, it is assumed to be labour-augmenting. This assumption is crucial for how the models function. However, why this is the case and under what circumstances it can change is not covered at this point but rather in chapters 7 and 8.

6.4.2.4 The Determination of the Level of Production

Thus far, the single mechanisms that are important for the level of production and economic growth have been assessed. It is also important to reflect on the overall logic of the models however. They are purely supply sided, meaning that any other aspect, in particular the role of aggregate demand, is neglected. Also, the central role of various institutions, such as market structure, ownership structure, the role of the state or the constitution of firms and labour unions are left out. As argued above, the reduction of the theory to only a few features is an inherent part of model building. Nevertheless, its limitations should be kept in mind. For this reason, other theories that cover these aspects are discussed in parts III and IV.

Chapter 7
Endogenous Technological Change

In the neoclassical models covered in the previous section the major determinant of growth, namely technological change, is exogenously given. Due to this shortcoming, various authors have endogenized technological change, so that the rate of technological change depends on parameters and mechanisms within the model. While contributions go back to the first half of the 20th century, only in the 1980s and 1990s was a set of theories developed that became prominent. Today, it is part of most neoclassical textbooks on economic growth. In the following, four different types of these endogenous growth theories are discussed. Theories in section 7.1 focus on *human capital* and its potential to account for constant instead of decreasing marginal returns to capital. In the theories of section 7.2, technological change is modelled as the outcome of *extensions* of the variety of production technologies (in the form of intermediate goods). Inventions take place in a separate sector, which is of monopolistic instead of competitive nature. In a similar vein, the Schumpeterian theories of section 7.3 argue that new technologies *replace* old ones so that labour productivity increases over time. In section 7.4, the Directed Technical Change approach is investigated. Here, technological change is not necessarily labour-augmenting but can take different forms. Finally, the results are summarized and discussed in section 7.5.

7.1 AK Model: Human Capital and Improvement of Knowledge

The AK Model is a simple model of endogenous growth.[1] In the Solow Model, production was determined by the amount of capital, labour and the exogenously given technology. Without exogenous technological change, economic growth comes to an end when depreciation equals investments. The reason is that capital is assumed to have decreasing marginal returns, while depreciation is a constant proportion of capital. In the AK Model, there are no decreasing marginal returns to capital. There are various lines of reasoning that explain why this might be the

1 "A" refers to the state of technology, "K" stands for the amount of capital.

case. The prominent contributions are outlined here, before laying out the model in detail.

According to Barro and Sala-i Martin (2004), the first to develop such an approach was von Neumann (1937). Other early contributions were made by Kaldor (Kaldor, 1957; Kaldor and Mirrlees, 1962), who argues that the accumulation of capital and the introduction of new technologies are closely intertwined. Therefore it makes no sense to distinguish their effects. The result is the *technical progress function*, discussed in further detail in section 11.6.

Arrow (1962) argues that technological change is the effect of increasing knowledge, which is equivalent to increasing experience. Investments lead to such new knowledge and experiences: “I therefore take instead cumulative gross investment (cumulative production of capital goods) as an index of experience. Each new machine produced and put into use is capable of changing the environment in which production takes place, so that learning is taking place with continually new stimuli” (p. 157). This approach was taken up later by Romer (1986) and Lucas (1988), whose seminal articles are often considered as the start of modern endogenous growth theory (Barro and Sala-i Martin, 2004).

In an early endogenous model with human capital by Uzawa (1965), investments in education play the central role. Labour can either be used for the production of goods or be invested in education. The more labour is used for education, the faster labour productivity increases: “The rate of improvement in labour efficiency, [...] then, may be assumed to be determined by the ratio of labour employed in the educational sector” (p. 19). Together with the rate of capital accumulation, the increase in education (or human capital) determines the rate of growth.

These lines of reasoning lead to the possibility of constant instead of decreasing marginal returns to capital (including physical and human capital). The AK Model is a widespread representation of such reasoning and uses a broad concept of capital including physical and human capital.[2]

[2] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following analysis of the AK Model is primarily based on its layout in Barro and Sala-i Martin (2004). Equal or similar representations can be found in Aghion and Howitt (2009), Aghion et al. (1998) and Acemoglu (2009). The model in section 7.1.1 is a reproduction of the existing model. The application of the model to zero growth in section 7.1.2 includes rearranging and recombining the equations of the existing model.

7.1.1 The Theory

The production function is given by

$$Y = TK. \tag{7.1}$$

The state of technology (T)[3] is still exogenously given. Contrary to the Solow Model, the accumulation of capital has constant instead of decreasing marginal returns. The rate of capital accumulation behaves similarly as in the Solow Model (only the production function is replaced, compare to equation 6.17). It is equal to the rate of economic growth (g), which is therefore determined by:

$$g = \dot{K} = sT - \delta. \tag{7.2}$$

As in the Solow Model, the savings rate for the AK Model can also be microfounded. A typical neoclassical consumption function with a time preference for consumption today (represented by the term ρ) and decreasing marginal utility of consumption, represented by the term θ (this equation is already familiar from section 6.3), $u(c) = \frac{c^{1-\rho}-1}{1-\theta}$ is used. Based on this function, the growth rate of capital accumulation and of economic growth is given by[4]

$$g = \dot{K} = \frac{(T - \delta - \rho)}{\theta}. \tag{7.3}$$

In the AK Model with an exogenously given savings rate economic growth depends on the level of technology, the savings rate and the depreciation rate (see equation 7.2). In the microfounded AK Model (equation 7.3), growth also depends on the state of technology, the depreciation rate and the savings behaviour. The difference is that the savings behaviour is not exogenously given but determined by the utility function, in particular the decreasing marginal utility of consumption and the time preference.

7.1.2 The Theory and Economies Without Growth

Within the AK Model, zero growth takes place if net investments are zero and no technological change takes place, or if the two cancel each other out. For the model with an exogenous savings rate, equation 7.2 is set equal to zero. This gives the following condition:

[3] In the AK Model, A stands for technology. Here the state of technology is denoted with T, as in the rest of this work.

[4] For a detailed derivation, see Barro and Sala-i Martin (2004, pp. 164 – 167).

$$sT = \delta. \tag{7.4}$$

Assuming a constant state of technology, savings times the state of technology needs to equal the depreciation rate, in order to generate zero growth. Compared to a situation with positive economic growth, either the savings rate needs to be lower or the state of technology needs to be less productive or the depreciation rate needs to be higher. (1) A lower savings rate intuitively makes sense: Lower savings imply less capital accumulation which countervails the effect of depreciation. (2) A lower value for T, signifies a lower capital productivity. This means that more accumulation is needed to countervail the effect of depreciation. (3) A higher depreciation rate implies that any given amount of investments is more likely to be balanced out by depreciation.

Equation 7.4 is based on the assumption that the state of technology stays constant – as is the determination of economic growth in equation 7.2. If the possibility of technological change is taken into account, more possible conditions for a zero growth economy appear. Totally differentiating equation 7.1, setting it equal to zero and combining it with equation 7.2 yields

$$\frac{\dot{T}}{T} = -\frac{sT - \delta}{K}. \tag{7.5}$$

The speed of technological change ($\frac{\dot{T}}{T}$) needs to be of equal size and in opposite direction as the speed of capital accumulation ($-\frac{sT-\delta}{K}$). One possibility is that technological change that increases the productivity of capital is countervailed by a decrease in the stock of capital. This implies that $sT < \delta$ (see 7.4). The other possibility requires technological change that decreases the productivity of capital ($\frac{\dot{T}}{T} < 0$). In this case, capital accumulation needs to be positive.

For the microfounded version of the AK Model, the condition for zero growth is derived by setting equation 7.3 equal to zero:

$$T - \rho = \delta. \tag{7.6}$$

The interpretation is essentially the same: Larger productivity of capital (represented by T) and larger values of savings (represented by ρ) lead to capital accumulation and need to be countervailed by larger depreciation (represented by δ).

Here, the possibility of technological change can also be included. Using the same total differentiation but combining it with equation 7.3, the condition for zero growth is

$$\frac{\dot{T}}{T} = -\frac{(T - \delta - \rho)}{\theta K}. \tag{7.7}$$

The interpretation of the result is the same as before: Either technological change increases labour productivity and is countervailed by a decrease of the capital stock (which is due to a depreciation that exceeds the gross capital accumulation) or technological change decreases labour productivity and net capital accumulation is positive.

This conclusion is similar to the one from fundamental neoclassical theories. Increases in one production factor need to be countervailed by decreases in another. It should be noted though that this result is probably contrary to the theoretical understanding underlying the models. Capital accumulation is commonly seen to be positively related to technological change that increases labour productivity. They are often seen as mutually dependent. Therefore, the idea of having the two developing into opposite directions is counterintuitive at first sight. At the same time, it could be argued that the accumulation of capital only entails physical and human capital – and the technology could nevertheless become less productive, for example because fewer natural resources are available. Such scenarios will be discussed in part 8.3.

7.2 Endogenous Technological Change I: Extension of Technologies

The previous set of theories endogenize growth by broadening the concept of capital, in particular by including human capital. In the set of theories depicted in this section, technological change is endogenized due to incentives for firms to invest in the development of more productive technologies. The mechanisms are related to the assumption of monopolistic instead of competitive markets.

Early contributions to this type of theories were made by Nordhaus and Nordhaus (1969) and Shell (1973) who both "assumed that research was motivated by the prospect of monopoly rents" (Aghion and Howitt, 2009, p. 24). Nordhaus and Nordhaus (1969) starts at the firm level. Firms can invest in productivity increasing technologies and do so according to profit maximization. On the one hand, innovations introduce Hicks-neutral technological change; on the other hand, their introduction is related to financial costs. Shell (1973) argues on the macroeconomic level. In his model, there are three sectors within the economy: one producing consumption goods, one investment goods and one dedicated to the development of new technologies. Here, the speed of technological change depends on how many resources are assigned to the third sector.[5]

Such considerations have been developed further by Spence (1976), Dixit and Stiglitz (1977), Ethier (1982) and finally Romer (1987, 1990) to what is today called the "Expanding Variety Models" (Acemoglu, 2009, p. 479). According to Aghion et al. (1998) the central idea can be summarized as follows: "growth is sustained by the increased specialization of labour across an increasing variety of activities: As the economy grows, the larger market makes it worth paying the fixed cost of producing a large number of intermediate inputs, which in turn raises the productivity of labour and capital, thereby maintaining growth" (p. 36).[6]

7.2.1 The Theory

The basic idea of the model is as follows: There are two sectors. In the first, the final good is produced. In the second, new technologies in the form of new intermediate goods are invented. The first sector is a competitive market, while the second is of monopolistic nature, as inventions are patented. There is a given supply of labour ($\bar{L}$), a part of which (L_1) is being used for the production of final goods and the other part (L_2) for research ($\bar{L} = L_1 + L_2$). In research, new designs for intermediate goods are developed with the sole input labour. The intermediate goods are used for the production of final goods, together with labour (L_1). Economic growth primarily depends on how fast new technologies are developed.

Final goods production is determined by the amount of labour employed (L_1), its productivity (represented by its exponent $1 - \alpha$), the amount (T) of designs or intermediate goods (χ) and their productivity represented by the exponent (α):

$$Y = L_1^{1-\alpha} \int_0^T \chi_i^\alpha di. \tag{7.8}$$

The production of new designs $\dot{T}$ depends on the productivity of research

[5] As Shell (1973) also introduced a depreciation of technical knowledge, his contribution could also be associated with the set of theories in section 7.3.

[6] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following illustration is based on Aghion et al. (1998). The model in section 7.2.1 is a reproduction of the existing model. The application of the model to zero growth in section 7.2.2 includes rearranging and recombining the equations of the existing model.

activities (ϖ_e), the amount of labour employed in this sector (L_2) and the existing state of technology (T):

$$\dot{T} = \varpi_e L_2 T. \tag{7.9}$$

For the determination of economic growth, it is crucial how labour is distributed among research and final goods production. The central condition is that the marginal product of labour has to be the same in both sectors (as workers are paid according to their marginal product and individuals work where they get the highest wage). How much labour is attributed to each sector depends on the productivities of labour in final goods production ($1-\alpha$), the productivities of the intermediate goods (α) and of research activities (ϖ_e). Additionally, the utility function influences the distribution of labour between the sectors, as inventive activities only allow for consumption in the future. This is represented by the time preference (ρ) and the intertemporal elasticity of substitution (θ)[7]. Economic growth is determined by

$$g = \frac{\alpha \varpi_e \bar{L} - \rho}{\alpha + \theta}. \tag{7.10}$$

Growth depends on the productivity of the intermediate goods (as it increases the production of final goods), the productivity of research activities (as it increases the speed of inventions), the total amount of labour (as a larger amount of overall labour increases the total amount of labour dedicated to the research sector), the time preference (as a willingness to postpone production increases the share of labour dedicated towards research) and on the intertemporal elasticity of substitution.

7.2.2 The Theory and Economies Without Growth

In the fundamental neoclassical theories, usually the development of three factors determine economic growth: labour, capital and the state of technology. Accordingly, the central condition for zero growth is that growth of one of these factors is balanced out by the shrinkage of another.

In the model of Endogenous Technological Change I, on the other hand, economic growth solely depends on the amount of labour and its productivity. The latter is determined by technological change. There are two possible sets of conditions for zero growth. The first assumes constant labour. In this case, the condition for zero growth is that labour

[7] The utility function from section 6.3 is here applied as well

productivity does not increase or that technological change does not take place. This condition is reached by setting equation 7.10 equal zero:

$$\alpha\varpi_e\bar{L} = \rho. \tag{7.11}$$

The parameters on the left hand side are all positively related to economic growth. The productivity of intermediate goods (α) increases production and also decreases the productivity of labour ($1-\alpha$) in the final goods production, which leads to a higher share of labour employed in the research sector. The productivity of research (ϖ_e) directly increases the speed of technological change. The amount of overall labour in the economy ($\bar{L}$) also accelerates technological change. The parameter on the right hand side, the time preference for consumption (ρ), is negatively related to economic growth. A stronger preference for consumption in the present decreases savings and therefore decreases the amount of resources (labour) dedicated to research. The condition for zero growth in this model is that the time preference is sufficiently high to balance out the other factors which lead to the invention of new technologies. As there is no depreciation of technological know-how, the time preference needs to be high enough, to deter any savings. Without savings, there are no investments in research and no technological change.

The second possible set of conditions is that the positive effect of labour-augmenting technological change is countervailed by reductions in labour supply. The primary effect of such a reduction is a direct reduction of production according to equation 7.8. This effect is therefore similar to the argument for working hours reduction in the fundamental neoclassical theories. Additionally, lower labour supply slows down technological change (see equation 7.9) in this theory. The exact speed of necessary reductions is difficult to determine, as the determination of technological change builds upon the assumption that labour stays constant.

7.3 Endogenous Technological Change II: Replacement of Technologies

In the previous model, technological change took place as an *extension* of the variety of intermediate products. Another set of theories treat technological change as a *replacement* of existing technologies by new ones (these are sometimes also referred to as Schumpeterian theories). The innovations lead to higher labour productivity. As the two sets of theories are similar, the following section is kept short and it is focussed on differences between the two[8].

7.3.1 The Theory

The economy consists of two sectors. The final goods sector is characterized by a competitive market. The entire production in the intermediate goods sector is generated by a monopolist. Labour supply is constant.

Production of the final good (Y) takes place by using labour (L) and intermediate goods (x). Productivity is not determined by the amount of intermediate goods but by the productivity of the current intermediate goods. This is why the production function does not entail an integral of the intermediate goods but a factor representing technologically determined productivity of the current intermediate good (T). Production is determined by:

$$Y = (TL)^{1-\alpha} x^{\alpha}, \quad \text{with} \quad 0 < \alpha < 1. \tag{7.12}$$

Production in the intermediate goods sector uses final goods as sole input. This is another difference to the prior set of models, in which labour was used as production factor in this sector. It is assumed that a monopolist needs one final good for the production of one intermediate good. This is why GDP is equal to final goods production minus the amount of intermediate goods produced:

$$GDP = Y - x. \tag{7.13}$$

The central idea of this model is that in each period a monopolist invests in the invention of a new intermediate good, which enables her to remain the monopolist also in the next period. If the invention fails, a random other monopolist produces the same intermediate good as in the former period. The first determinant of technological change is therefore the increase in productivity that is achieved by the invention (ϖ_r): $T_t = \varpi_r T_{t-1}$, with $\varpi_r > 1$. The second determinant of the (average) speed of technological change is the probability (ϑ) that the research effort is successful. It de-

[8] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The illustration of this model is based on Aghion and Howitt (2009). Similar models can be found in (Aghion et al., 1998; Acemoglu, 2009; Maußner and Klump, 1996). The model in section 7.3.1 is a reproduction of the existing model. The application of the model to zero growth in section 7.3.2 includes rearranging and recombining the equations of the existing model.

pends on the amount of investments in research (J_t) by the monopolist and the level of technology (T_t). Research is undertaken by the sole use of final goods as input. The probability of success is represented by the function $\vartheta = f(\frac{J_t}{T_t})$.

In case the invention is successful, the growth rate of technological change (which at the same time is the rate of economic growth) is given by $g_T = \frac{\varpi_r T_{t-1} - T_{t-1}}{T_{t-1}} = \varpi_r - 1$ (remember that $\varpi_r > 1$ by assumption). If the invention is not successful, the growth rate is equal to $g_T = \frac{T_{t-1} - T_{t-1}}{T_{t-1}} = 0$. The average growth rate of the economy is the growth rate in case the invention is successful, multiplied by the probability that it is successful:

$$g_T = f(\frac{J_t}{T_t})(\varpi_r - 1). \tag{7.14}$$

The rate of economic growth is determined by three factors: The higher the effectiveness of inventions (ϖ_r), the larger is the increase in labour productivity; the more investments are made in research (J_t), the higher is the probability that the invention succeeds; and the higher the level of the state of technology (T_t), the less likely inventions become (because easy inventions are realized first).

7.3.2 The Theory and Economies Without Growth

The sole determinant of economic growth is technological change. As in section 7.2, there are two possible sets of conditions. In the first set, the labour supply is constant. In this case, the condition for zero growth is that technological change does not take place. Based on equation 7.17 there are two possible reasons for that. If no investments are made in research, no inventions take place:

$$J_t = 0. \tag{7.15}$$

As a result, economic growth is also zero. Research expenditures are determined by the marginal cost and marginal benefit of research. While the cost is taken as constant (one unit of research costs one final good), the marginal benefit depends on the effectiveness of inventions and on the probability that it is successful. Research therefore becomes very small or even zero, if inventions are difficult and unlikely to take place. As it is assumed that research has decreasing marginal returns, zero research is unlikely though (because for low values of research, the marginal return is high).

The other possible reasons is that the increase in productivity due to an invention is equal to zero:

$$\varpi_r = 1. \tag{7.16}$$

This is also unlikely, as only inventions that are more productive than the existing ones are put into place. It is therefore not possible that in some periods there are negative and in some there are positive effects on productivity by inventions. It seems very unlikely that there would be no inventions at all and no increases in higher productivity.

While the conditions for no technological change seem implausible, the mechanisms within the model make continuously decreasing growth rates even likely to take place. First, with constant research expenditures, the increase in T_t over time automatically leads to decreasing growth rates. Second, not only the effort needed for inventions increases with the state of research, but also the additional productivity of inventions decreases (as the most effective inventions are being done first). This would lead to a decline of ϖ_r over time, further supporting declining growth rates.[9]

The second set of conditions entails a reduction in labour supply. Contrary to the specification in the previous section 7.2, less labour supply has no impact on the speed of technological change. Using equation 7.12, the necessary speed of reductions in labour supply is deduced. It needs to be equal to the speed of technological change:

$$g_L = -g_T = -f(\frac{J_t}{T_t})(\varpi_r - 1). \tag{7.17}$$

Note that this is the same result as in the Neoclassical Growth Model (section 6.3). The difference is that the determinants of the speed of technological change are specified here.

In conclusion, the most plausible condition for zero growth economies within this model is that labour-augmenting technological change is countervailed by reductions in average working time. The more productive and successful inventions are, the more reduction in labour is needed. As in many models, working hours reductions therefore play an important role. In the next section, also sets of conditions for zero growth without reductions in working time are derived. The reason is that technological change is no longer assumed to be only labour-augmenting but can take different directions.

9 Note that this reasoning corresponds to the argument in section 2.3.2 that current innovations bring about less productivity gains than previous ones.

7.4 Directed Technical Change: Different Types of Technological Change

Since the late 1990s, Directed Technical Change Models have emerged and rapidly entered many textbooks on economic growth theory.[10] Central contributions have been made by Daron Acemoglu (Acemoglu, 1998, 2001, 2002, 2003). Models of Directed Technical Change help to investigate two issues related to economic growth in particular.

First, models of Directed Technical Change provide a framework to explain not only the speed but the direction of technological change. So far in all models a certain type of technological change has been assumed, most of the times it was labour-augmenting. The models explain how fast the certain type of change takes place. The Directed Technical Change literature, on the other hand, explains which production factor the technological change augments. This can be applied to the questions whether it is labour-augmenting vs. capital-augmenting, skilled labour-augmenting vs. unskilled labour-augmenting and labour-augmenting vs. resource-augmenting. The theory can also be used to investigate whether technological change augments the productivity in environmentally dirty or clean sectors. The latter issue is part of section 8.5

Second, the models deliver a framework to improve the understanding of what determines the prices of production factors. An example often given by Acemoglu (1998, 2001, 2002) is why the difference between wages for skilled and unskilled labour increased in the 20th century despite the fact that the (relative) supply of skilled labour increased at the same time. This is counterintuitive from neoclassical perspective, as an increase in the supply of a production factor should decrease its price. Both issues have interesting implications for the conditions for zero growth economies, as will be seen in due course.

The Directed Technical Change Models build on earlier contributions on induced innovation such as Hicks (1932), Kennedy (1964), Samuelson (1965) and Drandakis and Phelps (1966). These contributions focus particularly on the question under which circumstances technological change is labour-augmenting or capital-augmenting. In the Directed Technical Change Models, there are two effects determining the direction of technological change. They are called *price* and *market size effects*. While the induced innovation literature already covered the first, the second is new in the recent models of Directed Technical Change.

The basic intuition of the model is as follows: Production takes place in two sectors, which use different production factors as input. One sec-

10 See for example Acemoglu (2009), Aghion et al. (1998), Aghion and Durlauf (2005), Aghion and Howitt (2009) and Eriksson (2013).

tor uses labour and the other uses another production factor, for example skilled labour, capital or land. Each sector applies its own set of machines. Technological change increases the productivity of machines and is undertaken by monopolists who can decide in which sector to innovate. They choose to innovate in the sector where they can gain the highest profits for their new machines. These profits depend primarily on two aspects. First, they are higher when the goods produced in the sector are more expensive: the *price effect*. Second, profits are larger when the machines can be sold and applied to a larger production: the *market size effect*. These two effects determine where technological change is directed.[11].

7.4.1 The Theory

The model is based on a typical utility function of a representative household,

$$\int_0^\infty \frac{C_t^{1-\theta} - 1}{1-\theta} e^{-\rho t} dt, \tag{7.18}$$

with the common notations: the consumption at time t is C_t; the intertemporal elasticity of substitution is θ; and the time preference is ρ.

Production is divided into two sectors, which produce two different final goods (Y_L and Y_Z). The aggregate produced is

$$Y = [\gamma Y_L^{\frac{\varepsilon-1}{\varepsilon}} + (1-\gamma) Y_Z^{\frac{\varepsilon-1}{\varepsilon}}]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{7.19}$$

γ determines how strong the application of each good influences the size of aggregate production and ε defines the elasticity of substitution between the two goods.

One good, Y_L, is produced with the use of labour (L) and a set of intermediate goods (χ_L), that is "machines" (Acemoglu, 2002, p. 787), similar to the logic in section 7.2. The number of machines is determined by the value N_L. The other good, Y_Z, is produced by the use of another production factor (Z)[12] and a different set of machines (χ_Z), whose number is determined by the value N_Z. β determines the productivities of the

[11] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following illustration is based on Acemoglu (2002). The model in section 7.4.1 is a reproduction of an existing model. The application of the model to zero growth in section 7.4.2 includes rearranging and recombining the equations of the existing model.

[12] According to Acemoglu (2002), this "could be capital, skilled labour or land" (p. 785).

different production factors (machines on the one hand and L and Z on the other) in each sector. Production in the two sectors is determined by

$$Y_L = \frac{1}{1-\beta}(\int_0^{N_L} \chi_L(j)^{1-\beta} dj) L^\beta \quad \text{and} \quad Y_Z = \frac{1}{1-\beta}(\int_0^{N_Z} \chi_Z(j)^{1-\beta} dj) Z^\beta. \tag{7.20}$$

Based on these production functions, the profit maximizing demand for machines is given by[13]

$$x_L = (\frac{p_L}{p_{XL}(j)})^{\frac{1}{\beta}} L \quad \text{and} \quad x_Z = (\frac{p_Z}{p_{XZ}(j)})^{\frac{1}{\beta}} Z. \tag{7.21}$$

Higher prices of the final goods (p_L and p_Z) increase the demand for the respective machines, as it becomes more profitable to apply them. Higher prices of the respective machines ($p_{XL}(j)$ and $p_{XZ}(j)$)that depend on price setting by the monopolists (see below) decrease the demand for them, as they are more expensive. Finally, a larger supply of the respective production factor (labour, L, and the other production factor, Z) increases the demand for the respective machines, as it implies more workers who can use the machines.

The monopolists who innovate face this demand for their machines. They innovate in the sector in which they can earn the largest profits. Profits per unit of production of monopolists are determined by the difference between the price of machines ($p_{XL}(j)$ and $p_{XZ}(j)$) and the costs they face (assumed to be of a certain size, $\xi = 1 - \beta$). In order to derive total profits of the monopolists, this difference is multiplied by the number of units they sell ($x_L(j)$ and $x_Z(j)$). Profits in the two sectors (Π_L and Π_Z) are therefore determined by

$$\Pi_L = (p_{XL}(j) - \xi) x_L(j) \quad \text{and} \quad \Pi_Z = (p_{XZ}(j) - \xi) x_Z(j). \tag{7.22}$$

Based on these profit equations and the machine demand functions from equation 7.21, net present discounted values of future profits (V_L and V_Z) are derived (additionally constant interest rates and profits over time are assumed). They are determined by

$$V_L = \frac{\beta p_L^{1-\beta} L}{r} \quad \text{and} \quad V_Z = \frac{\beta p_Z^{1-\beta} Z}{r}. \tag{7.23}$$

[13] This and several other derivations are not included here. The reader is referred to Acemoglu (2002) and Acemoglu (2009).

The equations 7.23 show the determinants of the profits monopolists can make in the two sectors. As monopolists invest according to the expected profits and higher investments lead to more innovations, this also determines the speed of technological change in the two sectors.

Two factors are central in determining the profits in equations 7.23. First, profits are larger for higher prices of the goods produced (p_L and p_Z). The reasoning is that higher prices of the final goods lead to more production in the final goods sectors, which in turn increases demand for the machines needed in this production: "a greater price for the product increases the value of the marginal product of all factors, including that of machines, encouraging firms to rent more machines" (Acemoglu, 2002, pp. 788 – 789). This effect is called the *price effect*. Second, profits increase with the amount of the production sector (L and Z) available in the respective production. Here, the idea is that a larger amount of available production factors increases production (as all available production factors are applied) and hence also increases the demand for machines and hence the profits for the monopolists: "A greater level of employment [...] implies more workers to use the machines, raising demand" (Acemoglu, 2002, p. 789). This is called the *market size effect*.

The two effects usually work in opposite directions. The central example mentioned above (see e.g., Acemoglu (2001)) is the effect of an increase in the supply of one of the two production factors. Z is determined as skilled labour and L is unskilled labour. According to Acemoglu (2001), the supply of skilled labour rose in the USA in the 20^{th} century. On the one hand, it leads to decreasing production costs in the final goods sector using skilled labour, as the wage for skilled labour decreases. The falling price of the skill-intensive good makes it less profitable to invest in new technologies to produce it. On the other hand, the increased supply of skilled labour expands the production of the skill-intensive good Z and hence increases profits in inventing new technologies to produce it.

An important question is which of the two effects is stronger. Acemoglu (2002) shows that this depends on the "elasticity of substitution between the two factors (and indirectly between the two goods)" (p. 790). The intuition is as follows: When the two goods are easily substitutable, the market size effect predominates the price effect. An increase of the supply of one of the production factors (e.g., skilled labour) leads to a decrease in the price of the skill-intensive good. If the substitutability of the two goods is low, the increase in the price will be high and the price effect is strong. If, on the other hand, substitutability is high, the increase in price will be low and the market size effect prevails.

Thus far, the profitability from innovations in the two sectors or what Acemoglu (2002) calls "the demand for innovation" (p. 791) has been investigated. The other aspect that needs to be understood are the costs associated with innovations or the "innovation possibilities frontier" (p. 791). The state of technology in the two sectors (N_L and N_Z) changes due to research in the respective sector (R_L and R_Z) and costs of achieving innovations in the two sectors (ϖ_L and ϖ_Z).[14][15] Technology therefore changes according to

$$\dot{N}_L = \varpi_L R_L \quad \text{and} \quad \dot{N}_Z = \varpi_Z R_Z. \tag{7.24}$$

In equilibrium, research in both sectors needs to be equally profitable. Based on this condition, the states of technology need to be of the relation

$$\frac{N_Z}{N_L} = (\frac{\varpi_Z}{\varpi_L})^{\sigma}(\frac{1-\gamma}{\gamma})^{\varepsilon}(\frac{Z}{L})^{\sigma-1} \tag{7.25}$$

in the steady state, with $\sigma \equiv \varepsilon - (\varepsilon - 1)(1 - \beta)$. The relation of the two states of technology in a steady state depends on the relation of innovation costs ($\frac{\varpi_Z}{\varpi_L}$), the relative supply of the production factors ($\frac{Z}{L}$), their relative importance in production ($\frac{1-\gamma}{\gamma}$), the elasticity of substitution between the goods (ε) and the elasticity of substitution between the production factors (σ).

As Acemoglu (2002) is in particular interested in whether a change in the relative supply of the production factors ($\frac{Z}{L}$) changes the direction of technology, he focusses on the analysis of the role of σ. If the two production factors are gross substitutes ($\sigma > 1$), increasing the supply of Z also increases the relative productivity of that production factor (increasing $\frac{N_Z}{N_L}$). If, on the other hand, the production factors are gross complements ($\sigma < 1$), increasing the relative supply of Z will lead to a lower relative productivity of that factor. In other words, when substitutability between the factors is high, the market size effect prevails and an increase in the supply of a factor leads to innovation in the corresponding sector. When substitutability is low, it is the other way around. The price effect prevails and a higher supply leads to less innovations using that production factor.

Finally, the model can also be used to determine the overall growth rate. In the steady state, it is given by

$$g = \theta^{-1}(\beta[(1-\gamma)^{\varepsilon}(\varpi_Z Z)^{\sigma-1} + \gamma^{\varepsilon}(\varpi_L L)^{\sigma-1}]^{\frac{1}{\sigma-1}} - \rho). \tag{7.26}$$

[14] Note that this conception is equivalent to the concept of productivity of research activities in section 7.2, hence the same connotation is used.

[15] Acemoglu (2002) develops two manners to model the costs of innovations. Only one of them is covered here, in which innovations are not state-dependent, meaning that the current productivity of innovations does not depend on the innovations of the past.

The growth rate depends on a large number of variables. These include the preferences of the households (θ and ρ), substitution elasticities (σ and ε), the relative role of the production factors (γ), the supply of production factors (Z and L) and the productivities of research activities (ϖ_Z and ϖ_L). The latter two will be of particular interest for the coming question, under which circumstances a zero growth economy is feasible.

7.4.2 The Theory and Economies Without Growth

7.4.2.1 Conditions in General

The conditions for zero growth in the Directed Technical Change Model can be derived by setting equation 7.26 equal to zero:

$$\theta^{-1}(\beta[(1-\gamma)^{\varepsilon}(\varpi_Z Z)^{\sigma-1} + \gamma^{\varepsilon}(\varpi_L L)^{\sigma-1}]^{\frac{1}{\sigma-1}} - \rho) = 0. \tag{7.27}$$

There are numerous possible combinations of the development of the variables in the equation to fulfil this condition. Here, three are covered. The first possibility is the very unlikely case that $\theta = \infty$.

The second more relevant possibility is that the term in the brackets $((\beta[(1-\gamma)^{\varepsilon}(\varpi_Z Z)^{\sigma-1} + \gamma^{\varepsilon}(\varpi_L L)^{\sigma-1}]^{\frac{1}{\sigma-1}} - \rho))$ is equal to zero. This is more probable when ρ takes high values and all the other factors take low values, in particular the productivities of research (ϖ_Z and ϖ_L). The intuition behind this is that ρ determines the willingness of households to save, and these savings are necessary for investments in research. The less willing the households are and the less productive the research is, the smaller the level of investments and hence also growth is.

The third, maybe most relevant option is to decrease the amounts of production factors available for production. Such a decrease would be able to countervail the positive effect of higher factor productivities on production. This effect can best be discussed by looking at equations 7.20. Production in the two sectors (Y_L and Y_Z) increase because of technological change (N_L and N_Z). The resulting growth can be countervailed by a decrease in the production factors (L and Z). The exact relations are again (as in the case of Endogenous Technological Change I) difficult to determine. The reason is that a change in the production factors also influences the speed of technological change, but the determination of the speed builds on the assumption of constant production factors.

The interpretation of such an outbalancing of technological change by a reduction in production factors depends on how the production factors are defined. As pointed out above, Acemoglu (2002) states that L should be interpreted as (unskilled) labour and Z either as skilled labour, capital or land.

Following Acemoglu's major example, L can be defined as unskilled and

Z as skilled labour. In this case, the increasing labour productivities that are achieved due to research would need to be countervailed by a decrease in labour supplies. As a constant population is assumed throughout the present work, labour supply can only be reduced by a reduction of average working hours. The exact relation depends on the relative productivities of skilled and unskilled labour and machines (in other words on the value of β, see equation 7.20).

Z can also be defined as capital and L as labour. Again, one of the two would need to decrease in order to balance out increases in productivity. Several combinations are possible. As there is no capital accumulation, the changes in labour or capital take place exogenously. Therefore, the same interpretation as above applies (the exact relations depend on the value of β). Economically speaking, the technological change needs to be balanced out by a reduction of average working hours and/or a shrinkage of the capital stock.

7.4.2.2 Natural Resources as Second Production Factor

It is most interesting regarding economies without growth when the production factor Z is interpreted as natural resources[16] and L is labour. In this case, an exogenously given decrease in the use of natural resources (as for example argued for by Aghion and Howitt (2009, Chapter 16.3)) accounts for the decrease of natural resources over time. Assuming a constant supply of labour, this could countervail the effects of increasing productivities. The supply of natural resources would decrease exogenously and consequently the development of environmental quality is given exogenously, as well.

Hence, the model primarily gives a framework to understand distributional effects. There are two specifications that lead to different distributional outcomes due to different elasticities of substitution. The decrease of natural resources has a price and a market size effect. A lower supply of natural resources increases its price and the price of the goods produced in the sector. This encourages research in resource-augmenting technical change. At the same time, the lower availability of natural resources decreases the production in this sector and therefore the profits from innovations in resource-augmenting technical change. Which effect prevails depends on the elasticity of substitution between labour and natural resources. If the substitution is high, the market size effect prevails and research is directed to labour-augmenting innovations (specification one). In case of low substitutability, the price effect dominates and research

16 Acemoglu (2002) calls it "land" (p. 785), but an interpretation of natural resources seems more timely and relevant.

is resource-augmenting.[17] The outcome has an effect on the distribution of income between the two production factors (specification two). In the first specification, the marginal product of labour increases and hence also the wage rate goes up. In the second specification, the price of natural resources increases relatively to the wage rate.

These two specifications are taken up in chapter 9. Specification one refers to Scenario II and specification two refers to Scenario III. Directed Technical Change is therefore the first theory which does not emphasize the role of working hours reductions. In all prior theories, a reduction in labour supply was the most plausible condition for zero growth. The Directed Technical Change Model instead suggests reductions in the supply of natural resources. This either leads to zero growth with labour-augmenting or resource-augmenting technological change. Section 8.5 covers a further application of Directed Technical Change. It deals with the question of whether technological change takes place in a clean or a dirty sector. Beforehand, more basic models, which include environmental aspects in the neoclassical framework, are discussed.

7.5 Results and Discussion

7.5.1 Summary of Conditions

In the discussion on fundamental neoclassical theories, the conditions for zero growth have been developed for different scenarios with different types of technological change. This made sense because technological change is exogenous to the models and therefore there is no compulsory reason for it to have specific characteristics. In the endogenous growth theories, certain types of technological change are explained endogenously. Most models allow for only one type of technological change (the DTC approach is the exception). The conditions reflect these assumptions.

7.5.1.1 Technological Change, Again

The AK Model has been interpreted in a similar manner. It can however not be separated between different types of economic growth, as there is only one production factor: capital. Therefore, the condition for zero growth is either a combination of positive technological change and a decrease in capital, or negative technological change and positive capital accumulation. As capital includes both human and physical capital in the AK Model, a third scenario is possible. Here, with a constant state of

[17] The two specifications will be part of two different scenarios for sustainable economies without growth in chapter 9.

technology, one kind of capital (e.g., human capital) can increase, while the other (physical capital) decreases to the same extent[18].

The models Endogenous Technological Change I & II, have both two specifications for zero growth. In the first, labour supply is constant and technological change is zero. The reasons for no technological change vary slightly between the two models. Generally speaking, innovations have to be very costly and ineffective. In the second specification, the positive effect of technological change is countervailed by working hours reductions. As technological change increases the effective amount of labour and working hours reductions decrease it, the two effects balance out each other so that effective labour stays constant.

The Directed Technical Change approach generates similar results. Zero Growth Economies either need to be characterized by negative technological change or a decrease in one or several production factors. The Directed Technical Change approach allows for the analysis of different production factors. Most relevant here is that zero growth economies could be achieved by either decreasing labour supply and/or decreasing use of natural resources.

7.5.1.2 Zero Growth Scenarios

The fundamental neoclassical theories included two plausible scenarios for zero growth. In the first, Harrod-neutral technological change is balanced out by working hours reductions. In the second scenario, a combination of Solow-neutral technological change with decreasing capital stock and natural resource use leads to zero growth.

The results from endogenous growth theories elaborate on the first scenario. Concerning the first scenario, they elaborate on the determinants of the speed of technological change and thus on the necessity to decrease one of the production factors, in particular labour. The speed of technological change depends on market structures, on the amount of resources dedicated to research and on the effectiveness of research. By determining the speed of technological change, the necessary speed of working hours reductions is deduced.

The endogenous growth theories additionally point towards two scenarios that include natural resources. Exogenously (e.g., by the government) given reductions in natural resource use influence the type of technological change and under certain conditions this leads to zero growth. Whether the resulting technological change is labour-augmenting or resource-augmenting depends on the elasticity of substitution between

18 For models with physical and human capital, see for example Uzawa (1965); Lucas (1988); Rebelo (1990); Caballé and Santos (1993)

the production factors. High substitutability leads to labour-augmenting technological change, low substitutability to resource-augmenting technological change.

Hence, there are three plausible scenarios for zero growth within the logic of endogenous growth theories. The first is already known from chapter 6. Labour-augmenting technological change is combined with reductions in working hours (Scenario I in chapter 9). In the second, reductions in natural resources do not change the direction of technological change. The resulting labour-augmenting technological change does not need to be balanced out by reductions in working hours though, as the decreasing use of natural resources has already a negative effect on production (Scenario II in chapter 9). In the third scenario, reduced use of natural resources leads to a redirection of technological change towards resource-augmentation. The effects of less natural resource use and resource-augmenting technological change balance out one another and generate zero growth (Scenario III in chapter 9).

7.5.2 Critical Assessment of Endogenous Growth Theories

The central intention of endogenous growth theories is to explain continuous economic growth differently than simply referring to exogenously given technological change. The theories in this chapter have found varying solutions to explain continuous economic growth. In the following, the theories are critically examined.

7.5.2.1 The AK Model

In the AK Model, growth is primarily due to the accumulation of capital, which includes physical and human capital. There are two central criticisms concerning this model. First, technological change is still exogenous. This limits the extent to which the mechanisms behind economic growth are explained within the model (Aghion et al., 1998). Second, the concept of capital is central in this theory but highly vague, and it is unclear how it can be quantified or aggregated (Hein, 2004). In the model, it is argued that investments in both physical and human capital increase the amount of capital. But there is no discussion or explanation concerning the question in how far such a broad concept of capital has any meaning (Kurz and Salvadori, 1998). Regarding the fact that there is a serious debate whether even physical capital can be aggregated, this is probably also a problem when combining it with human capital. Kurz and Salvadori (1998) make that point very strongly:[19]

[19] Due to the lack of a coherent explanation of the concept of capital, the AK Model and its conditions for zero growth are not taken up in the following discussions on conditions for zero growth economies.

> The overwhelming weight attributed to that factor [capital], its accumulation and incessant qualitative revolution consequent upon the growth in technological knowledge would seem to have as a prerequisite the elaboration of a coherent long-period notion of capital. However, nothing even remotely resembling a serious attempt to come to grips with this problem is to be found in the NGT [new growth theories, equivalent to what is called endogenous growth theories here]. On the contrary, the representatives of that theory seem simply to ignore the results of aggregation theory and of the controversy in the theory of capital in the 1960s and 1970s (Kurz and Salvadori, 1998, p. 85).

Third, the same criticism concerning the mechanism behind investments and savings that applied to fundamental neoclassical theories is also the case for the AK Model.[20] It is assumed that savings lead to investments and that the two are brought into equilibrium via the interest rate. As argued in section 6.4.2, it is questionable whether this mechanism suffices to guarantee an identity between savings and investments.

7.5.2.2 The Three Models with Endogenous Technological Change

In the other three models, economic growth is entirely due to technological change. Technological change takes place in a monopolistic sector of the economy. While the fundamental neoclassical theories assumed perfect competition in all sectors, these models divide the economy into different sectors, some being characterized by perfect competition, some by monopoly. As Dunn (2002) points out, this description of the economy is unrealistic, as inventions take place in all sectors of the economy and they are not confined to only those sectors with higher market concentration. Also, it is not the case that some sectors invent and other sections use the inventions for final goods production.

A second important point of criticism concerns the fact that the levels of the production factors are exogenously given. In Endogenous Technological Change I & II, labour is the only production factor, and it is exogenously given. In the Directed Technical Change theory, different combinations of two production factors are possible; their levels are still exogenously given though. Hence, the theories deliver no explanation for possible reductions in average working hours or the supply of natural resources.

In this line of reasoning, Kurz and Salvadori (2003) come to the conclusion that endogenous growth theories do not contribute anything particularly new. They "revolve around a few simple and rather obvious ideas

[20] Original quote in German: "Die keynesianische Kritik an der neoklassischen Wachstumstheorie trifft in vollem Umfang ebenfalls die Neue Wachstumstheorie" (Hein, 2004, p. 129).

which have been anticipated by earlier economists" (p. 21). Compared to the fundamental neoclassical theories, they nevertheless contribute to the understanding of economic growth and therefore the conditions for zero growth – namely the aspect that monopolistic competition plays an important role in explaining the invention of new technologies. This matter is taken up again in particular in part IV.

The results from the preceding chapter need to be viewed with these points of criticism. Their strength lies within a clear understanding of types of technological change. They also contribute to the mechanisms determining its speed and its direction. At the same time, they leave out many important additional aspects that influence technological change. Finally, they are weak in explaining the developments of the production factors labour, capital and natural resources. These issues are taken up in part III and IV.

Chapter 8
Environment and Technology

The classical theories of Smith, Malthus, Ricardo and others (see section 2.3.1) take nature as a production factor seriously. Older neoclassical theories on the other hand focus on other production factors. As has been seen in the previous two chapters, these are capital, labour and sometimes human capital. Nevertheless, a vast amount of macroeconomic models that include an environmental analysis have been developed since the 1970s.

The debate on the connection between economic activity and environmental aspects can be separated into issues on sources and sinks (see also section 2.2). This is also reflected in the models. Environmental aspects are either included as natural resource use (a source) or pollution (a sink). While early contributions mainly concentrated on finite natural resources, more recent works often include pollution.

The models concerning the use of natural resources can be further divided into those concerning renewable and non-renewable resources. As especially the latter ones play a central role in the debate on economic growth and the environment, only those are covered here. The contributions on pollution can be grouped into approaches that use "end-of-pipe abatement" and "beginning-of-the process activity" (Eriksson, 2013, p. 169). In the former, abatement leads to a reduction of pollution after the pollution has been generated. Pollution is first determined by the level of production and the pollution intensity and then reduced based on the level of abatement and its effectiveness. In the latter, the pollution intensity of production is reduced in the first place. Investments in cleaner production technologies lead to cleaner production and overall less pollution than for investments in dirty production. Models of both types are included below.

There are models for every possible combination between the growth theories covered thus far and the types of modelling environmental aspects just mentioned. It is beyond the scope of this work to discuss all possible combinations. Therefore, a specific set of models has been selected. In order to cover a wide range of theoretical arguments, the models were chosen so that every type of economic growth theory from the previous two chapters has been included at least once and each of the manners to model environmental aspects is being used at least once.

The first model is called the Dasgupta-Heal-Solow-Stiglitz Model. It combines static macroeconomic models (section 6.1) with non-renewable resources. Second, the Green Solow Model combines the Solow Model (section 6.2) with end-of-pipe pollution abatement. Third, the AK Model (section 7.1) is extended to include pollution abatement that actually has features of both, end-of-pipe and beginning-of-the-process abatement. Fourth, an endogenous technological change model with replacement of the technological state (from section 7.3) is combined with non-renewable resource use. Finally, a model of Directed Technical Change (from section 7.4) with pollution only in dirty sectors in included.[1]

8.1 Dasgupta-Heal-Solow-Stiglitz Model: Substitution and Technological Change

In the 1970s, following the publication of the report *The limits to growth* (Meadows et al., 1972), several influential papers were written by well-known economists on the connection between economic activity and non-renewable resources: "Exhaustible resources were integrated into the neoclassical growth model in the early 1970s. This happened partly as a reaction to various reports focusing on the limits to growth" (Erreygers, 2009, abstract). According to Groth (2007) "Prominent economists [...] took these challenges as an occasion for in-depth studies of the macroeconomics of non-renewable resources, including the big questions about sustainable development, defined as non-decreasing standard of living, or even sustained economic growth" (p. 127). These early considerations integrate environmental aspects and in particular the role of non-renewable resources into the basic neoclassical framework. Particularly influential were the publications by Dasgupta and Heal (1974), Stiglitz (1974) and Solow (1974a,b).[2]

1 Insights from environmental models using a Neoclassical Growth Model are very similar compared to those using the Solow Model and insights from environmental models using endogenous technological change with extension of the technological state are very similar to those using endogenous technological change with replacement of the technological state. For this reason Neoclassical Growth Models and endogenous technological change models with extension of the technological state are not covered in this chapter.

2 Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is primarily based on Groth (2007), who compiles the contributions from the aforementioned authors. The model in section 8.1.1 is a reproduction of an existing model. The application of the model to zero growth in section 8.1.2 includes rearranging and recombining the equations of the existing model.

8.1.1 The Theory

The model introduces a third factor of production to the production function from section 6.1: Non-renewable natural resources. The size of production is therefore determined by capital (K), labour (L), natural resources (R) and by the state of technology (T):

$$Y = F(K, L, R, T). \tag{8.1}$$

The developments of the capital stock and labour are already familiar from previous models. The development of physical capital depends on savings and depreciation

$$\dot{K} = sY - \delta K. \tag{8.2}$$

Labour changes according to an exogenously given rate

$$L_t = L_0 e^{nt}. \tag{8.3}$$

The developments concerning natural resources are new, however. As the natural resource is argued to be a non-renewable resource, there is a given stock of the resource (S), which changes according to its use (R):

$$\dot{S} = -R. \tag{8.4}$$

As there is a limited amount of the resource, the aggregate use of the resource cannot exceed its original stock ($S(0)$). This is represented by the following equation:

$$\int_0^\infty R_t dt \leq S(0). \tag{8.5}$$

According to Groth (2007), the mentioned economists investigated the question "what are the conditions needed to avoid a falling level of per capita consumption in the long run in spite of the inevitable decline in resource use?" (p. 134). They found three possible conditions, namely "substitution, resource-augmenting technical progress, and increasing returns to scale" (p. 134). In the following, the first two of them are examined, as they are of major importance in the theoretical discussions and of more concern in the following analyses.

8.1.1.1 Substitution

The first possibility to combine economic growth with decreasing resource use depends on the level of substitutability. To investigate the role of substitution, it is necessary to specify the production function beyond arguing that three production factors plus the state of technology determine production. In the Dasgupta-Heal-Solow-Stiglitz Model, a production function with constant elasticities of substitution is chosen. The function has constant returns to scale but there is no perfect substitutability (unlike the Cobb-Douglas function used above):

$$Y = (\alpha K^{\Psi} + \beta L^{\Psi} + \phi R^{\Psi})^{\frac{1}{\Psi}}, \tag{8.6}$$

with $\alpha, \beta, \phi < 1$, $\alpha + \beta + \phi = 1$, $\Psi < 1$ and $\Psi \neq 0$.

It is crucial how large the elasticity of substitution is. The elasticity of substitution is defined as the percentage rise of the ratios $\frac{K}{R}$ and $\frac{L}{R}$ that are caused by a one percentage change of the ratio of the price of the inputs $\frac{p_R}{p_K}$ and $\frac{p_R}{p_L}$ (p_R, p_K and p_L denote the prices of one unit of natural resources, physical capital and labour respectively). For the model above, this elasticity is given by the equation

$$\sigma = \frac{1}{1 - \Psi}. \tag{8.7}$$

Groth (2007) argues that the answer to the central question of whether a decline in per capita income can be prevented facing decreasing usage of natural resources, depends on the elasticity of substitution. In particular, if $\sigma > 1$ (which is the same as the assumption $0 < \Psi < 1$) continuous per capita growth is possible. The reason is that natural resources are "*inessential* in the sense that it is not necessary for a positive output". If, on the other hand, $\sigma < 1$ ($\Psi < 0$) continuous per capita growth is not possible. The reason is that the resource is "*essential* in the sense that output is nil in its absence" (p. 135). The intermediate case is where $\Psi < 0$. This is the case of Cobb-Douglas. According to Groth (2007), in this case the resource is essential and "at the same time output per unit of the resource is not bounded from above" (p. 135 − 136). Output can therefore be positive over an indefinite time.

The underlying intuition behind substitution is as follows: The supply of natural resources decreases.[3] This leads to an increase of its price.

[3] In the early contributions in the 1970s, this was commonly argued to be a decision of the owners of natural resources. They decide upon the level of supply due to considerations of profit maximization. One central outcome was that while constant consumption is possible in the Cobb-Douglas case

Therefore, it is substituted by labour and/or capital. If the increase in price causes a sufficiently high substitution of natural resources by other production factors, economic growth can take place. If the substitution is small, economic activity declines over time, due to declining supply of natural resources.

Whether substitution of natural resources is feasible also depends on which other production factor it is substituted by, physical capital or labour. In the aforementioned papers from the 1970s, the focus was on the question of whether physical capital can substitute natural resources. This can answer whether economic growth *per capita* is feasible in light of decreasing natural resource usage. The analysis can also be applied to labour however. It suggests that increases in the price of natural resources leads to more usage of labour. The first crucial question is thus how the supplies of physical capital and labour respond to such changes. While physical capital can be accumulated, labour supply can only be increased to a limit extent for a given population.

8.1.1.2 Resource-Augmenting Technological Change

The second possibility to reconcile decreasing resource use with non-decreasing per capita income is to introduce resource-augmenting technological change. The concept is equivalent to labour-augmenting technological change introduced in chapter 6. Technological change increases the *effectiveness* of natural resources. In this manner, constant or even increasing production is facilitated. The production function from equation 8.6 is modified to

$$Y = (\alpha K^{\Psi} + \beta L^{\Psi} + \phi(T_R R)^{\Psi})^{\frac{1}{\Psi}}. \tag{8.8}$$

Technological change alters the effectiveness of natural resources (T_R) by a certain percentage (y_R) in each period:

$$T_R = e^{y_R t}. \tag{8.9}$$

Economic growth (and growth per capita if constant L is assumed) increases if the supply of natural resources decreases slower than the natural resource effectiveness rises:

$$\frac{\dot{R}}{R} < y_R. \tag{8.10}$$

under a social planner it does not result from the behaviour of profit-maximizing economic actors. Accordingly, in other contributions (see also section 8.4) the government determines the supply of natural resources.

The use of natural resources needs to be of such nature that the stock is never entirely depleted (in other words, so that condition 8.5 is satisfied). Under such conditions, "the finiteness of nature need not be an insurmountable obstacle within any timescale of practical relevance" (Bretschger and Smulders, 2007, p. 136). The feasibility to reconcile continuous growth with decreasing use of natural resources therefore entirely depends on the rate of resource-augmenting technological change.

8.1.2 The Theory and Economies Without Growth

The degree of substitutability and that of resource-augmenting technological change also matter for the conditions of zero growth economies. High substitutability and sufficient resource-augmenting technological change represent two different specifications of the Dasgupta-Heal-Solow-Stiglitz Model (these two specifications refer to two different scenarios in chapter 9).

First, the role of substitution in a zero growth economy is examined. As above, an increasing price of natural resources and consequently a substitution of them by capital and/or labour is assumed. In order to generate zero growth, the negative effect of using fewer natural resources needs to be exactly countervailed by the positive effect(s) of the additional use of the other two production factors. Regarding equation 8.6, the condition is thus $\alpha\Delta K^{\Psi}+\beta\Delta L^{\Psi}=\phi\Delta R^{\Psi}$. The function is rearranged and the feature of the production function that "the elasticity of substitution between all pairs of production factors is the same" (Bretschger and Smulders, 2007, p. 135) is used: $\Delta K=\Delta L\equiv\Delta F$. The resulting condition is

$$\frac{\Delta R}{\Delta F}=\sqrt[\Psi]{\frac{\alpha+\beta}{\phi}}. \tag{8.11}$$

The relation between the necessary increase of capital and labour (ΔF) to countervail the decrease in the usage of natural resources (ΔR) therefore depends on the elasticity of substitution (dependent on Ψ) and in particular on the parameters α, β and ϕ, representing the productivities of the production factors. The more productive capital and labour (higher values for α andβ) are relative to natural resources (lower values for ϕ), the larger the relation between the change in natural resources and the other two production factors must be. In other words: If capital and labour are more productive compared to natural resources, a large decrease in natural resources can be countervailed by a relatively small increase in the other two factors. Equation 8.11 depicts the exact relations.

Second, the case of resource-augmenting technological change is investigated. The economy generates zero growth when the technological change increases the effective amount of the natural resources to exactly the same extent as the use of it decreases:

$$y_R = \frac{\dot{R}}{R}. \tag{8.12}$$

Additionally, both capital and labour need to stay constant. Using equations 8.2 and 8.3 the already familiar conditions $sY = \delta K$ and $n = 0$ are derived. This is the case when the only thing that changes is the technologically determined productivity of natural resources. In case of additional capital accumulation, increases in the supply of labour or factor-augmenting technological change, the decrease of the use of natural resources would need to be stronger ($y_R < \frac{\dot{R}}{R}$).

8.2 Green Solow Model: Abatement

In neoclassical approaches, the connection between environmental degradation and economic growth is often modelled by including an abatement sector in the model. This sector reduces the pollution that takes place in the rest of the economy.[4]

8.2.1 The Theory

The basic set up of the model is very similar to the Solow Model of section 6.2. The production function entails labour-augmenting technological change. Production (Y) is determined by the amount of capital (K), labour (L) and the state of technology (T):

$$Y = F(K, TL). \tag{8.13}$$

Investments depend on the savings rate (s) and overall production (Y). Capital accumulation is the result of investments and the depreciation (δ) of the capital stock (K):

$$\dot{K} = sY - \delta K. \tag{8.14}$$

The amount of labour develops due to an exogenously given rate (g_L):

[4] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is based on Brock and Taylor (2005, 2010). The model in section 8.2.1 is a reproduction of the existing model. The application of the model to zero growth in section 8.2.2 includes an interpretation of the model's equations.

$$\dot{L} = g_L L. \tag{8.15}$$

Labour productivity also evolves at an exogenously determined rate (g_T):

$$\dot{T} = g_T T. \tag{8.16}$$

Pollution (E) is defined by the average pollution intensity of economic activity (Ω) and the size of the economy (Y). Additionally, it depends on the amount of abatement practised (A), which in turn is determined due to a function of overall production (Y) and the amount of production used for abatement (Y^A) (instead of using it for consumption or investments). One unit of abatement reduces pollution to the same extent as production generates pollution (Ω). Overall pollution is given by

$$E = \Omega Y - \Omega A(Y^A, Y) = \Omega Y[1 - A(1, \frac{Y^A}{Y})] = Ye(\Phi), \tag{8.17}$$

with $e(\Phi) \equiv \Omega[1 - A(1, \Phi)]$ and $\Phi = \frac{Y^A}{Y}$. Intuitively, the level of pollution depends, in addition to the pollution intensity, on the share of production dedicated to abatement and the effectiveness with which these efforts are translated into abatement. The development of environmental quality is the combination of pollution and natural regeneration. The latter is assumed to be a portion (ς) of the current quality of nature (N):

$$\dot{N} = Ye(\Phi) - \varsigma N. \tag{8.18}$$

Finally, there is exogenous environmental technological change. It is represented by a decline in the intensity of pollution and it develops according to an exogenously given rate (g_{IP}):

$$\dot{\Omega} = -g_{IP}\Omega. \tag{8.19}$$

As Brock and Taylor (2005) show, the growth rate of emissions (or pollution, g_E) entirely depends on the growth rates of labour productivity, labour supply and pollution intensity:

$$g_E = g_T + g_L - g_{IP}. \tag{8.20}$$

Accordingly, the condition for declining pollution ($g_E < 0$) is

$$g_{IP} > g_T + g_L. \tag{8.21}$$

Notably, this condition does not entail the level of abatement. This is the case because it only changes the level of pollution, not its development.

Therefore, in case economic growth has a larger effect than the environmental technological improvements (in other words, condition 8.21 is not fulfilled), additional abatement can only countervail it up to a certain point. As abatement has declining marginal returns, in the long run it is not possible to balance out an insufficient environmental technological development by larger abatement.

8.2.2 The Theory and Economies Without Growth

In section 6.2 the conditions for zero growth for the Solow Model have been developed. Since the environment is only seen as a sink and its quality has no feedback on the economy in the present model, the analysis does not change. The Green Solow Model delivers additional insights concerning the conditions for environmental sustainability in a zero growth economy. The simplest condition from the Solow Model for a zero growth economy is chosen, namely the absence of technological change concerning labour productivity ($g_T = 0$) and no change in labour supply ($g_L = 0$). In this case, the condition for pollution to decline is given by

$$g_{IP} > 0. \tag{8.22}$$

Whenever the (exogenously given) average pollution intensity of production declines over time, pollution does as well. The condition is therefore less restrictive than the condition for positive growth (compare condition 8.22 with condition 8.21). The reason is that environmental technological change is assumed to be independent from other developments of the economy, in particular the rate of economic growth. This assumption will be changed in the following sections.

8.3 AK Model with Environment: Abatement Depending on Technological Change

The AK Model in section 7.1 is a simple way of endogenizing continuous growth. In the following section, this model is extended by an environmental aspect. As in the previous section, total pollution of the economy is modelled as the outcome of economic activity, pollution intensity and abatement.[5]

[5] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is based on Bretschger and Smulders (2007). The model in section 8.3.1 is a reproduction of an existing model. The application of the model to zero growth in section 8.3.2 includes an interpretation of the model's equations.

8.3.1 The Theory

The production function is the same as in section 7.1. Production is determined as follows:

$$Y = TK. \tag{8.23}$$

Production can either be used for consumption (C), investments (I) or abatement (A):

$$Y = C + I + A. \tag{8.24}$$

Pollution (E) is argued to be a by-product of the use of capital and of consumption. Again, abatement is assumed to decrease pollution. The level of pollution is hence determined by the levels of capital (K), consumption (C) and abatement (A). The function is increasing in K and C and decreasing in A:

$$E = f(K, C, A). \tag{8.25}$$

Whether pollution increases or decreases depends on the amount of abatement used and the specification of the relations covered in function 8.25. One possible specification made by Bretschger and Smulders (2007) is derived based on the assumption that additional pollution (due to additional use of capital and additional consumption) can be balanced out by a proportionate increase in abatement. In this case, a balanced growth path, in which all variables (production, capital, consumption and abatement) grow at a constant and the same rate, leads to constant pollution. This becomes clear when specifying the determination of pollution in equation 8.25 in such a way that it represents this assumption:

$$E = f(\frac{K}{A}, \frac{C}{A}, \frac{A}{A}). \tag{8.26}$$

Along the balanced growth path, K, C and A all grow at the same rate, so that the terms $\frac{K}{A}$, $\frac{C}{A}$ and $\frac{A}{A}$ stay constant and pollution does not change. As Bretschger and Smulders (2007) point out, “the specification [...] might be seen as an overly optimistic view: doubling capital, consumption, and abatement does not double pollution but in fact leaves pollution unaffected” (p. 5). Comparing it to the way abatement was modelled in the previous section, equation 8.26 assumes that the effectiveness increases with higher levels of production. In other words: It is assumed that increasing the amount of abatement has a large effect on the efficiency of abatement.

This implicit role of abatement technology can be made more explicit by use of an alternative specification of equation 8.25. Here, pollution depends on the amount of capital (K – and hence the level of production), the amount of abatement (A) and a technological parameter (T_P). The effects of capital and abatement on pollution depend additionally on the parameter ϵ. For larger values of ϵ, capital increases pollution more and abatement decreases it less (it is assumed that $\epsilon > 1$):

$$E = \frac{K^{\epsilon} A^{1-\epsilon}}{T_P}. \tag{8.27}$$

Contrary to the first specification, a balanced growth path leads to an increase of pollution according to the growth rate of the variables K and A – when leaving the role of technology aside.

The behaviour of the technological parameter T_P determines whether pollution grows, is constant or declines. A causal relation between the amount of abatement and the state of technology is assumed:

$$T_P = A^{\kappa}. \tag{8.28}$$

When $\kappa = 1$, the technology is of the same size as abatement and grows at the same rate. In this case, pollution stays constant for growing output. Equation 8.27 changes to $E = \frac{K^{\epsilon} A^{1-\epsilon}}{A} = (\frac{K}{A})^{\epsilon}$. When K and A grow by the same rate, pollution stay constant, as was the case in the first specification (compare equation 8.26). If on the other hand $\kappa < 1$, the technology parameter is smaller and growth leads to increasing pollution. If $\kappa > 1$, growth leads to decreasing pollution.

8.3.2 The Theory and Economies Without Growth

In the model above, the conditions for the economy not to grow do not alter as compared to the model of section 7.1.[6] Therefore, the interesting question here is under what conditions a zero growth economy does also lead to decreasing pollution.

In a zero growth economy, production stays constant. Additionally, here it is assumed – as is in the model – that the distribution of production among consumption, investments and abatement (see equation 8.24) stays the same. The logic of this assumption is as follows. In a zero growth economy, investments stay constant in order to replace capital depreciation. Consumption stays constant in order to facilitate the same

[6] As Bretschger and Smulders (2007) point out, it is also possible to model a causal link from pollution to economic growth by assuming a negative effect of pollution on productivity (the parameter T).

level of material well-being. Per definition then also abatement needs to stay constant. It could also be assumed that an increasing proportion of production is reassigned from consumption towards abatement, due to environmental necessities. In order to keep things simple, this possibility is left out.

The two specifications from above are investigated in turn. Under the first specification, zero growth leads, as does positive growth, to constant pollution (see equation 8.26). Capital, consumption and abatement all stay constant, so that pollution stays constant. The same is true for the second specification (see equation 8.27). Capital and the level of abatement stay constant. As the third parameter of the equation, T_P, is determined by the constant level of abatement, it does not change either.

The result that pollution is not lower in zero growth than in growing economies is intuitively surprising, as pollution is due to economic activity. The reason for this surprising result is that environmental technological change depends on economic growth in both specifications. In the first it is implicit, as abatement only increases when the economy grows and the increase in abatement leads to less pollution per production. The second specification makes it explicit. As technology depends on abatement, it only improves if abatement increases (see equation 8.27). At the same time, it should be noted that under assumptions that lead to increasing pollution in the growth scenario ($\kappa < 1$), environmental outcomes of zero growth are better (pollution is constant).

The result also represents an issue that comes up repeatedly when discussing the relevance of zero growth from an environmental perspective. The issue is whether environmental technological change, that is, technological change that decreases the environmental impact per unit of production, depends entirely or primarily on economic growth. If it does, the prospects for zero growth to generate better environmental results than positive growth become worse.

8.4 Endogenous Technological Change with Environment: Natural Resources

Apart from the AK Model, various other endogenous growth theories have been combined with pollution or resource use.[7] In this branch of the literature, a similar model as the one in section 7.3 is commonly used. Here, research brings about new technologies that replace the old ones.[8]

7 See for example Brock and Taylor (2003), Groth (2007) and Xepapadeas (2005).

8 Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the

8.4.1 The Theory

The production function is the same as in equation 7.12, only that natural resources (R) are included as an additional production factor:

$$Y = (TL)^{1-\alpha} x^{\alpha} R^{\phi}. \quad (8.29)$$

Economic growth in the model without environment (in section 7.3) depends entirely on the speed of technological change. In the model with environment, the rate of economic growth (g_Y, which is also the rate of growth per capita as labour is constant) depends on the rate of technological change (g_T), the development of the use of natural resources (g_R) and its output elasticity (ϕ):[9]

$$g_Y = g_T + \phi g_R. \quad (8.30)$$

For the development of g_T, equation 7.17 is used:

$$g_T = f(\frac{J_t}{T_t})(\varpi_r - 1). \quad (8.31)$$

J_t are investments in research, T_t is the state of technology and ϖ_r is the effectiveness of inventions. The amount of investments in research determines the probability of success in the invention process.

The model assumes that the government can control the use of natural resources, so that it can enforce a certain percentage (q) decrease of its use in each period. The use of natural resources (R) changes according to $\dot{R} = -qR$. The growth rate of natural resource use is

$$g_R = -q. \quad (8.32)$$

The rate of economic growth is determined according to (combining equations 8.30, 8.31 and 8.32):

$$g_Y = f(\frac{J_t}{T_t})(\varpi_r - 1) - \phi q. \quad (8.33)$$

Economic growth thus depends on the amount of research dedicated to the development of new technologies, the state of technology, the effectiveness

present work: The following illustration is based on Aghion and Howitt (2009). The model in section 8.4.1 is a reproduction of the existing model. The application of the model to zero growth in section 8.4.2 includes rearranging and recombining the equations of the existing model.

9 For a derivation see Aghion and Howitt (2009, pp. 379 – 380).

of inventions, the output elasticity of natural resources and the speed at which the government reduces the supply of natural resources.

8.4.2 The Theory and Economies Without Growth

Setting equation 8.33 equal to zero the condition for zero growth is derived:

$$f(\frac{J_t}{T_t})(\varpi_r - 1) = \phi q. \tag{8.34}$$

On the one hand, innovations (the left hand side of the equation) increase the state of technology and thus foster economic growth. On the other hand, decreasing the use of natural resources (the right hand side) decreases economic output and growth. Therefore, in order to combine a fast reduction of natural resource use and constant production, a high amount of research is needed. Additionally, for higher states of technology (T_t), higher amounts of research are necessary to countervail the same percentage of decrease in natural resource use. As economies with higher states of technology have also higher levels of production (ceteris paribus), the relative amount of research needed stays similar, however.

8.5 Directed Technical Change with Environment: Clean and Dirty Sectors

Section 7.4 has covered the theory of Directed Technical Change. While the theory is more often applied to biased technical change concerning skilled and unskilled labour or capital and labour, it has also been used to investigate the relationship between economic activity and the environment. Multiple models have been developed (Di Maria and Valente, 2008; Acemoglu et al., 2012; André and Smulders, 2014) and already entered several textbooks (Eriksson, 2013; Aghion and Howitt, 2009).

In the model presented here, the economy is divided into a clean and a dirty sector. While the clean sector is pollution free, the dirty sector emits pollution. The size of pollution depends on the size of the dirty sector and its pollution intensity. The core question investigated in the model is in which sector technological change takes place. The sector that experiences technological change grows. When only the clean sector grows, pollution stays constant. When the dirty sector (also) grows, pollution increases. Whether economic growth is compatible with environmental sustainability therefore primarily depends on where technological change takes place.[10]

[10] Regarding the question, which aspects of the following investigation are

8.5.1 The Theory

8.5.1.1 General Set-Up

The general set up of the model is similar to that in section 7.4. Nevertheless, the basic functions are slightly different.

The utility function includes environmental quality (S_t) next to consumption (C_t). Additionally, it depends on the time preference (ρ). The preferences of the representative household are given by

$$\sum_{0}^{\infty} \frac{1}{(1+\rho)^t} u(C_t, S_t). \tag{8.35}$$

Overall production is determined equivalently as in section 7.4, only that the relative importance of the two production factors for the size of overall production is left out. Again, there are two different goods, this time denoted with C and D (instead of L and Z as in section 7.4), representing the clean and the dirty sectors, respectively. Production is determined according to

$$Y_t = [Y_{Ct}^{\frac{\varepsilon-1}{\varepsilon}} + Y_{Dt}^{\frac{\varepsilon-1}{\varepsilon}}]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{8.36}$$

Production in the two sectors again takes place by "using labour and a continuum of sector-specific machines (intermediates)" (Acemoglu et al., 2012, p. 136). The production functions are slightly different, however. The reason is that the two goods are produced with the same production factor, labour (L) (and not two different ones as in section 7.4).[11] The difference between the production of the two products is instead that two entirely different production methods regarding the machines (χ_C and χ_D) are applied. Production in the two sectors is determined according to

$$Y_{jt} = L_{jt}^{1-\beta} \int_0^1 T_{jit}^{1-\beta} \chi_{jit}^{\beta} di, \tag{8.37}$$

with the sectors $j \in \{C, D\}$.

adopted from other studies, and which are novel developments of the present work: The following illustration is based on Acemoglu et al. (2012). The model in section 8.5.1 is a reproduction of the existing model. The application of the model to zero growth in section 8.5.2 includes rearranging and recombining the equations of the existing model.

11 Acemoglu et al. (2012) also discuss a production function with the additional use of a natural resource. Here, only the case without natural resources is used.

Future quality of the environment (S_{t+1}) depends most importantly on the size of the dirty sector (Y_{Dt}) and its pollution intensity ($\Omega_D > 0$), which is taken as constant over time. Production in the clean sector is assumed to have no impact on the environment ($\Omega_C = 0$). Future environmental quality further depends on the current environmental quality (S_t) and environmental regeneration, which is defined by the current environmental quality and an exogenously given constant (ς):

$$S_{t+1} = -\Omega_D Y_{Dt} + (1 + \varsigma)S_t. \tag{8.38}$$

8.5.1.2 States of Technology and Technological Change

Technological change also takes place similarly as in section 7.4. The basic idea is that monopolists have a given number of scientists who work on the innovation of machines. The inventive capabilities of the scientists are assigned to the sector in which production of new machines facilitates the highest profits. The states of technology (T_{jt}) depend on the previous states of technology (T_{jt-1}), the number of scientists working on innovations in the respective sector (s_{jt}), the probability of success of innovation endeavours (ϑ_j) and the increase of productivity per innovation ($(1 + \varpi)$, with $\varpi > 0$):

$$T_{jt} = ((1 + \varpi)\vartheta_j s_{jt})T_{jt-1}. \tag{8.39}$$

The mechanism concerning how many resources, in this case the number of scientists, are dedicated to research is also very similar as in the previous model in Directed Technical Change. A monopolist produces new technologies and receives a patent on it, in case of successful invention. The monopolists' profits are according to

$$\Pi_{jt} = \vartheta_j (1 + \varpi)(1 - \beta)\beta p_{jt}^{\frac{1}{1-\beta}} L_{jt} T_{jt-1}. \tag{8.40}$$

Profits hence depend on the productivity of research in the sector ($\vartheta_j(1+\varpi)$), the productivity of machines (dependent on the parameter β), the price of the respective good (p_{jt}), the amount of labour applied in the sector (L_{jt}) and the previous state of technology (T_{jt-1}).

This previous state of technology becomes very important in the further reasoning. Acemoglu et al. (2012) assume "that initially the clean sector is sufficiently backward relative to the dirty (fossil fuel) sector that under laissez-faire the economy starts innovating in the dirty sector" (p. 139). He develops the concept of a *direct productivity effect* in addition to the already familiar *price* and *market size effects*. The "direct productivity effect [...] pushes towards innovating in the sector with higher productivity" (p. 140)[12].

The current states of technology thus also play a major role in determining where technological change takes place. Other factors are the productivities of research in the respective sectors and the substitutability between the goods. The relation of the following equation defines in which sector technological change takes place:

$$\vartheta_C T_{Ct-1}^{-\upsilon} \gtreqqless \vartheta_D (1+\varpi\vartheta_C)^{\upsilon+1} T_{dt-1}^{-\upsilon}, \tag{8.41}$$

with $\upsilon \equiv (1-\beta)(1-\varepsilon)$. If the left hand side is larger, innovations take place in the clean sector. If the right hand side is larger, they take place solely in the dirty sector. Only when the two sides of the equation are exactly of equal value does technological change take place in both sectors.

8.5.1.3 Subsidies and Taxes to Redirect Innovations

As argued above, Acemoglu et al. (2012) assume that in the beginning the state of technology of the dirty sector is by far more productive than the one of the clean sector. This makes the right hand side of equation 8.41 larger than the left hand side, so that technological change takes place in the dirty sector. The question is therefore how the state of the clean technology can be brought above that of the dirty technology ($T_{Ct} > T_{Dt}$). One possibility put forward by Acemoglu et al. (2012) is that the government pays a subsidy (q_t) on research in clean technologies. The profit equation for the monopolists in the clean sector from equation 8.40 changes to

$$\Pi_{Ct} = (1+q_t)\vartheta_C(1+\varpi)(1-\beta)\beta p_{Ct}^{\frac{1}{1-\beta}} L_{Ct} T_{Ct-1}. \tag{8.42}$$

When comparing these profits in the clean sector with those of monopolists in the dirty sector (determined by equation 8.40), it is clear that a sufficiently high subsidy will make profits in the clean sector larger and therefore redirect research into the clean sector.

According to Acemoglu et al. (2012), the other possibility is a tax on the use of natural resources. The effects are very similar. A tax decreases the profits from innovations in the dirty sector so that research is redirected into the clean sector.

12 This effect is also present in the model from section 7.4. For example, it is present in (Acemoglu, 2002, p. 790, equation 17). It has not been emphasized in earlier publications though, probably because there it is focussed on steady state solutions.

8.5.1.4 Substitute Goods

Acemoglu et al. (2012) further show that the elasticity of substitution between the goods (ε) is decisive for the question of whether only the sector with the higher state of technology grows or the other sector as well. In this set up, the clean sector is initially more productive than the dirty sector, for example because clean innovations have already been subsidized for some time.

When the goods are "strong substitutes" (Acemoglu et al., 2012, p. 142), ($\varepsilon \geq \frac{1}{1-\alpha}$), the "direct productivity effect" is large enough for growth to only take place in the sector with the higher state of technology. Intuitively, substitution is so strong that even with an ever increasing clean sector, there is no incentive to increase production of the dirty sector. On the other hand in the case of "weak substitutes" (Acemoglu et al., 2012, p. 142), ($\varepsilon \in \{1, \frac{1}{1-\alpha}\}$), technological change still takes place in the clean sector. But the dirty sector also grows, as the increase of the number of clean products increases the marginal productivity of the dirty goods (compare to the aggregate production function 8.36).

In the case of strong substitutes, it is therefore sufficient to subsidize clean innovations until the state of technology in the clean sector is larger than the one in the dirty sector. If, on the other hand, the goods are only weak substitutes, a continuous, sufficiently high subsidy is necessary to prevent growth of the dirty sector.

8.5.1.5 Complimentary Goods

The situation changes fundamentally if the goods are assumed to be complements. An initial situation is assumed where the state of technology is more productive in the dirty sector (the opposite as above). The clean and dirty goods are complements ($\varepsilon < 1$). In this case, the price and the market size work in the same direction, namely push innovations into the clean sector. The sum of these two effects is larger than the direct productivity effect. But after some time, innovations will also take place in the dirty sector, as its products are complements to the ones in the clean sector. Therefore, "innovations will first occur in the clean sector until that sector catches up with the dirty sector; from then on innovation occurs in both sectors" (Acemoglu et al., 2012, p. 19). In the long run, therefore, both sectors grow.

In this case, the implementation of environmental policies such as research subsidies is of very limited benefit. A research subsidy on clean innovations would increase clean innovations and decrease dirty innovations temporarily, but the subsidy's necessary size would increase over time, as the amount of clean goods rises continuously compared to the dirty goods. The reason is that with an increasing clean to dirty goods ratio, the productivity of dirty goods continuously increases as the two are complements. In this situation, economic growth is incompatible with environmental sustainability, as the growth of the dirty sector is needed for long-run growth but at the same time pollutes the environment.

8.5.2 The Theory and Economies Without Growth

Before outlining the conditions for zero growth, two central assumptions, which are necessary for sustainable growth to take place, are examined critically.

8.5.2.1 Controversial Assumptions for Sustainable Growth

Acemoglu et al. (2012) come to the conclusion that “when the inputs are sufficiently substitutable, sustainable long-run growth can be achieved using temporary policy intervention” (p. 29). When substitutability is lower, “permanent government regulation is necessary to avoid environmental disaster” (p. 13) and when the two are complements “environmental disaster can only be avoided if long-run growth is halted” (p. 15). It is important to note, however, that Acemoglu et al. (2012) need to make several assumptions that are necessary to come to this conclusion. Two seem especially controversial.

First, they assume that the current level of pollution is still within sustainable limits. In other words, the pollution stemming from dirty production is smaller than the environmental regeneration ($\Omega_D Y_{Dt} < \varsigma S_t$). Otherwise, even when only the clean sector grows, the environmental quality would deteriorate over time. Regarding the discussions in section 2.2, this assumption does not hold, since current levels of pollution are argued to be unsustainable.

Second, the clean sector is assumed to emit no pollution at all ($\Omega_C = 0$). This is a very strong assumption, in particular as the clean sector would entail an ever increasing share within the economy and in the long run, almost all production (and the production of all types of goods) would need to have zero emissions. Both criticisms make a sustainable path with continuous economic growth less plausible.

8.5.2.2 Conditions for Zero Growth

In order to generate zero growth within the framework of Directed Technical Change with Environment, either both sectors need to stagnate or the clean one grows while the dirty one shrinks. One central condition for this is that technological change takes place in the clean sector. Assuming that the goods are substitutes, a research subsidy or a tax are implemented. As a result, technological change takes solely place in the clean sector. Additionally, the dirty sector would need to shrink. As there is no good reason for the state of technology to deteriorate, the amount of labour in the dirty sector needs to decline. To keep things analytically simple, working hours are only reduced for people working in the dirty sector.[13] Such a decrease in labour supply in the dirty sector would countervail the positive growth effect in the clean sector and additionally decrease pollution, as the dirty sector shrinks. When substitutability is strong, the shrinkage of the dirty sector does not lead to the redirection of inventive capacity into that sector to enable technological change.

The size of working hours reductions necessary to result in zero growth depends on several parameters. First, the more productive the technology in the dirty sector compared to the clean sector ($\frac{T_{Dt}}{T_{Ct}}$), the smaller the reduction has to be, as the impact of reducing labour in the dirty sector on production is strong and the impact of technological change in the clean sector is weak. Second, the more productive labour in the dirty sector is (represented by $1-\beta$), the smaller the reduction in working hours must be, as a reduction in working hours leads to a stronger reduction in production. Third, the faster technological change takes place in the clean sector (depending on the number of scientists (s_{Ct}), the additional productivity of innovations (ϖ) and the probability of success (ϑ_j)), the larger the reduction in working hours must be.

This set of conditions for zero growth lessens the necessity to make the two controversial assumptions discussed above – which have been argued as being necessary for making green growth possible. The set of conditions deals with the problems of the first assumption. As the dirty sector shrinks, pollution declines over time. Whether the decline suffices to bring pollution down to sustainable levels cannot be answered on a purely theoretical basis.

The second assumption is more complicated. Under the zero growth conditions, the dirty sector shrinks continuously and the clean sector grows until the dirty sector has disappeared and the clean sector is of the size of aggregate production in the beginning (this point in time is denoted with $t = \omega$). At this point, pollution is equal to the product of aggregate production and the environmental intensity of clean production ($\Omega_C > 0$). The clean sector would need to stop growing in order to stay within the zero growth condition.[14] Possibly, working time could be further reduced – also in the clean sector. In this case, the pollution from

13 The model also allows for a migration of workers from the dirty into the clean sector. The extent to which this is compatible with zero growth would require further investigation

14 Within the strict assumptions of the model, this is no desirable outcome. As the clean sector is assumed to have no pollution at all, there is no reason why it should stop growing. In case also the clean sector has positive pollution, zero growth can still make sense.

the clean sector must be below the regeneration of the environment, in order for the zero growth economy to be sustainable in the long run. This condition is given by

$$\Omega_C Y_{t=0} < \varsigma S_{\omega}. \tag{8.43}$$

It therefore depends on the initial size of the economy ($Y_{t=0}$), the pollution intensity of the clean sector (Ω_C), the environmental quality of the situation once entirely clean production is achieved ($S_{t=\omega}$) and the rate of environmental regeneration (ς).

8.6 Results and Discussion

The investigation on neoclassical theories with environment has resulted in a number of additional findings on how zero growth can be initiated. More importantly, it has delivered insights into the relation between zero growth economies and the environment. In the following, first the results from theories that include pollution are summarized and then from including natural resources. Afterwards, the additional insights concerning scenarios for economies without growth are laid out.

8.6.1 Summary of Conditions

8.6.1.1 Environment Introduced as Pollution

In the theories of sections 8.2, 8.3 and 8.5 environmental aspects are modelled in the form of pollution. These models did not generate significant additional conditions concerning the question how production can be kept constant. The reason is that pollution is not necessary as input but solely an output from production. The conditions for zero growth to take place stay the same as in the models without environmental aspect from chapter 6 and 7. Only when an ever increasing share of production would be used for abatement might this result differ.

At the same time, these models deliver insights into the conditions for zero growth economies (and growth economies) to be environmentally sustainable. In all three models, environmental outcomes are better in zero growth than in growing economies. In the Green Solow Model, the development of the pollution intensity is exogenously given and therefore less production signifies less pollution. In the AK Model with Environment, the zero growth economy generates the same results as the growth economy under optimistic assumptions concerning environmental technological change. Under pessimistic assumptions, zero growth generates better results. In the Directed Technical Change with Environment model, zero growth is the only possibility to improve the environmental situation, as the dirty sector needs to shrink in order to reduce pollution.

8.6.1.2 Environment Introduced as Natural Resources

Sections 8.1 and 8.4 cover theories in which the environmental aspect is the use of non-renewable natural resources. These models have led to additional possible conditions for zero growth. Due to environmental reasons, the use of natural resources can/should be reduced. In both models, this leads to a lower level of production. In order to generate zero growth, either the supply of other production factors needs to increase (section 8.1, first specification) or technological change can countervail the reduced application of natural resources (section 8.1, second specification and section 8.4).

Again, the environmental results are better in zero growth economies. In both models natural resource use can be reduced faster when aiming for zero growth. For given developments of the other production factors and technological change, natural resource use needs to be reduced stronger in order to generate zero growth economies.

8.6.1.3 Zero Growth Scenarios

The conditions for zero growth from the theories of this chapter are compatible with the three scenarios developed at the end of the previous chapter.

In Scenario I, labour-augmenting technological change is countervailed by reductions in working hours. The Green Solow Model delivers a framework to investigate the environmental aspects of this scenario. Pollution declines only when the pollution intensity declines as well over time.

In Scenario II, labour-augmenting technological change is countervailed by reduced use of natural resources. In the Dasgupta-Heal-Solow-Stiglitz Model, a reduction of natural resource use can be *substituted* by an increase in effective labour supply due to labour-augmenting technological change. The Endogenous Technological Change with Environment model also contributes to this scenario. It shows that the necessary reduction in natural resource use (in order to balance out the effect of technological change on economic growth) depends on the productivity of natural resources on the one hand, and the speed of technological change on the other.

Finally, the other specification of the Dasgupta-Heal-Solow-Stiglitz Model and the Directed Technical Change Model relate to Scenario III. Here, technological change is redirected from being labour-augmenting. The Dasgupta-Heal-Solow-Stiglitz Model shows that the speed of reduction of natural resource use in this case depends on the speed of resource-augmenting technological change. The Directed Technical Change Model elaborates on the conditions for technological change to be redirected. Most importantly, the elasticity of substitution between production factors determines what measures are necessary. This model also shows that it does not suffice to redirect technological change towards the clean sector, but rather that either labour supply needs to be reassigned or reduced.

8.6.2 Critical Assessment of the Neoclassical Theories With Environment

Most of the more fundamental points of criticism from sections 6.4 and 7.5 also apply to the respective models in this chapter. They are not repeated here. Instead, this section focusses on the manner in which environmental aspects are included in the theories and models. There are at three central points of criticism.

First, a continuous substitutability between all production factors is assumed. This criticism applies in particular to the models with natural resource use. They usually assume that both physical capital and labour are substitutes for natural resources. Therefore, it is possible to decrease the use of natural resources and keep or even increase the level of production. As argued in section 2.2, this assumption has been criticized by various authors. In particular, it is argued that physical capital is a complement of natural resources.

Second, all relations are considered to be continuous relations. The models do not allow for possibly existing tipping points or points of no return (Pollitt et al., 2010). For example, the regeneration of nature is modelled as a linear function of the existing stock of nature. The possibility that negative feedback loops take place below a certain level of environmental quality, is not allowed for.

Third, the environmental measures often remain unclear. In the Green Solow Model and the AK Model with Environment, it is clear that additional resources need to be put into abatement. But in the models with natural resources, it is simply assumed that the input of natural resources is reduced. While older theorists mention an increasing scarcity that is naturally given (Groth, 2007), newer contributions refer to a governmentally implemented reduction (Aghion and Howitt, 2009). How this could be conceptualized and implemented concretely remain an open question, however. In particular the political economy behind this question is left out. The topic is discussed further in part IV.

Chapter 9
Sustainable Economies Without Growth in Neoclassical Theories

> There is no reason at all why capitalism could not survive without slow or even no growth. I think it's perfectly possible that economic growth cannot go on at its current rate forever. [...] There is nothing intrinsic in the system that says it cannot exist happily in a stationary state (Solow, 2008, p. 92).

In part II, a total of twelve types of neoclassical theories have been discussed. The theories have been represented as formal models, as it is common in neoclassical economics. Out of the twelve models, seven present how the macroeconomy functions and explain in particular the determination of the level of production and economic growth. The other five additionally take environmental aspects into account. In the following chapter, first an overview of the conditions for zero growth is given. Second, three scenarios for zero growth economies (research-subquestion 1) are developed. Third, the results from neoclassical theories concerning the environment, economic inequalities and economic stability (research-subquestions 2 – 4) are summarized. Fourth, the findings are placed within the context of existing literature and finally, limitations to the insights from neoclassical theories are pointed out.

Throughout this chapter, references are made to single theories. At the end of the next section, a table summarizes the results from all neoclassical theories.[1] It serves as a summary of the theories and as a reference point for comparison and integration of the theories throughout this chapter.

9.1 Overview

Table 9.1 summarizes the results from investigating the twelve neoclassical models. For each theory (column (1)) first the determinants of growth are described (column (2)), in order to recapitulate the central mechanisms of each model. The following four columns cover the findings on the research

[1] Note that all results, conditions, limitations etc. are only based on the neoclassical theories discussed in this work, not neoclassical theories in general. The term *the neoclassical theories* hence also refers to those neoclassical theories used in this work and not all neoclassical theories.

subquestions. Column (3) entails the central contribution of each model to answer the first subquestion, namely what conditions lead to a zero growth economy. Afterwards, the relationships between the zero growth economy with (4) the environment, (5) individual income distribution and (6) the stability of the economy are investigated.

In neoclassical theories production is determined via the supply side, that is, by the amounts and productivities of production factors. There are two manners by which the level of production changes. First, the amount of production factors (capital, labour, natural resources) can increase or decrease. Second, the productivities of the production factors can alter due to technological change. **The central condition for zero growth economies from the perspective of neoclassical theories is that aggregate supply stays constant over time. Therefore, any change of either a level of supply or productivity of one production factor needs to be countervailed by a proportional and opposite change of a level of supply or productivity of the same or another production factors.**

The following list summarizes the determinants of the levels of supply and productivities of the production factors and points out the subsequent roles regarding zero growth economies:

1. Physical capital: The accumulation of physical capital is determined by the amount of investments and capital depreciation. The latter is commonly assumed to be a given share of capital stock. The former depends on two aspects: savings behaviour and the marginal productivity of capital. Savings behaviour is determined by households' preferences. A lower time preference for consumption generates larger savings. The marginal productivity of capital is determined by the state of technology and is increased by the introduction of labour-augmenting and/or resource-augmenting technological change. Regarding zero growth economies, physical capital therefore plays a comparatively passive role. The level of the capital stock primarily depends on technological change. Altered savings behaviour only has a one-time effect on it.
2. Capital productivity: Technological change can in principle be capital-augmenting, as it can be labour-augmenting or resource-augmenting in the neoclassical paradigm. As no theory covered here assumes such technological change, it is not discussed further.
3. Labour: The supply of labour is determined by households' preferences.[2] The major motivation of households to supply labour is to earn income in order to be able to consume – instead of opting for

[2] Remember that a constant population is assumed throughout this work.

more leisure. Regarding zero growth economies, a central condition is therefore that households prefer to use increases in labour productivity for reductions in average working hours rather than increasing consumption.

4. Resources/environmental factors: The supply of natural resources depends on the ownership structure. If they are privately owned, the owners supply them according to their calculation of profit maximization. In other theories, the government can control the supply. As it is not possible to use all reserves of fossil fuels when central environmental goals are to be achieved (see section 2.2), the government has to intervene. Therefore, the supply of natural resources is in the following assumed to depend on governmental decisions. Concerning zero growth economies, this implies that the government has to reduce the supply over time.
5. Labour and resource productivities: The productivities of labour and natural resources are determined by the speed and direction of technological change. The speed primarily depends on the level and effectiveness of research and development. The direction is determined by price and market size effects. Taxes and subsidies can help to redirect technological change towards resource augmentation. This is also the primary condition for sustainable economies without growth regarding technological change.

Based on this very general conclusion, three different scenarios for zero growth emerge. Each of the neoclassical theories covered is represented by one of them. The scenarios represent three strategies of how zero growth economies can be initiated: Either by reductions in average working hours, by a reduction in natural resource use and/or by a redirection of technological change. These are discussed in detail in the subsequent section (9.2).

The neoclassical theories also deliver clear answers concerning the other three subquestions. In all theories, zero growth economies generate better environmental outcomes than growing economies (subquestion 2).[3] The neoclassical theories generate very few insights concerning distributional aspects (subquestion 3), since a representative agent is usually assumed. Therefore there are no economic inequalities. These subquestions are covered in more detail in section 9.3.

Finally, from the point of view of these theories, there are no problems concerning macroeconomic stability in a zero growth economy (subques-

[3] Only in certain specifications can growing economies generate better results. The prime condition is that the speed of resource-augmenting technological change depends on the rate of economic growth.

tion 4), as indicated by the quote in the beginning of this chapter. The central reason is that the neoclassical models assume an equilibrium and provide no room for imbalances or instabilities.

9.2 Three Scenarios for Economies Without Growth

The results from the analysis of the neoclassical theories can be grouped into three scenarios of conditions for zero growth economies. The aim of developing these three scenarios is to summarize the results and therefore to allow for a coherent understanding on conditions for sustainable economies without growth from a neoclassical perspective.

The three scenarios relate to different sub-sets of the neoclassical theories. Some of the theories entail themselves several specifications, so that sometimes different specifications of one theory refer to different scenarios. All but two of the theories covered are part of one or two of the scenarios. The two AK Models (sections 7.1 and 8.3) have not been included.[4]

In the first scenario, labour-augmenting technological change is countervailed by continuous reductions in average working hours. This scenario represents the insights from the largest sub-set of theories and is specified in section 9.2.1. It is the only scenario with only labour as production factor. It includes theories with exogenous and endogenous technological change. The second scenario includes natural resources as an additional production factor and is described in section 9.2.2. The central condition for zero growth here is that labour-augmenting technological change is contrasted with a reduction in the supply of natural resources. It incorporates models with exogenous, endogenous and directed technological change. In the third scenario, technological change is resource-augmenting instead of labour-augmenting (section 9.2.3). Here, zero growth is also generated by a reduction in the supply of natural resources. It follows a different logic though and has somewhat different outcomes. It represents models with exogenous and directed technological change.[5]

These three scenarios represent three strategies, which lead to zero growth economies within the framework of the neoclassical theories. These strategies are (1) reductions in average working hours, (2) reductions in the supply of natural resources and (2) the redirection of technological

[4] The reason is the strong criticism on these models, in particular concerning the plausibility of including physical and human capital into one factor that can be accumulated (see section 7.5)

[5] It should be noted that the scenarios take different assumptions concerning the question of decoupling (compare with section 2.2). While the first one only assumes relative decoupling in a growing economy, the second and third assume absolute decoupling.

Table 9.1: Summary of the Results From Neoclassical Theories

(1) Theory	**(2) Determinants of Econ. Growth**	**(3) Conditions for Zero Growth**	**(4) Environment**	**(5) Distribution**	**(6) Stability**
Basic Macroeconomic Model	Household preferences and the state of technology determine the level of labour (due to the wage level) and the amount of capital (due to the interest rate) in the short run. Long-run economic growth is determined by technological change.	No technological change. Changes in households' preferences only have a level effect on production.	Plays no significant role in the theory.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
Solow Model	Capital accumulation (dependent on the savings rate and capital depreciation), change in labour supply and labour-augmenting technological change (TC) determine economic growth.	Effects of TC, capital (de-) accumulation and changes in labour supply must cancel each other out.	Plays no significant role in the theory.	No individual income distribution as no microfoundations.	Always stable as all markets clear. No instabilities.
Neoclassical Growth Model	Capital accumulation (dependent on household preferences and depreciation), change in labour supply and labour-augmenting TC determine economic growth.	Effects of TC, capital (de-) accumulation and changes in labour supply must cancel each other out.	Plays no significant role in the theory.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
AK Model with Human Capital and Improvement of Knowledge	Capital accumulation (dependent on household preferences and depreciation) determines economic growth. Capital also entails human capital and/or knowledge.	Zero net capital accumulation. Savings and depreciation must cancel each other out.	Plays no significant role in the theory.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.

Endogenous TC I: Extension of the Technological State	Labour-augmenting TC. Speed of TC is determined by production productivity, research productivity, total labour supply and household preferences.	Positive effect of research on state of technology can be countervailed by reduction of average working hours. Speed of technological change depends positively on the levels of production factor productivities, research productivity and total labour supply. It is negatively related to preferences of households to consume.	Plays no significant role in the theory.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
Endogenous TC II: Replacement of Technologies	Labour-augmenting TC. Speed of TC is determined by effectiveness of inventions, amount of investments in research and current state of technology.	Three possibilities: (1) Increasing state of technology due to research is balanced out by reduction in average working hours, (2) no investments in research and (3) effectiveness of inventions is zero.	Plays no significant role in the theory.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
Directed Technical Change	Overall economic growth depends on factor-augmenting TC, which is determined by i.a. household preferences, supply of the two production factors and productivities of research activities. In which sector economic growth (and TC) takes place depends on the prices of the goods, the supplies of the production factors and the elasticities of substitution.	Two possibilities: (1) No research takes place as time preferences and low research productivity prevent savings. (2) Increase in production due to TC is countervailed by lower supply of production factors (e.g., reduction of average working hours or reduction of natural resources).	When one production factor is defined as natural resources: Reduction of supply of natural resources leads (in case of high substitutability) to labour-augmenting TC. Under specific conditions, this leads to zero growth and continuous reductions of natural resource use.	Income distribution depends on wages for skilled and unskilled labour.	Always stable as all markets clear. No instabilities.

Dasgupta-Heal-Solow-Stiglitz Model	Decrease of natural resource use is assumed. Economic growth takes place either in the case of high substitutability between natural resources and other production factors (labour and capital), or when resource-augmenting TC exceeds the reduction of resource use.	Two possibilities: (1) Substitutability exactly high enough that increase in capital and labour balances out reduction of natural resources. (2) Resource-augmenting TC exactly balances out reduction of natural resources.	The use of natural resources can be reduced in order to establish a zero growth economy and at the same time reduce environmental impact. The exact speed of reductions in resource use depends on the degree of substitutability between production factors or the speed of exogenously given resource-augmenting TC.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
Green Solow Model	See "Solow Model".	See "Solow Model".	Abatement reduces pollution. In a growing economy, environmental TC needs to increase faster than labour-augmenting TC to reduce overall pollution. In a zero growth economy, environmental TC only needs to increase, independent of the speed. For an (exogenously) given speed of environmental TC, the zero growth economy reduces pollution faster.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.

AK Model with Environment	See "AK Model with Human Capital and Improvement of Knowledge".	See "AK Model with Human Capital and Improvement of Knowledge".	The speed of abatement efficiency due to environmental TC depends on economic growth. Therefore, the lower pollution due to less production in a zero growth economy is balanced out by less environmental TC and pollution is of equal size in growing and zero growth economies.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.
Endogenous TC with Environment	Labour-augmenting TC increases economic growth, a reduction of natural resource use decreases it. Speed of TC is determined by effectiveness of inventions, amount of investments in research and current state of technology (as in "Endogenous TC II").	Positive effect of labour-augmenting TC on economic growth is countervailed by a reduction of natural resource use.	Reduction of natural resource use decreases environmental impact. As reduction is faster in zero growth than in growing economy, the environmental impact therefore also decreases faster.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.

Directed Technical Change with Environment	Overall economic growth depends i.a. on the productivities of research activities, the amount of capacities dedicated to research and the state of technology. In which sector economic growth (and TC) takes place depends primarily (as in "Directed Technical Change") on the price of the good, the supply of the production factor in each sector and the elasticities of substitution. Additionally, the relative states of technology in the two sectors are decisive.	A research subsidy redirects labour-augmenting TC into the clean sector. The resulting growth of the clean sector is balanced out by a shrinkage of the dirty sector, which is achieved by a reduction in working hours.	Pollution takes place in the dirty but not the clean sector. In a growing economy, pollution thus either grows (when the dirty sector grows) or stays constant (when only the clean sector grows). In the specified zero growth economy on the other hand, pollution declines, as the clean sector grows and the dirty sector shrinks.	No individual income distribution due to representative agent.	Always stable as all markets clear. No instabilities.

change to be resource-augmenting instead of labour-augmenting. Each of the scenarios focusses on one of the strategies. Nevertheless, a combination of them is possible within the analytical framework of neoclassical economics.

For each scenario, first its intuition and its relation to the set of neoclassical theories it represents, are explained. Next, a reference model is developed that explains how this sub-set of theories views *growing* economies. Finally, it is shown under what conditions *zero growth* is generated.[6]

9.2.1 Scenario I: Labour-Augmenting Technological Change

9.2.1.1 Intuition and Relation to Neoclassical Theories

In the first scenario, the positive effect of technological change on economic growth is balanced out by a reduction in working hours in order to obtain a zero growth economy. Technological change is assumed to be labour-augmenting and therefore has a positive effect on the level of production. Technological change depends on several factors, most importantly the efforts dedicated to research and its effectiveness (compare sections 7.2 and 7.3).

Economic growth is additionally determined by the development of labour supply. The development of labour supply is assumed to be exogenously given. Within the logic of neoclassical theories, there are ambivalent arguments whether it should increase or decline over time. On the one hand, an increasing wage rate makes it lucrative to work more. On the other hand, with a high level of consumption, the marginal utility from consumption is low (compare section 6.1), which increases the relative attractiveness of leisure time. An exogenous reduction of labour supply, by reducing average working hours, is the most viable condition for a zero growth economy, however (compare in particular with section 6.3). Therefore, one central condition for zero growth are appropriate preferences in favour of additional leisure over additional consumption.

Physical capital is not included because it can only have a level but not a growth effect on output. The rate of capital accumulation is determined by the savings behaviour, the marginal productivity and capital depreciation. Savings behaviour combined with the marginal productivity of capital determine gross investments. The inclusion of capital depreciation gives net investments. These three aspects alone do not lead to positive long-term growth, however. The reason is that physical capital has diminishing marginal productivity for a given state of technology. When effective labour increases over time, capital accumulation takes place – but

6 The entire following models are developed here and not replicated from other works – contrary to the case in the prior neoclassical chapters.

only according to the increases in effective labour. When effective labour is constant, the capital stock stays constant as well. Therefore, capital accumulation does not need to be modelled explicitly in a neoclassical setting in order to derive conditions for zero growth economies.

Pollution is regarded as dependent on the level of production, the average pollution intensity and abatement efforts. The latter only has level effects on pollution, however (compare section 8.2).

The logic of this scenario is represented by many of the neoclassical models discussed above. In the following list, it is analysed in how far the scenario reflects the theories it is build upon and which particular features are taken from each theory.

1. In the *Basic Macroeconomic Model* no long-run growth is anticipated. It has been argued that technological change is the only feasible manner to increase production continuously within the logic of this model. Scenario I reflects this feature.

   Two aspects of scenario I build upon the Basic Macroeconomic Model. First, investments depend on the demand and supply of capital, with the interest rate aligning the two. Due to this mechanism investments depend primarily on the state of technology. Therefore, it is difficult to argue for a reduction of capital that could continuously countervail the positive effect of technological change on production. Based on this reasoning, capital accumulation can be left out of scenario I. Second, the analysis that economic growth and labour supply stand in an ambivalent relationship rests on mechanisms of the Basic Macroeconomic Model. The reductions in labour supply in scenario I can therefore be explained by changing household preferences in favour for leisure.
2. In the *Solow Model* the level of production is determined by a similar process. However, contrary to the Basic Macroeconomic Model it explicitly takes into account technological change, which is assumed to be labour-augmenting. This central characteristic is represented in scenario I.

   The two aspects from the Basic Macroeconomic Model are also mirrored in the Solow Model. Capital accumulation adjusts automatically to the increase in effective labour. Therefore, the behaviour of long-run growth can be depicted without explicitly including capital as production factor. Second, in the Solow Model labour supply is exogenously given.
3. The *Neoclassical Model* is very similar to the Solow Model, only that it is microfounded. Its long-term behaviour is therefore equivalently well represented by scenario I and the developments of technological change and labour supply are also the same.

4. In the *Endogenous Technological Change I* economic growth is entirely determined by labour-augmenting technological change and labour supply, as is the case in scenario I.
   The new aspect taken from Endogenous Technological Change I that is included into scenario I is the determination of the speed of labour-augmenting technological change. The determinants are the productivity of the intermediate goods, the productivity of research activities, the time preference, the intertemporal elasticity of substitution and the total amount of labour. These concepts are taken up in scenario I in a simplified manner.
5. The *Endogenous Technological Change II* have a very similar understanding of economic growth as the prior set of theories and is therefore reflected in scenario I in the same manner.
   The contribution of Endogenous Technological Change II is also very similar – only that the determinants of the speed of economic growth and technological change are slightly different. Here they are the effectiveness of inventions, the amount of investments in research and the level of the state of technology.
6. The *Green Solow Model* is similarly well represented by the scenario as the Solow Model.
   It additionally contributes the relationship between the economy and pollution to the model. The growth of pollution is determined by the rate of technological change and the growth rate of pollution intensity. This logic is incorporated into scenario I. The level of abatement only has a level effect on pollution, which is why it has been left out of the scenario.

9.2.1.2 Reference Model I

Production (Y_t) at time t is determined by the state of technology (T_t) and the supply of labour (L_t) (compare to the production functions 6.15, 6.36, 7.8, 7.12 and 8.13 which take similar forms):

$$Y_t = T_t L_t. \tag{9.1}$$

Technological change takes place in a purely labour-augmenting fashion (compare in particular equations 6.15 and 6.36). The speed of technological change depends on various factors (compare in particular equations 7.9 and 7.17), which are combined into one variable called the *overall effectiveness of research activities* (Υ). This factor determines the rate of technological change: $g_T = g_T(\Upsilon)$. The state of technology is normalized at time 0 to 1. The state of technology at time t depends on the growth rate of technology (g_T):

$$T_t = e^{g_T * t}, \tag{9.2}$$

where $g_T \geq 0$ so that economic growth is positive. Labour supply develops according to an exogenously given growth rate (g_L). This depends on the amount of average working hours reductions. Labour at time 0 is normalized to 1. The development of labour supply is therefore given by (compare with equation 6.18):

$$L_t = e^{g_L * t}, \tag{9.3}$$

Combining equation 9.1, 9.2 and 9.3 gives the determination of production:

$$Y_t = e^{(g_T + g_L) * t}, \tag{9.4}$$

The rate of economic growth (g_Y) therefore depends on the rates of growth of technology and labour and is given by

$$g_Y = g_T + g_L. \tag{9.5}$$

Pollution (E_t) is determined by the level of production (Y_t) and the pollution intensity (Ω_t):

$$E_t = Y_t \Omega_t. \tag{9.6}$$

According to the Green Solow Model, the long-run development of pollution intensity depends on its exogenously given change (g_{IP}) – and not the level of abatement. The pollution intensity at time 0 is normalized to 1. It is determined by

$$\Omega_t = e^{g_{IP} * t}. \tag{9.7}$$

with $g_{IP} \leq 0$. Combining equations 9.6, 9.13 and 9.7 yields (compare with equation 8.19)

$$E_t = e^{(g_T + g_L + g_{IP}) * t}. \tag{9.8}$$

The change of pollution (g_E) is therefore determined according to

$$g_E = g_T + g_L + g_{IP}. \tag{9.9}$$

Figure 9.1a displays the development of production, the state of technology, pollution and labour over time. It is assumed that the labour supply does not change ($g_L = 0$). The rate of labour-augmenting technological change determines the rate of economic growth. Pollution is determined by the combination of economic growth and decreasing pollution intensity. Whether pollution decreases or increases depends on the assumptions concerning these parameters. The development of pollution intensity is exogenously given. The rate of technological change and of economic growth depend on the overall effectiveness of research activities (Υ). In the illustration, it is assumed that technology and production increase twice as fast as pollution becomes less intensive ($g_T = -2g_{IP}$). If the pollution intensity declined faster than the state of technology grows, pollution would decrease.

9.2.1.3 Conditions for Sustainable Economies Without Growth in Scenario I

The next step is to investigate under what conditions zero growth is generated. One way would be to bring technological change to a halt by stopping research activities all together or making them absolutely ineffective. As argued in sections 7.2 and 7.3, this is implausible, however. It would require a time-preference high enough to deter any savings for and investments in research activities. The other possibility is to reduce the supply of labour in order to countervail the positive effect of technological change on economic growth. In order to achieve zero growth, the reduction in average working hours needs to exactly balance out the effect of technological change. From equation 9.5 it is known that this is the case when

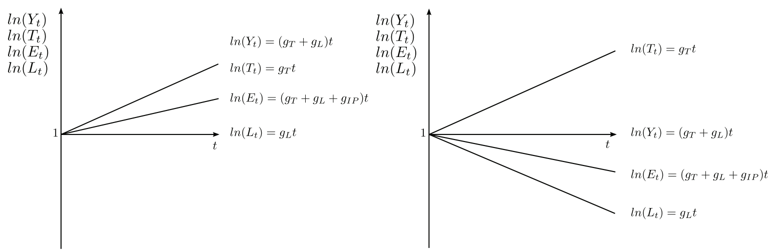
$$g_T = -g_L. \tag{9.10}$$

The reduction of working hours has to be undertaken at the same rate, as the average labour productivity increases. The required level of working hours reduction hence depends on the overall effectiveness of research (Υ).

In neoclassical theories, labour supply is commonly determined by preferences regarding consumption and leisure. The central conditions for zero growth in this scenario is therefore that preferences are of such nature that increases in hourly wages are used to increase leisure rather than consumption. Such decisions could additionally be supported by the government in form of taxation – for example by treating part-time jobs preferably or by progressive taxation.

Figure 9.1b illustrates the development of the macroeconomic variables for the first zero growth scenario. The central prerequisite is that condition 9.10 is fulfilled.

Figure 9.1: Neoclassical Scenario I



a Scenario I with Positive Economic Growth

b Scenario I with Zero Economic Growth

Logarithms of production ($ln(Y_t)$), the state of technology ($ln(T_t)$), pollution ($ln(E_t)$) and labour ($ln(L_t)$) against time (t). Scales are not precise.

Note that pollution is lower in case of the zero growth than with positive growth (independent of the relation $g_T \gtreqless -g_{IP}$). The reason is that the decrease in pollution intensity is assumed to be exogenously given and independent on economic growth.[7] Note also that it is unclear what happens when average working hours become very low. This gives rise to the question of whether low levels of average working hours alter the speed of technological change. The model in section 7.2 suggests that the speed of technological change decreases when overall less labour is supplied. Such effects are not taken into account in this scenario.

One unsatisfactory element of this model is however that the environmental impact of economic activities can be altered exclusively by changing the rate of economic growth. In fact,the opposite causal effect, represented by a model in which environmental measures change the rate of economic growth, would be more realistic. Also, pollution intensity is modelled as exogenously given. In particular, the role of natural resources

7 In the AK Model with Environment from section 8.3 on the other hand, development of pollution intensity depends on economic growth and therefore different results are obtained.

in production, and their effect on pollution are not taken into account. Both problems are tackled in the next two scenarios.

9.2.2 Scenario II: Labour-Augmenting Technological Change with Natural Resources

9.2.2.1 Intuition and Relation to Neoclassical Theories

In the second scenario, labour-augmenting technological change increases production and a continuous reduction in the use of natural resources decreases it. It builds on the Directed Technical Change Model (section 7.4), the Dasgupta-Heal-Solow-Stiglitz Model (8.1), the Endogenous Technological Change with Environment model (8.4) and the Directed Technical Change with Environment approach (8.5). When the two effects are of equal size, a zero growth economy is generated. Many of the other aspects are the same as in scenario I. The speed of technological change again depends on the effectiveness of innovation research (compare section 8.4). Capital accumulation is not included as explicit production factor because it adjusts to technological change, labour supply and the supply of natural resources. Contrary to scenario I, the remaining production factor, labour, is assumed to stay constant (as in the theories 7.4 and 8.4). This scenario primarily represents the reasoning of the following neoclassical models:

1. Scenario II reflects one of the two relevant specifications from the theory on *Directed Technical Change*. The second production factor is defined as natural resources and substitutability is assumed to be high. Only in this case does a reduction in natural resource supply lead to labour-augmenting technological change (the other specification follows in scenario III).
   The central lesson from this model is that high substitutability is a necessary assumption for scenario II to take place. Otherwise, a reduction in natural resources leads to scenario III.
2. For the *Dasgupta-Heal-Solow-Stiglitz Model*, scenario II also refers to one of two specifications. When the reduction of natural resources leads to substitution, this is reflected by an increasing use of the other production factors. One reason is an increase in effective labour due to labour-augmenting technological change, as displayed in scenario II.
   This theory also sheds light on the importance of substitutability between production factors. Scenario II can only take place in the described manner when substitutability is sufficiently high.
3. In *Endogenous Technological Change with Environment* labour-augmenting technological change and reductions of natural resources

are explicitly opposite factors in the determination of economic growth – the reasoning is hence very similar as in scenario II.

Three aspects are taken from this theory. First, the incorporation of natural resources into the production function is very similar. Second, the manner of reductions in natural resource is due to government decisions. Finally, the determination of the speed of technological change follows the same logic.

4. Finally, the model of *Directed Technical Change with Environment* also generates results along the lines of scenario II. This model is different, as it does not use natural resources as a production factor. Instead, pollution is assumed to be only emitted in the dirty sector. Pollution therefore decreases when the dirty sector shrinks. This is the case when labour is reassigned from the dirty to the clean sector. The condition for this to happen is that labour-augmenting technological change solely takes place in the clean sector. If one additionally assumes that the dirty sector is polluting because it uses natural resources (and the clean sector does not), the model is represented by scenario II.

   The most important aspect from this model is that the technology in the clean sector must first attain a certain level in order for technological change to take place in this sector. Up to this point, research in the clean sector needs to be subsidized or pollution needs to be taxed. Depending on the level of substitutability, this subsidy needs to be temporary or lasting.

9.2.2.2 Reference Model II

Here, production is not only determined by labour (L_t) and labour-augmenting technology (T_t), but additionally by the supply of natural resources (R_t) and its productivity (ϕ) (see equation 8.29):

$$Y_t = T_t L_t R_t^{\phi}. \tag{9.11}$$

The development of technology and labour is equivalent to scenario I, only that labour is assumed to be constant ($g_L = 0$). The use of natural resources is assumed to be determined by its supply, which is determined by the government. Following the model described in section 8.4 the "government can impose that R decreases over time" (Aghion and Howitt, 2009, p. 380). The (negative) growth rate of natural resource use (g_R) is therefore central in determining the level of resource use. As for labour and the state of technology, natural resource use is normalized to 1 at time 0. Natural resource use at time t is determined by

$$R_t = e^{g_R t}, \tag{9.12}$$

with $g_R \leq 0$. By combining equations 9.11, 9.2 and 9.12, production is determined according to[8]

$$Y_t = e^{(g_T + g_R \phi)t}. \tag{9.13}$$

The economic growth rate is

$$g_Y = g_T + \phi g_R. \tag{9.14}$$

The level of pollution (E_t) is in this case assumed to be in a constant relation (Ω) to the amount of natural resources used (R_t):

$$E_t = \Omega R_t. \tag{9.15}$$

Therefore the growth rate of pollution (g_E) is equal to the growth rate of natural resource use:

$$g_E = g_R. \tag{9.16}$$

This scenario is displayed in figure 9.2a. The slopes of the curves, beginning from the top, are g_T for the state of technology, $g_T + \phi g_R$ for production, $g_L = 0$ for labour and $g_E < 0$ for pollution. In this specific illustration, it has been assumed that the use of natural resources shrinks more slowly than the state of technology grows $|g_R| < g_T$. More specifically, it has been assumed that $g_R = -\frac{g_T}{2}$. An additional assumption is that $0 < \phi < 1$. Due to these assumptions, the rate of economic growth is positive and adds up to more than half of the rate of technological change.

9.2.2.3 Conditions for Sustainable Economies Without Growth in Scenario II

In this scenario, the central mechanism establishing a zero growth economy is to reduce the use of natural resources to such an extent that it balances out the positive effect of labour-augmenting technological change on economic growth[9]. Looking at equation 9.14, this is the case when the growth rate of technological change (g_T) is equal to the rate of shrinkage of natural resource use (g_R) multiplied by ϕ. As $0 < \phi < 1$, the rate

8 Labour is assumed to be constant ($g_L = 0$) and is therefore not included.

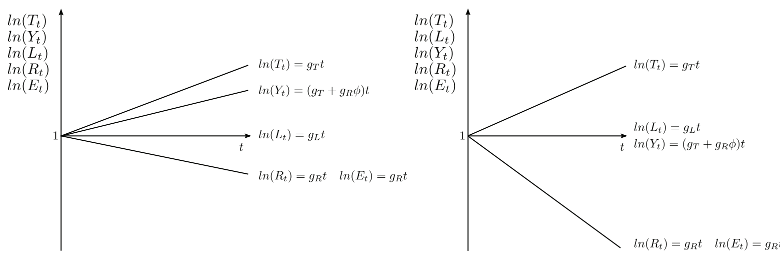
9 A combination of reducing working time and reduction of natural resources is also possible, in principle. It has not been included here in order to keep the illustration simple and because it overlaps with scenario I.

of shrinkage of natural resource use needs to be larger than the rate of technological change:

$$g_T = -\phi g_R. \tag{9.17}$$

This situation is represented in figure 9.2b

Figure 9.2: Neoclassical Scenario II



a Scenario II with Positive Economic Growth

b Scenario II with Zero Economic Growth

Logarithms of production ($ln(Y_t)$), the state of technology ($ln(T_t)$), pollution ($ln(E_t)$), natural resources ($ln(R_t)$) and labour ($ln(L_t)$) against time (t). Scales are not precise.

In scenario I, the central condition were preferences and regulations that lead to reductions in average working hours. In scenario II, on the other hand, a reduction in the supply of natural resources is essential. As argued above, this is most likely to be done by the government, as profit-maximizing private owners of natural resources have an incentive to exploit them, and a large share of natural resources has to stay unexploited in order to stay within planetary boundaries (see section 2.2.1).

Note that both natural resource depletion and pollution decrease at a faster rate than in the growth scenario. The reason is not (as it was in the first scenario) that pollution intensity is exogenously given. Instead, natural resources are withdrawn from the production process, which reduces both production and pollution. As has been revealed by the Directed Technical Change Model and the Dasgupta-Heal-Solow-Stiglitz Model, the central assumption for this scenario to take place is that substitutability between the production factors labour and natural resources is high. The following scenario depicts the opposite case.

9.2.3 Scenario III: A Redirection of Technological Change

9.2.3.1 Intuition and Relation to Neoclassical Theories

The central feature of the third scenario is that technological change takes a different form than was the case before. It is resource-augmenting instead of labour-augmenting. If the supply of natural resources is reduced at a rate that balances out its increasing productivity, a zero growth economy is generated. As in Scenario II, the speed of technological change depends on research activities (compare section 7.4), capital accumulation plays no role and labour supply is constant. This scenario reflects two theories discussed before.

1. Scenario III represents the *Directed Technical Change* model, in case the second production factor is natural resources and substitutability is low. In this case, resource-augmenting technological change takes place.
   The aspect adopted from this model is that a reduction in natural resources directs technological change towards resources, so that it is resource-augmenting. It is important to note that the prerequisite is low substitutability between production factors, as otherwise the market size effect prevails and innovations take place in the other sector.
2. Scenario III also applies to the second specification in the *Dasgupta-Heal-Solow-Stiglitz Model*, namely the case with resource-augmenting technological change. This type of technological change is assumed.
   This version of the Dasgupta-Heal-Solow-Stiglitz Model shows explicitly, how large the reduction in natural resources needs to be in order to countervail the effect of technological change and generate zero growth.

9.2.3.2 Reference Model III

In this scenario, production is determined by the amount of natural resources (R_t) and the state of technology, which is resource-augmenting (this different type of technology is denoted as Γ_t). The second production factor is labour (L_t) with a certain productivity (α).

$$Y_t = \Gamma_t R_t L_t^{\alpha}. \tag{9.18}$$

Technological change is resource-augmenting and also depends on the effectiveness of research activities ($\Gamma_t = \Gamma_t(\Upsilon)$):

$$\Gamma_t = e^{g_{\Gamma} * t}, \tag{9.19}$$

with $g_\Gamma \geq 0$. The supply of labour, the reduction of natural resources and the level of pollution are all determined as in scenario II. Production is determined according to (again assuming constant labour)

$$Y_t = e^{(g_\Gamma + g_R)*t}. \tag{9.20}$$

The economic growth rate is

$$g_Y = g_\Gamma + g_R. \tag{9.21}$$

Figure 9.3a depicts a situation with economic growth in scenario III. The slopes of the curves are g_Γ for the state of technology, $g_\Gamma + g_R$ for production, $g_L = 0$ for labour and $g_E < 0$ for pollution. As in the illustration of scenario II, it has been assumed that the rate of reduction of natural resources and therefore pollution is half the size as the rate of technological change ($g_R = -\frac{g_\Gamma}{2}$).

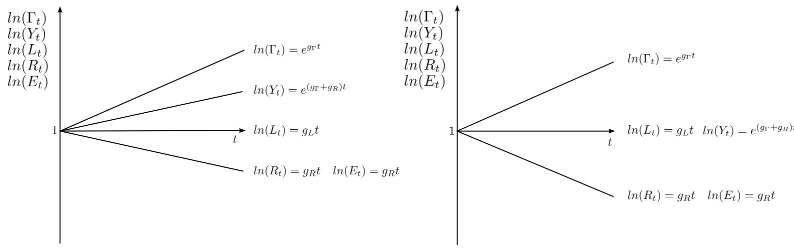
9.2.3.3 Conditions for Sustainable Economies Without Growth in Scenario III

In the third scenario (illustrated in figure 9.3b), the reduction of the use of natural resources is – as it was in the second scenario – the essential manner of reducing economic growth to zero. The idea behind it is slightly different, however. In the second scenario, production expanded due to an increase in effective labour. This was countervailed by a reduction of natural resources. In the third scenario, economic growth takes place due to increasing effective natural resources, and this is balanced out by less supply of natural resources. The outcome concerning the levels of production, labour and natural resource use are the same. The factor productivities are different though, and this impacts the functional income distribution. In essence, in the third scenario more of the income is attributed to suppliers of natural resources, as the productivity of them is relatively larger than in scenario II.

As in scenario II, the central condition is that the supply of natural resources decreases and this is most reasonably introduced by the government. Additionally, other measures can support a redirection of technological change. These are a taxation of natural resources and subsidies in clean sectors (compare section 8.5). The condition for zero growth is that the amount of natural resources decreases at the same rate as the resource-augmenting technological change takes place (see equation 9.22):

$$g_\Gamma = -g_R. \tag{9.22}$$

Figure 9.3: Neoclassical Scenario III



a Scenario III with Positive Economic Growth

b Scenario III with Zero Economic Growth

Logarithms of production ($ln(Y_t)$), the state of technology ($ln(\Gamma_t)$), pollution ($ln(E_t)$), natural resources ($ln(R_t)$) and labour ($ln(L_t)$) against time (t). Scales are not precise.

The use of natural resources decreases slower in Scenario III than in Scenario II. The reason is that natural resources play a more important role in production in Scenario III and can therefore not decline as fast, while keeping production constant.

9.2.4 Summary of Conditions

In a zero growth economy, the aggregated productivity of all production factors stays constant. Any increase of the amount or the productivity of a production factor therefore needs to go along with an equivalent decrease of another amount or productivity. The three scenarios have presented three different combinations of this sort. In the first, increasing labour productivity is balanced out by decreasing supply of labour. The major causes for decreasing labour supply are appropriate preferences and regulatory incentives introduced by the government. In the second, increasing labour productivity is countervailed by decreasing supply of natural resources. And in the third, increasing resource productivity is countervailed by decreasing supply of natural resources. In scenarios II and III, the major cause to reduce economic growth to zero is a reduction of the supply of natural resources by the government. The government can additionally support the redirection of technological change by appropriate taxation and subsidies by the government.

9.3 Environment, Distribution and Stability

After having discussed the results for the conditions for zero growth (subquestion 1) in detail, the following section covers the results for the other three subquestions. First, the results on the relation between zero growth economies and the environment are summarized shortly, as this issue has already been a subject of the previous section as well. The following sections on income distribution and stability are also short, as the results are the same across the different theories.

9.3.1 Environment

In all of the theories with environment, the zero growth economy produces better environmental outcomes than growing economies (see column (4) in figure 9.1). This result has also been reproduced in the three scenarios. When environmental technological change is exogenously given, lower production leads to lower environmental impact (section 8.2). In the case in which the environmental impact is modelled as the use of natural resources, zero growth economies go hand in hand with less exploitation of natural resources (sections 7.4, 8.1 and 8.4). As zero growth implies a stronger reduction of the supply natural resources, it generates better environmental outcomes in these models. Finally, when pollution takes place only in dirty but not in clean sectors, it stays constant when the dirty sector stagnates (in growing economies) and declines when the sector shrinks (in zero growth economies) – see section 8.5. The only theory that differs partly in this respect is the AK Model with Environment. In this model, the effectiveness of abatement rises at the same rate as economic growth and therefore the level of pollution is independent of economic growth. The environmental effect of production is the same in growing and stagnating economies.

9.3.2 Income Distribution

The neoclassical theories investigated provide no insights concerning the relation between zero growth economies and income distribution (see column (5) in figure 9.1).[10] The models do not generate any insights on the impacts on income distribution as they either assume a representative agent or only look at macroeconomic variables without different societal groups. The functional income distribution differs between the models and between growing and zero growth economies. As labour and the possession of assets are equally distributed – due to the assumption of a

10 The only exception is the Directed Technical Change approach, when the two production factors are skilled and unskilled labour. The two wage levels influence income distribution.

representative agent – this does not affect personal income distribution, however.

9.3.3 Stability

According to the neoclassical theories investigated, there are no instabilities related to a zero growth economy (see column (6) in figure 9.1). The models assume a clearing on the labour market, which is why there is no unemployment. As money is not included in the analyses, there can be no imbalances in the monetary or financial sectors. There is also no problem concerning the ability of firms to make profits. Firms either still earn profits (according to their holdings of physical capital and the still positive interest rate) or they have zero profits (in case they do not earn the physical capital they use). The neoclassical theories do not argue that either situation (no profits or profits) imply a problem for firms' willingness to pursue production.

9.4 Insights in the Light of Existing Literature

The results from this investigation are similar to the findings in the existing literature. While they overlap on several issues, some aspects from the literature have not been included here. At the same time some aspects brought to light here have not yet been discussed by other authors.

The approach here has been to apply existing models to the question of which conditions lead to zero growth. Only Irmen (2011) has conducted a methodologically similar investigation, while not explicitly showing the conditions for zero growth in concrete models. The present work has also incorporated a wider spectrum of neoclassical theories.

The results of the three scenarios partly overlap with results from other investigations. In scenario I, reductions in working hours play the major role in achieving zero growth despite labour-augmenting technological change. This path has also been pointed out by Heikkinen (2015). Scenario II leads to zero growth when labour-augmenting technological change is combined with decreases in the use of natural resources. This has also been pointed out by Irmen (2011), though he did not analyse it in a concrete model. Scenario III focusses on a redirection of technological change. This avenue has not been investigated before.

An additional interesting commonality between the present work and earlier work (in particular Irmen (2011) and Bilancini and D'Alessandro (2012)) is that strong governmental intervention is necessary to achieve zero growth. In scenario II as well as in Irmen (2011), the government has to decrease the availability of natural resources. And while here it has been assumed that reductions in average working hours are induced by appropriate preferences, Bilancini and D'Alessandro (2012) make a convincing argument that it necessitates strong governmental interventions.[11]

9.5 Limitations to Insights from the Neoclassical Theories

The neoclassical theories provide a framework to investigate the developments of production factors and their productivities. Usually this is used to explain the speed of economic growth. Here, it has been utilized to indicate conditions for zero growth.

Several of the underlying mechanisms and assumptions in neoclassical theories have been criticized. When these criticisms hold, the explanatory power of the mechanisms is limited. In particular, the causal link between savings and investments has been questioned (see section 6.4.2). The argument is that higher savings do not cause a decrease in the interest rate and subsequently higher investments. An alternative explanation of the link is developed in the subsequent part on Keynesian theories. A second criticism concerns the determinants of labour supply. In the theories covered here, it is either exogenously given or explained due to households' preferences regarding consumption and leisure. Other theories argue that single households are very limited in their ability to determine the amount they work. Average working hours are rather the outcome of societal negotiation processes (see in particular chapter 16).

Also, the neoclassical theories covered here are unable to shed light on certain important questions regarding economic growth and zero growth. First, unemployment does not play a role, although it is one of the most discussed problems regarding economies without growth (compare chapter 3). Second, the issue of effective demand cannot be discussed, as Say's law is assumed. Therefore, the potential effect of a deviation of effective demand from aggregate supply (either large effective demand can foster positive economic growth or low effective demand can introduce economic shrinkage) cannot be investigated. Third, neoclassical theories only take into account the part of the economy that is market based. A large part of economic activities are not market based, however (Sen, 1988b). Many of these activities are reproductive (or care) work (compare Biesecker et al. (2012)). These parts of the economy cannot be investigated by neoclassical economies at all, whereas they play a vital role for economies without growth (compare D'Alisa et al. (2015)).

[11] Conspicuous consumption leads to levels of labour supply and consumption far above welfare-maximizing levels.

Part III

Keynesian Theories

Chapter 10
Introduction

In this part, Keynesian[1] theories are applied to the question of how economies without growth can be organized. Keynesian approaches are, along with Marxian theories, arguably the most influential heterodox, that is, non-neoclassical school of thought (compare to Lee (2009) and Heise and Thieme (2015)). The Keynesian approach developed after the Great Depression, following the Great Financial Crisis of 1929. After the Second World War, Keynesian analyses even became the prominent school of thought until they were superseded by neoclassical theories (King, 2002).

Keynesian Compared to Neoclassical Theories

Keynesian approaches are different to neoclassical theories in various ways. The set of characteristics that distinct the Keynesian approaches from the neoclassical ones differs between authors.[2] Concerning the conditions for economies without growth, five appear to be most relevant.

1. *The determination of the size of production:* In neoclassical economics, the size of production is determined by the amount of production factors supplied. Underutilization of production factors is not possible. In Keynesian theories, on the other hand, the amount of production is determined by an interplay between aggregate demand and aggregate supply, which depends on *choices*, most importantly by entrepreneurs, consumers and the government.
2. *The relation between the short and the long run:* Neoclassical authors usually distinguish between mechanisms relevant in the short and the long run. The view of Keynesian theories is very different. Here, the short run determines the long run, as the long run is only the outcome of a series of business cycles (Kalecki, 1968). Therefore, while it was possible to focus on theories that explicitly concern the long run in

[1] Instead of using the term *Post Keynesian*, the term *Keynesian* is selected. This is because while many of the theories covered in the part can be classified as Post Keynesian, some (in particular the Neoclassical Synthesis and Binswanger's theory) do not fall into this category (compare with the discussions in King (2002, 2005), and Davidson (2003).

[2] See for example Hoffmann (1987, pp. 9 – 36); Davidson (2003) and Davidson (2011, pp. 13 – 22).

the neoclassical part, in the Keynesian part short run considerations also need to be taken into account.

3. *The relationship between investments and savings:* In neoclassical growth theories, savings are an important determinant for the level of investments either in capital goods, human capital or research and development. In Keynesian theories, the causal logic is opposite. The level of investments determines the amount of savings.
4. *The role of the monetary sector:* In neoclassical growth theories, the monetary sector either plays no role, as it is not included in the analysis, or it is regarded as a market with households supplying money due to their preferences and firms demanding money due to the state of technology. In Keynesian theories, investments are financed by loans that are funded by money creation. The workings of the monetary sector therefore play a vital role to facilitate economic growth. Accordingly, the monetary sector is also important concerning conditions for zero growth economies.
5. *Substitution of production factors:* In neoclassical theories, it is assumed that technology allows for a substitution of production factors. In most Keynesian theories, the ratios of the production factors are given for a given technology and point in time.

Due to these differences, Keynesian approaches regard a very different set of factors and mechanisms as decisive for how the economy functions in general and for the determination of economic growth in particular. Accordingly, the analysis of Keynesian theories leads to a very different set of conditions for zero growth economies.

State of Research on Economies Without Growth

Economic growth is a central goal in most Keynesian theories. The underlying reason is "the Keynesian promotion of full employment as the societal goal" (Spash and Schandl, 2009b, p. 16). The basic reasoning is that due to increases in labour productivity, economic growth is needed in order to prevent unemployment. This line of argument goes back to Keynes (2006) and has been a key component of the Keynesian literature ever since.

Accordingly, the question of zero growth has rarely been investigated by Keynesian theorists. Only in recent years have some authors approached the question. Nevertheless, there are still more contributions on the issue than from neoclassical theorists. The following list summarizes these contributions by dividing them into six groups and connecting them to different sections in the following three Keynesian chapters:

1. First, Keynes himself laid the groundwork for explaining an end of eco-

nomic growth. There are different interpretations of his theory. Peters (2000), Kerschner (2010) and Zinn (2015) argue that in Keynes' analysis, the main reason for declining growth rates is the decline in the marginal efficiency of capital, when the capital stock rises. An additional characteristic of an economy with rising income is the decline of the consumption rate. When combined, these two aspects explain the currently debated secular stagnation in early industrialized countries. Spahn (1986), on the other hand, argues that there are no structural reasons (such as a naturally declining marginal efficiency of capital) for secular stagnation within Keynes' theory. Instead, investigating stagnation in the 1970s and 80s, he argues that macroeconomic conditions, in particular monetary policies, were responsible. In the section on Keynes (11.1) it is investigated under what assumptions concerning technological change and consumption behaviour economies generate zero growth.

2. The seminal contributions on economies without growth by Jackson and Victor include many Keynesian attributes. Aggregate demand is the prime force behind economic growth for Victor (2008).[3] Jackson (2009a) develops a theory with mutually reinforcing mechanisms on the supply and the demand side. Concerning supply, competition and profit interests induce firms to invest. Demand increases due to a social logic of status consumption. The two books entail many important Keynesian aspects, while not using a comprehensive Keynesian framework. Their approaches have been discussed in more detail in section 3.3.
3. There are two articles on the feasibility of zero growth in Kaleckian models. Rosenbaum (2015) argues that zero growth is possible when capital depreciation is taken into account. Zero growth requires low investments (due to low animal spirits and a low response to technological change) that solely replace capital depreciation. Padalkina adds that government intervention is necessary in order to keep investments low enough to prevent capital accumulation. Kaleckian approaches are investigated in section 11.5. There, additionally the functioning of the economic circuit is taken into account and the business cycle in a zero growth economy is developed.
4. Another strand of literature combines stock-flow consistent models with the question of whether zero growth is feasible. The central question investigated is whether a zero growth economy is compatible with a positive interest rate. All investigations (Wenzlaff et al. (2014); Berg

3 Victor also developed a formal model using system dynamics. His approach has been elaborated by Gran (2017).

et al. (2015); Jackson and Victor (2015)) come to the conclusion that they are compatible. In Wenzlaff et al. (2014), all incomes due to interest rates need to be consumed. Berg et al. (2015) take into account consumption out of wealth, so that earnings out of interest can also be (partly) saved. In Jackson and Victor (2015), consumption out of interest earnings which is too low can be countervailed by higher taxes, which transfer interest earning into demand via the government.
Whether a stable zero growth economy is feasible hence primarily depends on what is being done with the interest revenues. Generally speaking, when interest revenues are distributed to households and are therefore disposable for consumption, zero growth is compatible with a positive interest rate. This issue is further investigated in section 12.4. It is analysed what conditions in general are necessary for zero growth within a stock-flow consistent model.

5. Finally, there is a discussion on the reconcilability between zero growth and the existing monetary system based on the contributions by Hans-Christoph Binswanger and Mathias Binswanger. Mathias Binswanger (2009) argues that there is a growth imperative in modern economies. An increasing supply of money, based on endogenous money creation, is necessary for firms to make profits. In a zero growth economy, firms would make losses and therefore go out of business. Gilányi (2015) argues that Binswanger's growth imperative is not binding, but instead that there is a growth imperative based on "the money creation rule" (p. 590). Johnson (2015) on the other hand points out that, within a stock-flow consistent model, Binswanger's original growth imperative applies. In section 12.3, the more comprehensive theory of Hans-Christoph Binswanger, which is very similar in its argument concerning a growth imperative, is investigated on conditions for zero growth.

Based on this literature review, two research gaps emerge. First, there is a lack of investigations that attempt a comprehensive analysis of central macroeconomic factors and mechanisms (such as aggregate supply and demand, investments, technological change etc.), using a well-elaborated and established theoretical framework. Second, there is a large number of important Keynesian theories that have not been used to investigate conditions for zero growth economies at all. The following three chapters contribute to these two aspects.

Outline

The part starts with a chapter on fundamental keynesian theories. Here, contributions of many of the most prominent Keynesian theorists are examined on conditions for zero growth. The part covers questions of effective demand, capacity and demand effects, the relation between different sectors of the economy, the relation between savings and investments and different types of technological change. The second part is on monetary keynesian theories. Here, the role of the monetary and financial sector is examined in more detail. Also, it is covered what zero growth means from a stock-flow consistent perspective. In the third part, environmental keynesian theories are used. This relatively new strand of literature covers the introduction of natural limits to Keynesian analyses, the importance of sectoral change for environmental sustainability and the role of governmental intervention. The part concludes with a discussion on the limits to insights from Keynesian theories. A detailed summary of the results from Keynesian theories, and a development of different Keynesian scenarios of zero growth is included in chapter 14. Table (14.1) provides an overview over the results from each of the Keynesian theories.

Chapter 11
Fundamentals

This chapter examines what insights can be drawn from investigating fundamental keynesian theories on the conditions for zero growth. There are as many answers to the question as there are authors. In the final section, an attempt is made to develop a synthesis by integrating fundamental conditions from a Keynesian perspective.

The chapter covers the work by Keynes himself and many authors who are often called Post Keynesians (see for example Hoffmann (1987)). Additionally, the Neoclassical Synthesis has been included.[1] Each author contributes a unique understanding of the economy. The representations focus on those aspects that are relevant for economies without growth and that are peculiar to the respective theory.

First, the investigation of Keynes' *General theory* brings to light a variety of mechanisms and factors important for a zero growth economy. In particular, the conditions for constant effective demand and for positive entrepreneurial profits in a zero growth environment are pointed out. Second, Harrod's analysis is used to establish the conditions for zero warranted, actual and natural growth rates. Third, the conditions for zero growth regarding capacity and demand effects are investigated, using Domar's theory. Fourth, it is shown that zero growth does (solely) require constant exogenous parameters within the framework of the Neoclassical Synthesis. Fifth, Kalecki's theory is used to investigate the roles of investments and technological change in a zero growth economy. Additionally, the conditions for zero growth within his three sector economy model are developed and it is shown under what circumstances a business cycle can fluctuate around a constant level of production. In the sixth section, Kaldor's understanding of technological change is used to investigate different types of technology in zero growth environments. Finally, Robinson's concept of biased technological change is used to examine zero

1 The Neoclassical Synthesis could be attributed to either the neoclassical or Keynesian school of thought, as it entails aspects of both. It has been included here because the level of production is determined by the interplay between aggregate demand and supply – a unifying aspect among all Keynesian theories covered and different to all neoclassical theories of part II.

growth under different biases. The chapter concludes with a summary of the findings and a discussion on the fundamental keynesian theories.

11.1 Keynes: Effective Demand

Few authors have played an equally important role for economics as John Maynard Keynes. Many of his concepts have already been included in his first major book, *A treatise on money* (Keynes, 1930). However, his second book *General theory of employment, interest and money* (Keynes, 2006) has been more influential. In this work, he formulates a strong critique of the neoclassical paradigm. But most importantly, he conceptualizes a new framework for macroeconomic theory (Lavoie, 2011).[2]

First, Keynes' theory concerning the determinants of the level of production is summarized. In addition to explaining his textual theory, a formal model is developed that represents some of Keynes' core ideas. Second, it is investigated under what conditions zero growth is generated according to Keynes' theory.

11.1.1 The Theory

Keynes' theory entails far more variables and mechanisms than the neoclassical theories from part II. In order to grasp and interpret Keynes' theory regarding the research questions, it is developed in three steps. In step I, Keynes' central concept of *effective demand* is explained. Effective demand is the intersection between aggregate supply and demand. Therefore, step II examines the determinants of aggregate supply and demand. In step III, the two central determinants of aggregate demand, consumption and investments are discussed in more detail. This explanation in three steps is thereupon complemented by a discussion on positive and negative feedback loops concerning economic growth. Finally, a formal model is developed, which incorporates some central mechanisms from Keynes' theory.

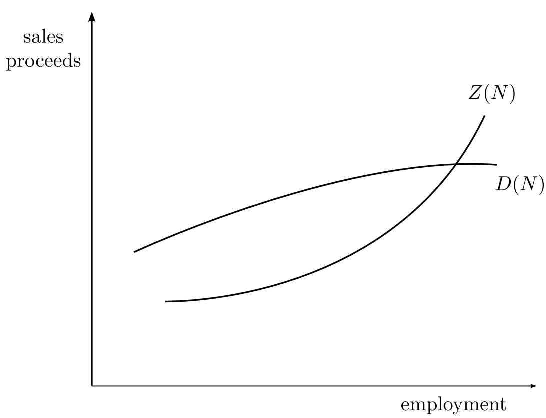
[2] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation of Keynes' theory is primarily based on the second book (Keynes, 2006). Section 11.1.1 is primarily a reproduction of his theory in textual form and in graphics. In addition, a formalized model is developed. The application of the theory to zero growth in section 11.1.2 includes interpretation of his theory by the author of this work.

11.1.1.1 Step I: Effective Demand as Intersection between Aggregate Supply and Demand

A good starting point for understanding Keynes' theory and in particular his concept of effective demand is to contrast it with the neoclassical concepts of aggregate supply and demand. In neoclassical theories, an increase in supply necessarily leads to an equivalent increase in income (as more capital and labour is employed and paid). Therefore, every increase in supply generates an equal amount of additional demand. This is called *Say's law*. Keynes rejects this argument, because additional income does not necessarily need to be consumed or invested. It can also be withheld from the economic circuit instead.

Based on this critical view concerning the neoclassical approach, Keynes develops an entirely different framework to explain the size of production. His central concept is effective demand. It determines the size of production. According to Keynes "the point of the aggregate demand function, where it is intersected by the aggregate supply function, will be called the effective demand" (Keynes, 2006, chapter 3, part I). Figure 11.1 depicts this relationship.

Figure 11.1: Effective demand as the intersection of aggregate demand and aggregate supply



Adapted Davidson (1978, p. 112).

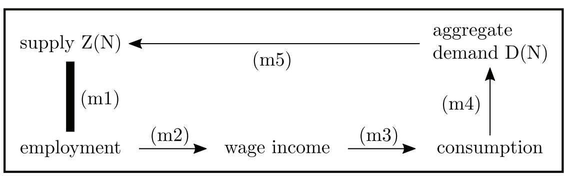
Both aggregate supply ($Z(N)$) and demand ($D(N)$) increase with the amount of employment. For low levels of production, an increase in employment has a larger effect on demand than on supply (represented by a steeper slope of the demand than the supply curve). For high levels of production, it is the other way around. Here an increase in employment has a stronger effect on supply than on demand, represented by a steeper slope of the supply than of the demand curve. Additionally, the demand curve is above supply for low levels of production. The economic intuition for high levels of production is as follows: On the supply side, increasing employment increases production due to a technologically determined proportion. On the demand side, it leads to an increase in wages. The increase in wages must be smaller than the value of the increase in production, as otherwise the costs for the entrepreneur were higher than the revenues. The increase in wage income leads to more consumption and higher aggregate demand. As the consumption rate is smaller than one, the increase in demand is smaller than the increase in income. Hence, an increase in employment must lead to a higher increase in aggregate supply than in aggregate demand.

Whenever the economy is not at the intersection point of effective demand, there are mechanisms that push it towards it. Whenever the economy is at a point left from the intersection point, entrepreneurs have an incentive to invest. The reason is that the wage cost is smaller than the price at which they can sell the additional products. On the other hand, when the economy is to the right of the intersection points, entrepreneurs have no incentives to invest. Here, the reason is that the demand does not suffice to generate revenues that are higher than production costs. In Keynes' own words:

> Let Z be the aggregate supply price of the output from employing N men, the relationship between Z and N being written $Z = \varphi(N)$, which can be called the Aggregate Supply Function. Similarly, let D be the proceeds which entrepreneurs expect to receive from the employment of N men, the relationship between D and N being written $D = f(N)$, which can be called the Aggregate Demand Function. Now if for a given value of N the expected proceeds are greater than the aggregate supply price, i.e., if D is greater than Z, there will be an incentive to entrepreneurs to increase employment beyond N and, if necessary, to raise costs by competing with one another for the factors of production, up to the value of N for which Z has become equal to D. Thus the volume of employment is given by the point of intersection between the aggregate demand function and the aggregate supply function; for it is at this point that the entrepreneurs' expectation of profits will be maximized. The value of D at the point of the aggregate demand function, where it is intersected by the aggregate supply function, will be called the effective demand (Keynes, 2006, chapter 3, section I).

Figure 11.2 is a different way of visualizing the concept of effective demand. Aggregate supply is related to a technologically determined level of employment (m1). The level of employment is an important determinant – it is not the only one – of income (m2), of consumption (m3) and therefore of aggregate demand (m4). The size of aggregate demand determines whether the firms can sell all their products and whether there is an incentive for entrepreneurs to expand production (m5). As long as the economy is below the level of effective demand, this positive feedback loop continues. At a certain point, the extra costs entrepreneurs encounter due to additional employment (m1) are higher than the effect on aggregate demand (m5) and the expansion of production comes to an end.

Figure 11.2: Keynes' theory of effective demand I



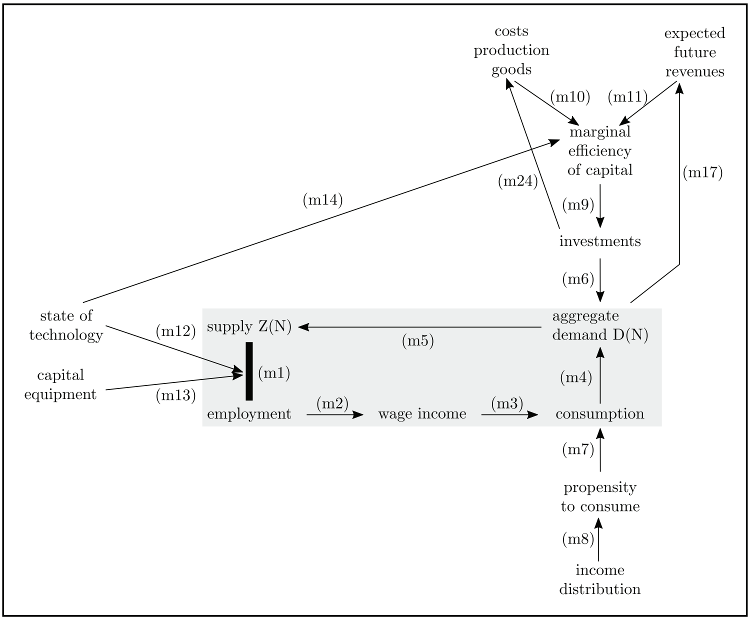
11.1.1.2 Step II: Determinants of Aggregate Supply and Demand

This section elaborates on the central determinants of aggregate demand and aggregate supply. Figure 11.3 depicts an elaboration on the framework of figure 11.2. Aggregate demand entails investments (m6) in addition to consumption (m4). In the prior section, it has been argued that one crucial determinant of consumption is employment and the wage income it generates. The second important determinant of consumption is the propensity to consume (m7). It in turn primarily depends on the distribution of income (m8).

The second component of aggregate demand is investments. Their primary determinant is the marginal efficiency of capital (m9). It in turn depends on the difference between the costs of buying production goods (m10) and the revenues that are expected to be gained from applying the production goods (m11).

On the supply side, the major question is how the relationship between production size and employment (m1) is determined. Two elements are important. First, the state of technologies determines how much capital and how much employment is needed for a certain amount of production

Figure 11.3: Keynes' theory of effective demand II



(m12). The ratios are assumed to be constant as substitution of production factors is not possible. Hence, the state of technology determines the capital and the labour coefficients.

The second important element on the supply side is the amount of physical capital in place, Keynes calls it the capital equipment. As the capital coefficient is assumed to be constant, the level of capital equipment determines the production capacity (m13).
The combination of the state of technology and the level of capital equipment also influence the marginal efficiency of capital (m14). The capital coefficient combined with the amount of capital equipment determine the production capacity. Given a certain amount of aggregate demand, a lower production capacity implies larger revenues on additional production and therefore a higher marginal efficiency of capital.

The result of all these mechanisms is a circular causal relationship: Consumption and investments (the determinants of aggregate demand) lead to a certain level of production. This leads (on the supply side) to a certain level of employment and incentives to invest, which in turn influences aggregate demand.

11.1.1.3 Step III: Detailed Determinants of Consumption and Investments

For Keynes, aggregate supply is not of particular interest as "[t]he aggregate supply function, [...] which depends in the main on the physical conditions of supply, involves few considerations which are not already familiar" (chapter 8, paragraph I). Instead he emphasizes the role of the demand side. This is why, in this section, the determinants of aggregate demand are investigated in more detail. First, it is looked at consumption and second at investments. The argument is illustrated in figure 11.4.

a Determinants of consumption

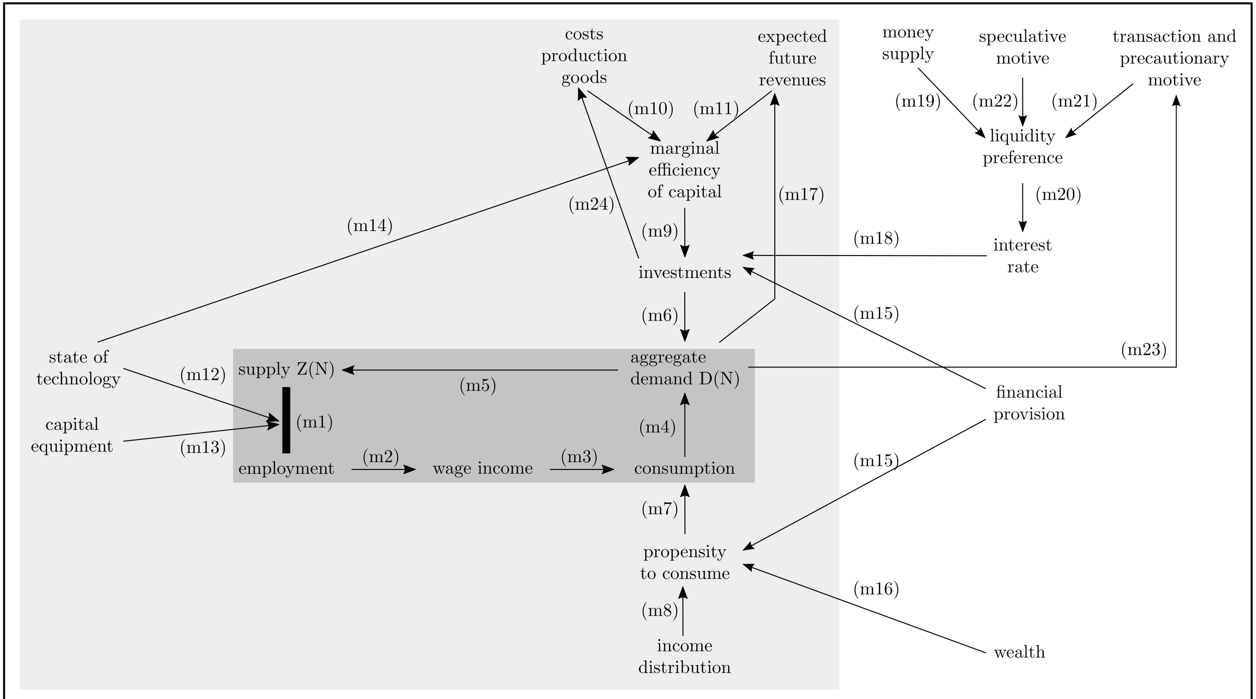
Income due to wages is the prime determinant of consumption (m3) for Keynes (2006): "[T]he aggregate income measured in terms of the wage-unit is, as a rule, the principal variable upon which the consumption-constituent of the aggregate demand function will depend" (chapter 8, paragraph II). In Keynes' analysis, wage income is determined differently than in neoclassical theories. There, the level of employment and the wage rate are due to households' preferences and the state of technology that determines marginal factor productivities. Keynes, on the other hand, argues that people cannot freely choose the amount they work. More specifically, it is a "fact that the population generally is seldom doing as much work as it would like to do on the basis of the current wage" (chapter 2, part II). Instead, the amount of employment depends on effective demand, as argued above.

Apart from income, the propensity to consume is most important in determining consumption (m4). The propensity to consume does not primarily depend on preferences but on the income distribution (m5). Individuals with low income consume a higher portion of their income than those with higher incomes.

Three additional determinants of consumption are insightful for the following analysis.[3] The financial provision (Davidson extends this concept under the name finance motive, see section 12.1) implies that people and firms can save in order to be able to buy an expensive good in the future (m15). This may lead to less consumption and investments (m15). Finally, Keynes (2006) argues that not only income but also wealth plays a role for the propensity to consume. A higher level of wealth is likely to incline individuals to consume more (m16).

[3] Keynes (2006) lists numerous additional factors that influence the propensity to consume and divides them into objective and subjective factors. According to Keynes, these are only of secondary importance, however, and can be assumed to be constant (for a detailed list see Keynes, 1936, chapter 8, II.).

Figure 11.4: Keynes' theory of effective demand III



b Determinants of investments

In Keynes' (2006) analysis, the marginal efficiency of capital and the interest rate are the two important determinants of investments: "the scale of investment depends on the relation between the rate of interest and the schedule of the marginal efficiency of capital" (chapter 12, part I). The investment is only pursued if the marginal efficiency of capital is higher than the interest payments.[4]

b.1 The marginal efficiency of capital

When a firm decides whether to make an investment, two aspects are important. First, it expects certain additional revenues related to the investment in the future (m11). This includes the entire future revenues of the investments (not only the revenues of the next period). The prime determinant of the expected revenues is aggregate demand, as it determines the amount of products firms are likely to be able to sell (m17). Second, the firm takes into account how expensive the production goods[5] are. The difference between the two numbers is the marginal efficiency of capital. The highest single marginal efficiency of capital is the macroeconomic marginal efficiency of capital, as investments in the most profitable sector/firm will be done first:

> I define the marginal efficiency of capital as being equal to that rate of discount which would make the present value of the series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price. This gives us the marginal efficiencies of particular types of capital-assets. The greatest of these marginal efficiencies can then be regarded as the marginal efficiency of capital in general (Keynes, 2006, chapter 11, part I).

Additional factors are the development of the stock of capital equipment over time and changes in the state of technology (m14). If there have been high investments in the recent past (and therefore the capital stock is large), it is likely that there are few investments left that lead to high revenues. The reason is that those investments with the highest marginal efficiency are done first. The state of technology plays an ambivalent role.

4 It should also be noted that Keynes (2006) argues that savings do not cause investments, as the neoclassical theories assume. Instead, investments cause savings. The reason is that investments are financed due to endogenous money creation and lead to increasing income and hence savings. The details why the subsequent savings need to be of the same size are not explained here. See the section on Kalecki (11.5) for his explanation, which is very similar to Keynes'.

5 What Keynes calls production goods is usually referred to as capital goods in other theories.

On the one hand, technological change can induce investments, as it reduces the production costs and therefore increases expected profits. On the other hand, technological change implies uncertainty concerning the profitability of investments. Future technological improvements can make current production processes uncompetitive and therefore investments today risky.

b.2 The interest rate

The second major determinant of investments is the interest rate (m18). Firms borrow money at a given interest rate to invest.[6] The interest rate is determined by supply and demand on the money market.

Keynes develops a different theory on the determination of the interest rate, as compared to neoclassical theories.[7] He assumes a given money supply (m19), determined by the central bank. The money demand is determined by the liquidity preference (m20), a central concept in Keynes analysis. Individuals have a certain income. First, individuals decide how much to spend and how much to save. Second, they can decide to either hold their savings as cash money (liquid holdings) or to dispense of the

[6] However, even if a firm holds enough money for an investment, they can compare the expected profits from the investment with bringing the money to the bank.

[7] In neoclassical theories, the interest rate is determined by the demand for and supply of money. The demand is due to the demand for investments and the supply is due to savings decisions of individuals. Investments in turn are due to the marginal productivity of capital (not to be confused with Keynes' marginal efficiency of capital) and the savings decisions depend on the preferences of individuals. Therefore, additional savings lead to an equal increase in investments: "Certainly the ordinary man – banker, civil servant or politician – brought up on the traditional theory, and the trained economist also, has carried away with him the idea that whenever an individual performs an act of saving he has done something which automatically brings down the rate of interest, that this automatically stimulates the output of capital, and that the fall in the rate of interest is just so much as is necessary to stimulate the output of capital to an extent which is equal to the increment of saving; and, further, that this is a self-regulatory process of adjustment which takes place without the necessity for any special intervention" (chapter 14, part I). Keynes criticizes that this cannot be the case, because decisions that change the demand side also change the supply side, and vice versa. An example: When people decide to consume less and save more, the money supply increases. At the same time, it means less consumption, therefore less aggregate demand, less production, fewer expected revenues and fewer investments. Overall income and demand for money decrease. Therefore, "the response of investment and the response of the amount saved out of a given income to change in the rate of interest, do not furnish material for a theory of the rate of interest" (Keynes, 2006, chapter 14, part I).

liquidity and provide it for investments. The interest rate is "the reward for parting with liquidity" (Keynes, 2006, chapter 13, section I). The liquidity preference depends on how much money is held for transactions and unexpected spending (m21) and for speculative reasons (m22). The transactions motive is primarily determined by the level of aggregate demand: With increasing income, individuals are likely to hold more money to be able to buy goods and when firms want to invest they are also likely to hold more liquid assets in order to pay for the investments (m23).

b.3 The level of investments

In sum, investments are determined by the marginal efficiency of capital and the interest rate. The marginal efficiency of capital in turn depends on expected future revenues and the costs of capital equipment. The major factor for the expected future revenues is the expected future aggregate demand. The interest rate is determined by the exogenously given money supply and the liquidity preference, which also depends to a large degree on the development of the income level. The development of aggregate demand is therefore of major importance in explaining one of its major components, investments. This exemplifies the circular nature of Keynes' analysis of the macroeconomy.

11.1.1.4 Technological Change in Keynes' Analysis

Keynes has a different understanding of technological change, than the neoclassical view. Technology (or what Keynes calls "technique" (Keynes, 2006, chapter 11, part III)) determines the relationships between labour, physical capital and natural resources. He does not argue that technological change increases the productivities of production factors, as neoclassical theories do. Instead, technological change is argued to facilitate production at a lower cost – either because it needs fewer natural resources, labour and/or physical capital: "[E]verything is *produced by labour*, aided by what used to be called art and is now called technique, by natural resources which are free or cost a rent according to their scarcity or abundance, and by the results of past labour, embodied in assets" (chapter 16, part II). [8]

Technological change goes hand in hand with investments. Investments are necessary in order to implement more efficient technologies and the availability of more efficient technologies is a major reason for investments. The two are therefore inseparable.

[8] The reason for this different perspective is a fundamentally different understanding of the determination of value. Keynes (2006) follows classical analyses and argues for a labour-value theory as the previous citation illustrates

The central aspect concerning technological change for Keynes' analysis is that it decreases the labour coefficient. Hence, innovations lead to reductions in employment. In order to achieve full employment, a constant increase in aggregate supply and demand is therefore necessary. However, the effect of technological change not only makes economic growth necessary. It also makes it difficult to achieve. The reason is that lower employment implies less aggregate demand.

Increasing government spending therefore gains an important role. The lack in consumption demand that results from technological change can be reduced or abolished by increases in government spending. This is necessary in order to facilitate full employment and at the same time leads to continuous economic growth.

11.1.1.5 Positive and Negative Feedback Loops

The analysis by Keynes (2006) entails both positive and negative feedback loops concerning the development of the level of output. There are two central positive feedback loops: (1) Increasing employment leads to increasing income and consumption and higher aggregate demand. This causes an expansion of production and further increases employment (via mechanisms (m2), (m3), (m4), (m5) and (m1), compare with figure 11.2).[9].(2) A second mechanism supports the first feedback loop. The expansion of production does not only lead to more employment but also to higher investments (via mechanisms (m17), (m11) (m9) and (m6)). This increases aggregate demand further.

At the same time, there are also at least two negative feedback loops. (1) Investments lead to higher demand for production goods and hence increase their price (m24). The costs of capital rise, which decreases the marginal efficiency of capital. This effect dampens the effect of the second positive feedback loop (via mechanisms (m24), (m10) and (m9)). (2) An increase in aggregate demand fosters money holdings due to the transaction motive (m23). Therefore, the interest rate rises, which dampens investments (via mechanisms (m23), (m21), (m20) and (m18)).

11.1.1.6 A Formalization of Keynes' Theory

In order to improve the investigation of Keynes' model concerning the first research subquestion, a simple model is developed that covers some

9 How well this cycle works depends to a large degree on the connection between production and employment. The higher the labour/production ratio, the stronger the effect of an increase in production is on employment and subsequently on consumption. The state of technology determines this link. If technology with higher labour productivity is introduced, the ratio decreases and consumption is low.

important aspects of Keynes' theory concerning economic growth.[10] The model focusses on the investment decisions of firms, as these are crucial for the level of production, employment and economic growth. It has been argued that firms need to expect future revenues that are higher than the costs of production goods and the interest rate in order to make investments. This is simplified by arguing that firms need to expect higher revenues than they have expenditures (in other words, that they make entrepreneurial profits) in order to make investments. It is assumed that to have the expectation of making entrepreneurial profits over time, firms actually need to make profits. Hence, the central condition for investments is that firms' revenues are higher than their expenditures.

Firms expenditures (Ю_0) in period 0 are determined by wages (W_0), investments (I_0) and interest payments (Ψ_0) in the same period:

$$\text{Ю}_0 = W_0 + I_0 + \Psi_0. \tag{11.1}$$

As seen above, the revenues of firms (Σ) are equal to aggregate demand, which consists of consumption (C) and investments (I).The expected revenues in the future are the deciding factor in the firms' decisions to invest. These are denoted by the time period 1:

$$\Sigma_1 = C_1 + I_1. \tag{11.2}$$

The firms compare their current expenditures (Ю_0) with their future revenues (Σ_1). Firms' profits (Π_1) are the difference between the current expenditures and the future revenues:

$$\Pi_1 = C_1 + I_1 - (W_0 + I_0 + \Psi_0). \tag{11.3}$$

The difference between the investments of period 0 and 1 is denoted as $dI = I_1 - I_0$. Wages are decomposed into consumption out of wages (C^w) and savings out of wages (S^w): $W = C^w + S^w$. Consumption is decomposed into consumption out of wages (C^w) and consumption out of profits and wealth (C^p): $C = C^w + C^p$. Finally, the difference between consumption out of wages of period 0 and 1 is defined as $dC^w = C_1^w - C_0^w$. Putting these equations into 11.3, the following equation is derived:

$$C_1^p + dC^w + dI = \Pi_1 + \Psi_0 + S_0^w. \tag{11.4}$$

[10] Note that the following theoretical contribution has been developed by the author of the present work.

Following Keynes' theory, all variables on the right hand side are usually positive. Entrepreneurial profits (Π_1) need to be positive to make investments profitable. Interest payments (Ψ_0) have to be above zero as long as the interest rate is positive. Savings out of wages (S_0^w) are positive as long as the propensity to consume is below 1.

Subsequently, some of the factors on the left hand side need to be significantly above zero as well. Either there is significant consumption out of profits and wealth (C_1^p), or consumption out of wages has to increase (dC^w) over time or investments (dI) need to increase.

In a growing economy, usually all three terms are positive. While consumption out of profits and wealth is usually argued to be lower than consumption out of wages, it is nevertheless assumed to be positive. Investments are likely to increase continuously in a growing economy, in order to replace depreciation and increase the capital stock. Consumption out of wages usually increases as well, as wages rise. As long as the three amounts together are larger than savings out of wages and interest payments, entrepreneurial profits can be realized. Below, it is investigated how the picture changes in a zero growth economy.

11.1.2 The Theory and Economies Without Growth

The investigation of conditions for zero growth according to Keynes' analysis follows the same sequence as the explanation of the theory. First, the role of effective demand and its determinants in a zero growth economy are examined (referring to sections 11.1.1.1 – 11.1.1.3). Second, the technological change is included in the analysis of effective demand (referring to section 11.1.1.4). Third, conditions for the feedback loops (of section 11.1.1.5) to be compatible with zero growth are investigated. Finally, the insights from the formal model (section 11.1.1.6) for economies without growth are discussed.

11.1.2.1 Effective Demand Without Technological Change

The central condition for a zero growth economy within Keynes' analysis is that effective demand stays constant over time, as effective demand determines the level of production. This means that the position of the intersection between aggregate supply and demand does not change (see figures 11.1 and 11.2). As long as the state of technology is constant, aggregate supply does not change. This implies that aggregate demand must not change either, in order to have a constant effective demand and zero growth.

There are two insightful manners to investigate whether a constant level of aggregate demand is feasible. The first manner is to assume that the economy is already in a situation of zero growth, with constant aggregate demand, aggregate supply and investments that just replace capital depreciation. The question then is whether there are forces that increase aggregate demand and therefore bring the economy into a growth phase again. The central determinant for the first component of aggregate demand – consumption – is the level of employment. With a given level of the state of technology and constant aggregate demand, there is no reason for employment, or subsequently consumption, to change. The central determinant for the second component of aggregate demand – investments – is the marginal efficiency of capital. When technology does not change and aggregate demand stays constant (so that expected revenues also do not change), there is no reason for the marginal efficiency of capital to change. What happens if any of the numerous additional factors changes is explained below.

The second manner is to start in a growing economy. In this case, the positive feedback loops prevail. Most importantly, increases in aggregate demand lead to an expansion of the supply of consumption goods and of investments, further increasing aggregate demand. However, without technological change, the marginal efficiency of capital will decline over time. The reason is that the most productive investments are undertaken first, so that the marginal efficiency declines with an increasing level of capital equipment. As a result, investments decrease over time. This also slows down the expansion of aggregate demand, which in turn slows down investments even further. At a certain point, economic growth comes to an end, when the marginal efficiency is equal to the interest rate.[11]

The declining marginal efficiency of capital also explains, why any change of one factor that also influences aggregate demand (income distribution, liquidity preference, monetary supply, the cost of production goods, ...) does not lead to continuous economic growth. It barely gives a one-off push and therefore increases the level of production only once. The assumption underlying this entire argument that there is no technological change is withdrawn in the next section.

11.1.2.2 Effective Demand With Technological Change

In section 11.1.1.4, the consequences of technological change have been explained. First, the availability of new production methods increases the marginal efficiency (and subsequently investments and aggregate demand), because firms can lower their production costs by using them. Second, the introduction of more efficient technologies leads to a lower labour coefficient, hence less employment and a decrease in wage income

[11] Note that this argument is very similar to the reasoning of Keynes' long-term view on economic growth in section 2.3.3.

(and subsequently in consumption and aggregate demand). The usual reaction of Keynesian authors to this analysis is that consumption demand needs to be fostered by redistribution or government expenditures in order to increase production and the level of employment (Stockhammer, 2011).

In order to facilitate zero growth, the reaction instead needs to be a redistribution of working hours, while keeping the wage level constant. If the average working hours are decreased by the same rate as the labour coefficient declines and the wage per hour increases by the same rate, the wage level and the level of employment stay constant. Hence, also consumption demand stays the same.

Such a stabilization of consumption demand is also likely to stabilize the level of investments. Firms still have the incentive to invest in order to decrease their production costs and therefore have a competitive advantage. At the same time, the expected revenues are lower than before. In particular, the consumption demand does not expand any more, so that firms are unable to increase the amount of sales. This may lead to a situation in which firms have the incentive to introduce cost-reducing technologies without expanding their production capacity.[12] If it is assumed that technological change is of such kind that it increases the capital coefficient at a constant rate (as is usually the case), investments stay constant over time. In other words: If each new production technology requires an equal increase in physical capital (as compared to the former) and firms aim to replace (not expand) their old production facilities by new ones, then investments are constant over time.

Under such conditions, consumption and investments are constant over time. As a consequence, also aggregate demand and aggregate supply do not change.

11.1.2.3 Feedback Loops

In section 11.1.1.5 two positive and two negative feedback loops in Keynes analysis have been explained. These are helpful in examining which conditions are necessary for a zero growth economy. In a growing economy, the positive feedback loops prevail. In a zero growth economy, positive and negative feedback loops need to balance out each other.

Regarding the first positive feedback loop, the positive effect of additional employment on aggregate demand can be reduced by decreasing the

[12] The necessary condition is though that the dominant reason for firms' investment decisions are expected revenues. As will be argued below, firms also invest in order to increase shareholder values (see section 12.3) and because they have to increase production due to economies of scale (see part IV).

propensity to consume (see the first positive feedback loop). One possible reason that is also in line with proponents of economies without growth (from existing concepts, see chapter 3) would be lower consumption due to increased environmental consciousness among the population (Stengel, 2011). Concerning the second positive feedback loop, the positive effect of an increase in aggregate demand can be lowered, for example due to entrepreneurs who are less likely to invest. Possible causes are an altered entrepreneurial attitude (Posse, 2015), lower expectations of future revenues due to the experience of zero or low growth (see section 12.1) or different business types, which imply fewer incentives to invest (see section 12.3). The negative feedback loops concern the price of production goods and the transaction motive: In order to prevent economic expansion, the effect of investments on the price of production goods can be stronger and/or aggregate demand can have a stronger effect on the transaction motive. Higher prices of production goods can for example be initiated by taxes on natural resources (which are embodied in production goods) and on the production of production goods themselves (see section 12.1).

The analysis of the detailed illustration of Keynes' theory (section 11.1.1.3) points out additional aspects concerning a zero growth economy. There is a variety of factors that either influence investments or consumption. These factors are largely exogenously given in the theory. Compared to a growing economy these factors need to be less favourable for aggregate demand. The factors are costs of production goods, money supply, the speculative motive, expectation of future income, level of wealth, income distribution and fiscal policies.

11.1.2.4 Consumption Out of Profits and Wealth in the Formal Model

The model from section 11.1.1.6 is used to determine further conditions for zero growth economies. Based on the previous arguments, the following conditions in a zero growth economy are assumed: (1) Investments equal depreciation and stay of equal size over time. Therefore, investments are positive and stay constant: $I_0 = I_1 > 0$. (2) Consumption out of wages stays constant over time: $dC^w = 0$. This assumption is plausible due to constant production and income in zero growth economies. (3) Firms expect profits from their investments in order to invest. Therefore, both interest payments and entrepreneurial profits are above zero: $EP_0 > 0; \Psi_0 > 0$.

Combining these conditions with equation 11.4, the following central condition for zero growth economies is derived:

$$C_1^p = \Pi_1 + \Psi_0 + S_0^w. \tag{11.5}$$

Interest payments (Ψ_0) and the entrepreneurial profits (Π_1) need to be positive. According to Keynes line of argument, savings out of wages (S_0^w) are low, but also above zero. Therefore, consumption out of profits (C_1^p) needs to be significantly positive. It is of the same size of entrepreneurial profits, interest payments and savings out of wages combined. In other words: In order to have positive entrepreneurial profits and positive interest payments in a zero growth economy, there needs to be significant consumption out of profits or wealth.

When it is assumed that there are no savings out of wages ($S_0^w = 0$), an additional insight is gained. In this case, consumption out of profits are exactly equal to entrepreneurial profits and interest payments. The latter two represent total profits. Therefore, consumption out of profits need to be equal to total profits. As a consequence, there are no savings out of profits. The entire amount of profits and the entire amount of wages are consumed. With zero savings out of profits and zero savings out of wages, the overall savings rate of the economy is also zero.[13]

11.1.2.5 Results

There are four crucial results from this investigation. First – without technological change – an economy is likely to end up in a situation with zero growth automatically, due to a declining marginal efficiency of capital. Additionally, there is no reason for an economy to regain continuous growth (or shrinkage) once it has reached zero growth.

Second – with technological change – reductions in average working hours with compensatory wage increases are necessary for zero growth and to prevent unemployment. In this manner, consumption demand is stabilized and the need for increases in government expenditures (to prevent unemployment) is circumvented. Firms are likely to respond to such measures by focusing investments on *replacement* of old technologies by new ones instead of *expansions* of production capacity.[14] This leads to constant levels of investments. Aggregate demand stays constant because consumption and investments are constant. Aggregate supply is also constant, as firms do not expand their production capacities. With constant aggregate supply and demand, effective demand also stays steady, so that the economy generates zero growth.

Third, positive feedback loops need to be lessened and negative feedback loops strengthened to support a zero growth economy. A variety of changes and measures play a role here, such as an altered consumption

13 For a very similar result, see section 11.5.

14 Firms are only likely to behave in this manner according to the mechanisms in Keynes' analysis. In part IV it is shown that other mechanisms, in particular market competition, contradict such behaviour.

behaviour of households, fewer entrepreneurial spirits to invest, different business types and raising the price of production goods.

Fourth, there needs to be significant consumption out of profits in order to reconcile zero growth with positive profits for firms. Consumption out of profits and consumption out of wages need to equal overall income. In other words: The savings rate needs to be equal to zero.

There appears to be a contradiction within these conditions. On the one hand, savings need to be zero in order to facilitate entrepreneurial profits. On the other hand, aggregate demand, including consumption, needs to be kept from expanding. The key concept to reconcile this contradiction is the reduction in average working hours. It prevents incomes from growing and therefore also consumption demand from expanding. Even if the consumption rate is 1, consumption demand does not grow as long as incomes do not grow over time.

11.2 Harrod: Warranted, Actual and Natural Growth

Roy Harrod (1939) was the first to develop a long-term growth theory that has similarities with the assumptions and concepts from Keynes' analysis (Samuels et al., 2003). In many textbooks, Harrod's and Domar's (see next section) contributions are presented as one theory. But the two authors each developed unique theories on economic growth. This is why, here, the two approaches are investigated separately.

Harrod has written on the dynamics of economic growth in various publications (Harrod, 1939, 1948, 1973). His most prominent contribution to the discussions on economic growth has been the distinction between the *warranted*, the *actual* and the *natural* growth rates (Harrod, 1939).

Harrod's assumptions are contrary to the neoclassical ones. He assumes a given societal savings rate. The capital coefficient is constant, so that the marginal is equal to the average productivity of capital. Investments are assumed to be positively related to the growth rate of output and dependent upon the decisions of enterprises, but not on savings decisions.

The basic reasoning of his model goes as follows: The warranted growth rate is determined by the savings rate and the capital coefficient. In order to employ all savings (determined by the output level and the savings rate) and dependent upon how much more output can be produced by additional investments (dependent upon the capital coefficient), a specific growth rate is necessary. Second there is the actual growth rate. It depends upon investments and the capital coefficient. Third, the natural growth rate is determined by population increases, the preferences of individuals to work and technological changes. For given capital and labour coefficients, population growth and preferences to work determine the labour supply. Technological change alters the labour coefficient. The natural growth rate therefore displays the growth rate at which all available labour is employed (Harrod, 1939).

These three growth rates may coincide, but they do not need to. In fact, there are forces that allow the warranted and the actual growth rate to drift apart: If the actual growth rate is higher than the warranted growth rate, investments increase (as they depend upon the actual growth rate), leading to even higher actual growth and a shortage of capital. The opposite scenario works accordingly, leading to an oversupply of capital and continuously fewer investments and actual growth. The natural growth rate sets an upper boundary on the growth rate but usually the actual growth rates stays below, so that unemployment exists.

Harrod's result is chilling. He claims that capitalist economies systematically tend towards disequilibrium: "Thus in the dynamic field we have a condition opposite to that which holds in the static field. A departure from equilibrium, instead of being self-righting, will be self-aggravating" (Harrod, 1939, p. 22).[15]

11.2.1 The Theory

11.2.1.1 The Warranted Growth Rate

"The warranted rate of growth is to be that rate of growth which, if it occurs, will leave all parties satisfied that they have produced neither more nor less than the right amount" (Harrod, 1939, p. 4). This implies in particular that all savings are applied. The amount of savings (S) is given by the savings rate (s) and the output Level (Y):

$$S = sY. \tag{11.6}$$

Dividing both sides by the capital stock (K) gives the following equation:

$$\frac{S}{K} = \frac{S}{Y}\frac{Y}{K} = \frac{s}{v}, \tag{11.7}$$

with the capital coefficient $v = \frac{K}{Y}$. Output is therefore given by

$$Y = vK. \tag{11.8}$$

[15] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation of Harrod's theory is based on (Harrod, 1939) and (Hein, 2004). The model in section 11.2.1 is a reproduction of the existing model. In section 11.2.2 the existing model is interpreted in order to investigate zero growth conditions.

Due to the constant capital coefficient, output grows proportionally to the capital stock. The capital stock grows due to investments. The warranted growth rate is the rate at which all savings are invested:

$$g_w = \frac{S}{K} = \frac{s}{v}. \tag{11.9}$$

11.2.1.2 The Actual Growth Rate

The actual growth rate depends on the level of investments, relative to the existing capital stock. The reason is that a constant capital coefficient is assumed. Investments in turn depend on the actual growth rate. Harrod therefore argues very much in Keynesian lines: If an entrepreneur experiences that there is a high demand for her goods, she will be inclined to produce and invest more in the next period. At the same time, higher investments lead to higher production. The actual growth rate is determined by the level of investments:

$$g_a = \frac{I}{K}. \tag{11.10}$$

The level of investments is defined by the capital coefficient (v) and the actual growth rate:

$$I = I(v, g_a). \tag{11.11}$$

If output increases, investments increase, as firms experience high demand. The higher the capital coefficient, the higher the investments, as more capital is needed for additional production.

11.2.1.3 The Natural and the Proper Growth Rate

In his article from 1939, Harrod defines the natural growth rate as "the maximum rate of growth allowed by the increase of population, accumulation of capital, technological improvement and the work/leisure preference schedule, supposing that there is always full employment in some sense" (p. 33). While this definition is very broad, including basically all determinants of the actual growth rate, further below he coins another, more useful term: "Consideration may be given to that warranted rate which would obtain in conditions of full employment; this may be regarded as the warranted rate 'proper' to the economy" (Harrod, 1939, p. 33). This natural growth rate is defined as the growth rate that delivers full employment and is dependent upon the supply of labour (excluding technological change):

$$g_p = g(n, \Xi), \tag{11.12}$$

with the population growth g_L and the work/leisure preferences Ξ.

11.2.1.4 Knife-Edge Growth

When the three growth rates coincide, economic growth is stable. In the situation of stable growth, there is full employment and investments are equal to savings. This situation is called knife-edge growth, as a deviation of one of the growth rates makes the economy unstable. Harrod (1939) emphasizes two unstable constellations. (1) The actual growth rate can be below the warranted and the proper growth rate. This implies that there are low investments and an oversupply of savings. Due to low production relative to the capital stock, there is an oversupply of capital, leading to further decreases in investments and even less production. The result is a continuous oversupply of savings and less employment than possible. (2) The warranted and the actual growths rates can be below the natural growth rate. In this case, there are insufficient savings in order to have capital accumulation that delivers sufficient employment. The result is unemployment over long periods of time.

11.2.2 The Theory and Economies Without Growth

In order to investigate the conditions for stable zero growth economies, the conditions for each of the three growth rates to be zero are investigated.

From equation 11.9 it can be inferred that a low savings rate and a high capital coefficient lead to a low warranted growth rate. In order to have zero growth, the only possibility is to have zero savings. The reason for this strong and implausible result is that capital depreciation is excluded from the model. An inclusion would lead to the result that (low) positive savings are compatible and necessary for zero growth.

Given these assumptions of no capital depreciation, the actual growth rate is equal to zero when investments are equal to zero (see equation 11.10). Investments depend upon the capital coefficient and the actual growth rate (see equation 11.11). An appropriate combination of the two (one or both having very low values) is necessary for a zero actual growth rate.

In order to have a zero growth rate that is proper – namely that does not lead to unemployment – the combination of population size and preferences to work needs to account to zero (see equation 11.12). Therefore, either both of them stay constant over time, or population growth is combined with a reduction in average working hours. This reduction is caused by household preferences.

Overall, a zero growth economy is characterized by zero savings, no investments, and either a stagnating population or a reduction in average hours of work. If capital depreciation was taken into account, there would be low instead of zero savings and few instead of no investments. The zero growth economy is neither more nor less plausible or stable than a growing economy within Harrod's theory.

11.3 Domar: Capacity and Demand Effects

While Harrod focuses on the conditions for all savings being employed by investments, Evsey Domar builds a model investigating the effects of investments on potential output (supply side) and actual output (demand side). His theory constitutes a second approach to develop a long-run macroeconomic model along Keynesian ideas.

Domar develops a simple growth model in his article *Capital Expansion, Rate of Growth, and Employment* (1946). He combines two lines of thought. The first concerns the supply side: If the population grows or labour productivity increases due to technological change[16], the overall output needs to rise in order to prevent unemployment. As capital and labour coefficients are given by the state of technology, capital accumulation and therefore investments are needed in order to facilitate such output growth. This first effect of investments is called the *capacity effect*: Investments increase potential output.

The second line of thought concerns the demand side. One of Keynes' central messages is that investment decisions influence the size of aggregate demand based on multiplier effects. Investments lead to higher demand by a direct effect (i.e., rising demand for machinery) and an indirect effect (i.e., more workers are needed to produce the machinery, they earn more income which they partly spend on consumption). This is called the demand effect: Investments increase aggregate demand.[17]

11.3.1 The Theory

In the following, first the capacity and then the demand effect are explained in more detail. Third, the conditions for balanced growth are laid out.

[16] Domar takes into account technological change in his written analysis, but he does not explicitly model it.

[17] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation of is based on Domar (1946) and (Hein, 2004). The model in section 11.3.1 is a reproduction of the existing model. In section 11.3.2, the existing model is interpreted in order to investigate zero growth conditions. The original model is extended by capital depreciation (by the author of this work) to improve the analysis regarding zero growth economies.

11.3.1.1 The Capacity Effect

Domar's analysis begins with the concept of the "potential social average investment productivity" (Domar, 1946, p. 140) that determines the productivity of investments regarding the whole economy (ν_e). It is defined according to

$$\nu_e = \frac{\frac{d\Xi}{dt}}{I}. \tag{11.13}$$

with the potential output Ξ, and investments I. Rearranging equation 11.13 yields

$$\nu_e I = \frac{d\Xi}{dt}. \tag{11.14}$$

This is the central equation concerning the capacity effect of investments. The increase of the potential output is determined by the size of investments and the effect the investments have on potential output.

A second important concept is "the productive capacity of the new projects to capital invested in them" (Domar, 1946, p. 139). This means how productive the investments itself are, not counting its effects on the productivity of the rest of the capital in the economy. This term is denoted as ν_p, which stands for the productivity of investments regarding the specific projects they are invested in. The importance of the difference between these two concepts is discussed below.

11.3.1.2 Demand Effect

The demand side is modelled by the common *multiplier effect*. Investments lead to higher income that is partly consumed (depending on the savings rate), leading to further income and further consumption. The effect on overall demand is defined as

$$\frac{dY}{dt} = \frac{dI}{dt}\frac{1}{s}. \tag{11.15}$$

The effect of a change in investments ($\frac{dI}{dt}$) on aggregate demand ($\frac{dY}{dt}$) therefore primarily depends on the savings rate (s).

11.3.1.3 Balanced Growth

In Domar's model, the capacity and the demand effect need to be equal for balanced growth. The reason is that demand needs to equal supply in order to prevent overproduction or inflation. Starting from an economy in which demand and supply are equal, the question arises, under what conditions the two effects are of equal size.

By setting equation 11.14 equal to equation 11.15 the following equation is derived:

$$I\nu_e = \frac{dI}{dt}\frac{1}{s}. \tag{11.16}$$

Changes in investments ($\frac{dI}{dt}$) need to be higher, the larger their effect on potential output (ν_e) is and the larger the savings rate (s) is. The intuition behind it reads as follows: Investments always have a positive effect on the potential capacity (as long as they stay positive). However, only an *increase* in investments has a multiplier effect. Investments therefore need to continuously increase in order to ignite a sufficiently high demand for the additional capacity. The higher the additional capacity per unit of investments (ν_e), the faster must the investments increase. The investments must also increase faster for higher savings rates, as this implies that the multiplier effect is smaller.

Rearranging equation 11.16, the balanced growth rate of investments ($\frac{\frac{dI}{dt}}{I}$) is derived:

$$\frac{\frac{dI}{dt}}{I} = \nu_e s. \tag{11.17}$$

If the impact of investments on productivity concerning the entire economy (ν_e) and the concrete project the investment takes place (ν_p) are different, the relation in equation 11.17 is altered. A difference between the two, say, if $\nu_e < \nu_p$, has the following implications: Investments lead to a lower capacity effect. Therefore, the capacity effect of investments becomes smaller, the demand effect stays the same. The necessary relation between the two changes accordingly. The disparity between the two productivities can have several reasons: "The difference between them will depend on the magnitude of the rate of investment on the one hand, and the growth of other factors, such as labour, natural resources and technological progress on the other. A misdirection of investment will also produce a difference between [the two]" (Domar, 1946, p. 140).

What happens if capacity and demand effect are not of equal size? Domar is not clear on that matter in his paper. Hein (2004) argues that Domar' model does not entail an investment function, so that it is not possible to make statements concerning when an equilibrium is achieved and how the system reacts to departures from equilibrium.[18] Some arguments can be safely made, however: If the changes of investments $\frac{dI}{dt}$

[18] Original quote in German: "Das Domar-Modell enthält jedoch keine Investitionsfunktion, so dass keine Aussagen über die Erreichung des Gle-

are higher than in equilibrium, the income effect is larger than the capacity effect. Hence, there is excessive demand that cannot be satisfied by supply. Similarly, too low growth of investments leads to low demand and overcapacity of potential output. Domar does not discuss mechanisms that might aggravate such disequilibria or dampen them. This has been a major task for following authors, most prominently Kaldor (see section 11.6).

11.3.2 The Theory and Economies Without Growth

In Domar's theory, investments are at the core of the analysis. They lead to capacity and demand effects and to economic growth. In the following, it is investigated under what conditions the two effects go along with zero growth.

11.3.2.1 Capacity Effect

As long as there is no technological change (as assumed in the model), the capital coefficient stays constant.[19] Therefore, the capital stock needs to stay at the same level in order for the economy to generate zero growth. Hence, the capacity effect needs to be zero:

$$\frac{\Xi t}{dt} = 0. \tag{11.18}$$

This is the case, when

$$\nu_e I = 0. \tag{11.19}$$

Either investments need to be zero ($I = 0$) or the productivity of investments needs to be zero ($\nu_e = 0$). It seems implausible for investments to not take place at all, as it would mean that no entrepreneur undertakes expansion. It is also unlikely that the productivity of investments is zero, as only those investments that increase production are implemented. The analysis becomes more plausible when capital depreciation is taken into account, however (see section 11.3.2.3).

11.3.2.2 Demand Effect

In a zero growth economy, aggregate demand needs to stay constant. On the demand side, the demand effect needs to be zero:

ichgewichts sowie über Reaktionen des Systems bei Abweichungen vom Gleichgewicht möglich sind" (Hein, 2004, p. 138).

19 In fact, even with the commonly assumed Harrod-neutral technological change, the capital coefficient does not change.

$$\frac{dY}{dt} = 0. \tag{11.20}$$

From equation 11.15, the subsequent condition follows:

$$\frac{dI}{dt}\frac{1}{s} = 0. \tag{11.21}$$

Either investments must not change ($\frac{dI}{dt} = 0$) or the savings rate needs to approach infinity ($s = \infty$), which is impossible per definition as $0 < s < 1$. Therefore, the condition for zero growth for the supply side is that investments need to stay the same over time. Put together, zero growth takes place when investments are and stay zero. Then there is neither a demand nor a capacity effect and the overall output stays the same over time.

11.3.2.3 Introducing Depreciation

It is unlikely that a capitalist economy depicts zero investments, as argued above. Therefore, zero growth seems implausible within Domar's theory. Zero growth becomes more likely, when taking depreciation into account. The reason is that it allows for positive gross, but zero net investments.

On the supply side, positive gross investments are necessary to countervail the effect of capital depreciation and keep the capital stock constant over time. Assuming a percental depreciation (δ) of the capital stock (K), the equation 11.14 changes to

$$\nu_e I - \delta K = \frac{d\Xi}{dt}. \tag{11.22}$$

The condition for zero growth is accordingly:

$$I = \delta K \frac{1}{\nu_e}. \tag{11.23}$$

The analysis of the demand side does not change, as it is concerned with the change in investments. The condition from equation 11.21 still holds. Therefore, the condition for zero growth economies is that the level of gross investments is just sufficient to replace capital depreciation and that investments stay constant over time.

11.4 Neoclassical Synthesis: Aggregate Demand and Aggregate Supply

The Neoclassical Synthesis was developed in the 1950s and is a combination of neoclassical and Keynesian aspects into one model. It is difficult to assign it clearly to either one of the two schools of thought (Samuels et al., 2003). Here, it is included in the Keynesian theories, because it resembles more Keynesian than neoclassical attributes concerning the matter at hand. In particular, it takes into account both aggregate demand and aggregate supply. It also does not solely look at household preferences and the state of technology but includes additional societal factors to explain macroeconomic outcomes. At the heart of the Neoclassical Synthesis is the IS-LM Model, first developed by Hicks (1937). It focuses on the goods and the money market. Later it was combined with a model of the labour market, leading to the AS-AD model (Blanchard and Illing, 2006). In the following, both are outlined and set into relation to zero growth economies.[20]

11.4.1 The Theory

The Neoclassical Synthesis consists of a specific understanding of the determinants of aggregate demand and aggregate supply. Aggregate demand is modelled as the result of an interplay between demand in the goods market (the IS function) and the money market (the LM function – counter-intuitively, money supply is part of it). The resulting IS-LM Model leads to aggregate demand (the AD function). Aggregate supply (the AS function) primarily depends on the labour market. The amount of labour supplied is the decisive determinant of supply.

11.4.1.1 Aggregate Demand

The IS-LM Model consists of two parts. The first describes an equilibrium in the goods market, the second in the money market. The general idea on the goods market is that a change of the interest rate has an effect on production. The central mechanism on the money market is that a change in production leads to a change of the interest rate. The causal links thus move in opposite directions. There is an equilibrium between aggregate demand and aggregate supply that leads to certain levels of production and of the interest rate. Changes of the equilibrium can only take place by changing parameters (consumption behaviour, investment behaviour, government spending etc.) of the two functions.

The IS function describes the relationship between the interest rate and aggregate demand on the goods market. Aggregate demand (Y_D)

[20] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The Neoclassical Synthesis Model is part of most prominent textbooks today. The following illustration is based on Blanchard and Illing (2006). The model in section 11.4.1 is a reproduction of the existing model. In section 11.4.2, the existing model is interpreted in order to investigate zero growth conditions.

is determined by consumption (which is a function of after tax income, $C(Y-T)$), investments (I, which is a function of output and the interest rate $I(Y,i)$) and government expenditures (G). The independent variable is the interest rate (i):

$$Y_D = C(Y-T) + I(Y,i) + G. \tag{11.24}$$

An increase in the interest rate leads to a decrease in investments, which decreases overall demand. The causal chain can be summarized as: $i \uparrow \rightarrow I \downarrow \rightarrow Y_D \downarrow$.

The LM function describes an equilibrium in the money market. The interest rate is determined by supply and demand of money. Supply is given by the central bank. Demand depends on the interest rate and several other aspects (e.g., the preference of people for liquidity), incorporated in the function $L(i)$ and the level of output (Y). The equilibrium between money supply and demand is determined by

$$\frac{M}{P} = YL(i). \tag{11.25}$$

The independent variable here is the level of production. An increase in production generates an increase in money demand and (given a certain money supply) leads to an increase in the interest rate. $Y \uparrow \rightarrow M^d \uparrow \rightarrow i \uparrow$

By combining equations 11.24 and 11.25 the equilibrium condition for the goods and the money market are derived:

$$C(Y-T) + I(Y,i) + G = \frac{M}{PL(i)}. \tag{11.26}$$

Any change of one of the parameters depicts a shift of one of the curves. The IS curve may shift due to changes in consumption behaviour, investment behaviour or government spending. The LM curve can be altered due to a change in the liquidity preference or a change in the money supply by the central bank. In case one of these parameters shifts one of the curves, this has an effect via the other curve. For example, additional government expenditures may increase aggregate demand and therefore shift the IS curve to the right. This would increase production and additionally lead to an increase in the interest rate, as demand for money rises. This in turn would reduce investments, however, which is part of aggregate demand. Hence, the overall effect of government expenditure on aggregate demand and output is less than otherwise anticipated.

The IS-LM Model leads to an aggregate demand (AD) function. The central idea of the AD function is that a change of the price causes a change in production. The mechanism of this is based on the IS-LM functions (combined). An increase of the price level leads to a decrease of the real money supply and an increase of the interest rate (in the money market). The higher interest rate leads to fewer investments, less demand and hence less production (in the goods market). This is why the function is decreasing. Any changes of the parameters of the IS and LM functions lead to a change of the AD function (a shift of the curve). Aggregate demand is determined according to

$$Y_D = Y_D(M, L(), C(), T, I(), G). \tag{11.27}$$

11.4.1.2 Aggregate Supply

The labour market is not described as a market of labour demand and labour supply, but as an interplay between wage setting and price setting. The basic idea is that the *real* wage level is determined by the level of market power of the firms. The higher the market power, the lower is the real wage. The other factors solely determine the unemployment rate. The higher the bargaining power of unions and the larger the unemployment benefits, the higher is the unemployment rate.

The *nominal* wage level is seen as an outcome of a bargain between employees and employers. The central factors are the expected price level (P^e) and the unemployment rate (u). Other factors (such as the relevance of efficiency wages and the role of workers unions, legal institutions etc.) are incorporated in the factor z. The wage level (w) is determined according to

$$w = P^e F(u, z). \tag{11.28}$$

Firms determine the price. It depends upon the wages and a mark-up (m). The level of the mark-up depends on the market power of firms. In case of perfect competition, it is equal to zero. The higher the concentration of market power, the higher the mark-up is. The price level is defined by

$$P = (1 + m)w. \tag{11.29}$$

The unemployment rate is determined by the interplay of wage and price settings. It is assumed that the expected price level is equal to the actual price level. Setting equation 11.28 equal to equation 11.29 yields

$$F(u, z) = \frac{1}{1 + m}. \tag{11.30}$$

On the left hand side, an increase in u leads to a decrease of the term and an increase in z leads to an increase. This equation describes multiple connections between the three factors unemployment rate, bargaining power of unions and other institutions on the labour market and the mark-up. For example, a decrease in unemployment can be accompanied by a decrease in the mark-up. The logic is that less unemployment leads to higher wages and the firms are not able to increase prices according to their increasing costs. Or the lower unemployment could be accompanied by a weaker position of worker unions, so that wages do not increase and the mark-up can stay the same. To give a second example: If z increases for example due to a change in labour market regulation, this either leads to a lower mark-up, as wages increase and firms are not able to increase prices accordingly. If it is accompanied by an increase in unemployment, wages do not increase and the mark-up stays the same.

The determination of aggregate supply is simple and depends primarily on (un-)employment. Production is determined by the amount of labour employed (L) and labour productivity (T):

$$Y_S = TL. \tag{11.31}$$

Labour productivity is assumed to be constant. Therefore, only the amount of labour employed has an impact on the size of production. It is determined by the size of the labour force (B) and the unemployment rate:

$$L = B(1 - u). \tag{11.32}$$

Hence, the same factors that determine the unemployment rate (market power of firms, bargaining power of unions, unemployment benefits etc.) have an impact on the size of production.

The AS function describes the relationships on the labour market. The central mechanism is that an increase in production leads to less unemployment, which leads to an increase in wages; this in turn causes an increase in prices: $Y \uparrow \rightarrow u \downarrow \rightarrow w \uparrow \rightarrow P \uparrow$. Recall the two basic functions concerning the labour market. The first defines the determination of the wage level as a function of the expected price level, the unemployment rate and other factors (equation 11.28). The second is the determination of the price level (11.29). Combining the two equations, the following relationship is derived:

$$P = (1 + m)P^e F(u, z). \tag{11.33}$$

Additionally, u is substituted by $1-\frac{Y}{TB}$ (from equations 11.31 and 11.32). The result is the AS function:

$$P = (1+m)P^e F(1-\frac{Y}{TB}, z). \quad (11.34)$$

11.4.1.3 Aggregate Demand and Supply

The interplay of aggregate demand and aggregate supply is displayed by the AS-AD model. As with the IS-LM Model, the causal links for the two curves move in opposite directions. In the AD function, price determines production. Here, the central equation (11.27) concerning aggregate demand is reproduced:

$$Y = Y(M, L(), C(), T, I(), G).$$

The economic intuition is that an increase of the price leads to a decrease of the real money supply and an increase of the interest rate (in the money market). The higher interest rate leads to less investment, less demand and hence less production (in the goods market).

On the supply level on the other hand, production determines the price. The central equation (11.34) on aggregate supply is

$$P = (1+m)P^e F(1-\frac{Y}{TB}, z).$$

The reasoning is that an increase in production lowers unemployment; this leads to an increase in wages, which in turn causes an increase in prices as firms pass their higher costs at least partly on to the goods prices. In equilibrium, only a change of the parameters can change the price and production levels. In the following, it is investigated what conditions of such parameters are compatible with zero growth.

11.4.2 The Theory and Economies Without Growth

The Neoclassical Synthesis is a model on the short and not the long run.[21] The reason is the assumption of no technological change. In the Neoclassical Synthesis the level of production depends on the interplay of aggregate demand and supply. The central factors determining aggregate demand are consumption behaviour, investment behaviour and government spending. Additionally, money supply is important for the determinations of the interest rate, which has an impact upon the investment behaviour. On the

[21] The Neoclassical Synthesis Model is the only model that solely concerns the short run, apart from the Basic Macroeconomic Model.

supply side, various factors have an effect on the level of employment and hence production: unemployment itself, labour market regulations, labour unions and firms' market power.

The central condition for a zero growth economy in this model is that none of these factors changes. In other words, when the determinants of aggregate demand and aggregate supply stay constant over time. The other possibility is that two or several factors change with opposite effect on the level of production. The change of any of the aforementioned factors does not trigger continuous economic growth or shrinkage. It only has a one-off effect on the level of production.

Hence, the central insight is that no changes concerning macroeconomic factors are necessary for a zero growth economy, within the Neoclassical Synthesis Model. Zero growth economies are feasible and – maybe most significantly – there is no reason for them to be unstable.

11.5 Kalecki: Investments and the Business Cycle

The work of Michał Kalecki is one of the most influential contributions to heterodox and in particular Keynesian economics. He developed his theory parallel to Keynes' work; some say that he has anticipated major Keynesian concepts (Kühne, 1987). According to Kühne (1987), Kalecki's work is strongly influenced by Marx's analysis. The similarities to Keynes and Marx also become apparent in the explanations below.

Kalecki's theory is rather complex and differs significantly from the theories discussed thus far. This is why it is explained in some detail and via several steps. The same order is used for the investigation on conditions for zero growth.[22]

11.5.1 The Theory

Kalecki's theory is developed in six steps. First, the general macroeconomic framework is developed. The economy is divided into three sectors: investments, capitalists' consumption and workers' consumption. In each of the sectors, profits and wages are earned. It is shown how investments generate savings and determine economic growth via the investment mul-

22 Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is based on Kalecki et al. (1987). Section 11.5.1 is primarily a reproduction of his theory. The application of the theory to zero growth in section 11.5.2 includes rearranging and recombining the equations of the existing theory. Additionally, the model is extended by a formal representation of the connection between technological change and the capital coefficient (in section 11.5.2.5), in order to improve the analysis.

tiplier. Second, the price setting is laid out. It depends crucially on the mark-up and the degree of monopoly. These factors are also important for the functional income distribution. Third, the central determinants of investments are summarized. Fourth, the prior concepts are used to develop Kalecki's business cycle theory. Fifth, the business cycle theory is transformed into an economic growth theory. Finally, technological change is incorporated into the determination of economic growth.

11.5.1.1 The General Model of the Economy: The Three Sectors, Profits and Wages

Kalecki divides the economy into three sectors, which are all vertically integrated (this implies that in each sector the associated intermediate goods are produced). In the three sectors (1) investment/capital goods (I), (2) consumption goods of capitalists (C_K) and (3) consumption goods of workers (C_W) are produced. Therefore, total expenditures (Y) are the sum of these three sectors:

$$Y = \text{sector } 1 + \text{sector } 2 + \text{sector } 3 = I + C_K + C_W. \tag{11.35}$$

Overall income (Y) consists of profits (Π) and wages (W):

$$Y = \Pi + W. \tag{11.36}$$

It is assumed that there are no savings out of wages, so that consumption out of wages is equal to wages ($W = C_W$). It follows that

$$\Pi = I + C_K. \tag{11.37}$$

Kalecki argues that the causation of this relationship runs opposite to the logic of classical economists, in which profits determine capital accumulation. On the contrary, in Kalecki's theory investments and capitalists' consumption determine the size of profits. This is the reason for the famous statement that "capitalists earn what they spend, and workers spend what they earn" (Kaldor, 1955, p. 96).[23]

The three sectors[24] each have given profit and labour shares:

[23] According to Lavoie (2014) this quote is often attributed to Kalecki, but it was actually phrased by Kaldor as a summary of Kalecki's theory.

[24] The division into three sectors and the subsequent reasoning by Kalecki is based on Marx's reproduction schemes (Kalecki et al., 1987), see also part IV.

$$\text{sector 1: } I = W_1 + \Pi_1, \tag{11.38}$$

$$\text{sector 2: } C_K = W_2 + \Pi_2, \tag{11.39}$$

$$\text{sector 3: } C_W = W_3 + \Pi_3. \tag{11.40}$$

Several relationships between the sectors, wages and profits can already be identified at this point. (1) As all wage incomes are spent on consumption, $W_1 + W_2 + W_3 = C_W$. (2) As profits and investments are financed out of profits, $\Pi_1 + \Pi_2 + \Pi_3 = I + C_K$. (3) This also means that the wages from sector 1 and 2 are equal to the profits of sector 3: $W_1 + W_2 = \Pi_3$.

Consumption of capitalists is modelled as a constant share of profits ($q\Pi$) and some constant that changes slowly over time (A_t):

$$C_K = A_t + q\Pi. \tag{11.41}$$

Investments are the most important factor for the dynamics of the economy. They determine profits and economic growth. Kalecki undertook various endeavours to investigate what influences the size of investments and explained them endogenously in different ways (see below). At this point, it can already be discussed why Kalecki comes to the conclusion – as Keynes does – that investments lead to an equal amount of savings.

Savings are not required for investments beforehand, as investments can be financed by credit creation and the economy runs below capacity, so that capital goods and workers are disposable. Investments expand sector 1 and therefore W_1 and Π_1 increase according to the labour and profit shares in this sector. The expansion of sector 1 has two effects with a following series of reactions: (1) The additional wages are entirely consumed and therefore lead to an expansion of sector 3. The wages and profits in sector 3 increase. These wages are also entirely consumed and lead to a further expansion of sector 3. The profits are partly consumed due to equation 11.41 and partly saved. This leads to an expansion of sector 2, in which wages and profits increase. Here, the wages also entirely contribute to a further expansion of sector 3, while profits are partly consumed for goods in sector 2 and partly saved. (2) The second effect of the original expansion of sector 1 directly leads to an expansion of sector 2 due to the consumption of capitalists. The same mechanisms as before apply: Wages and profits in sector 2 rise, leading to a further expansion of sector 3 and sector 2.

The details of the resulting mechanisms are explained in appendix A. The savings due to the additional investments are equal to the investments. This is the case because the additional wages and profits earned in the investment sector are partly spent and partly saved. The part saved contributes directly to the additional savings. The part spent increases the production in the consumption sectors, which leads to further increases in wages and profits and therefore also further savings. Appendix A shows that total savings are exactly equal to the original investments:

$$\Delta S = \Delta I. \tag{11.42}$$

The additional investments cause an increase in production that is larger than the investments. Investments first increase production in sector 1 by the size of investments. As argued above, this leads to an increase in production in the consumption sectors 2 and 3, which generates further income and further demand for consumption. The relationship is also developed in appendix A.[25] The investment multiplier is given by

$$\Delta Y = \frac{\Delta I}{(1-w)(1-q)}. \tag{11.43}$$

The effect of investments on production is positively related to the wage share (w) and the consumption rate of profits (q). The underlying intuition is that higher values of both factors lead to stronger consumption effects of increases in production and therefore stronger additional demand.

The following understanding of the economy has evolved so far: The economy consists of three sectors producing goods for investments, consumption of capitalists and consumption of workers. Investments and consumption of capitalists determine the amount of profits and the size of production. In particular investments increase production via a multiplier and generate savings of an equal size. Next, it is discussed what determines the – so far assumed to be given – functional distribution of income between wages and profits.

11.5.1.2 Distribution: Mark-up, Pricing and Functional Income Distribution

What determines the price of a good? The vast majority of current textbooks and economic theories would say *demand and supply.* If the demand for a good increases, so does the price, as the supply curve has a positive slope. Kalecki gives a very different answer.

For Kalecki et al. (1987), most industries work below full capacity utilization and production has constant prime costs, that is costs for wages

25 The calculations of appendix A have been conducted by the author of this work. Appendix A shows Kalecki's slightly different derivation of the same investment multiplier.

and materials. Production is totally elastic. In other words, the supply curve is a horizontal line. Therefore, a change in demand does not change the price of a good but the quantity adjusts to the altered demand. The prime determinant of costs are two factors: prime production costs and a mark-up.

Prime production costs consist of wages and material costs. Both are costs per unit. Wages and materials are argued to be flexibly available. Kalecki et al. (1987) argue that the existence of a certain level of unemployment is the usual state of modern economies and therefore workers are available. The material inputs needed for production are also assumed to be available for a constant price per unit. As result, production has constant prime costs (within reasonable ranges).

The mark-up is the second determinant for the price of goods. It is central to Kalecki's (1987) analysis. Firms put a mark-up on top of prime costs.[26] The earnings due to the mark-up cover both the overhead costs (all other costs including costs for capital goods and salaries of employees who are paid regardless of the amount produced) and profits. For given overhead costs, the size of the mark-up therefore determines the size of profits and also profit and wage shares.

a Price setting

According to Kalecki et al. (1987) the price setting of a single firm (P_F) is a function of the prime unit costs (j) and the mark-up (m). The single firm additionally orientates at the average cost in the market (P). The strength of the influence of this consideration is denoted by $n < 1$. Price setting of a single firm is determined according to

$$P_F = mj + nP. \tag{11.44}$$

Prime unit costs, the mark-up and the influence of the average price can differ between firms and so can the price. The reason is the oligopolistic structure of the economy. The average price (P) depends on the average values of the determinants for the single price setting:

$$P = m\bar{j} + nP. \tag{11.45}$$

26 A central assumption underlying Kalecki's analysis is an oligopolistic economic structure in which firms have an influence on the market price. In case of perfect competition, the setting of a mark-up above prime costs would not be possible. Kalecki et al. (1987) argue though that the assumption of oligopolistic market structures is by far more realistic, in particular regarding the persistent existence of large profits and high overhead costs.

b The degree of monopoly

By reformulating equation 11.45, the following equation is derived:

$$P = \frac{m}{1-n}\bar{j}. \tag{11.46}$$

The term $\frac{m}{1-n}$ reflects the average degree of monopoly, a central concept in Kalecki's analysis. It reflects the average power of firms to set their price above prime unit costs. The term increases with m. This signifies the ability to set a mark-up above unit costs. The term also increases with n. This represents the ability to set the price above the average price. Kalecki et al. (1987) argues for four factors that influence the degree of monopoly:

1. Market concentration: The higher the market share of a firm, the higher is the mark-up. The reason is as follows: If a firm with a high market share increases its price, so does the average price. As the other firms orientate at the average price, they also increase their prices, causing a further increase of the average price.
2. Commercials: Commercials can replace price competition to some degree, as commercials influence consumers in their purchase decisions. When commercials become more important, the degree of monopoly increases and so does the mark-up.
3. Overhead costs: An increase of the overhead costs leads to a decrease in the profit rate, given a certain mark-up. The reason is that overhead costs are not included in the price setting, but nevertheless decrease firms' profits. In order to keep a certain profit rate, firms can increase the mark-up. This would also signify an increase in the degree of monopoly as defined above. The necessary assumption is that there is a tacit consent between the firms to do so. Otherwise, price competition would prevent it.
4. Worker unions: Strong worker unions can demand high wage increases. In principle, firms can balance these out by setting higher prices. In order to not loose competitiveness compared to other firms or entire other sectors (as far as goods are substitutable), firms have an incentive not to increase prices as much as wages do. This is why strong worker unions have the tendency to lower mark-ups and the degree of monopoly.

c Functional income distribution

The functional income distribution is determined by the size of the mark-up. The mark-up determines the difference between prices and prime costs of firms and hence the ability to generate profits. As will be seen below, an increase in the mark-up does not lead to increases in profits but barely an increase in the profit share. Consequently, a higher mark-up means both a lower wage share and lower total wages.

In order to investigate the determinants of the functional income distribution, a slightly different version of Kalecki's mark-up theory is used. Here, it is distinguished between the unit costs for wages and materials.[27] The average price is determined by the prime costs consisting of wage costs per unit (w) and material costs per unit (μ). The price is equal to these costs plus a constant ($\bar{m}$):

$$P = (1 + \bar{m})(w + \mu). \tag{11.47}$$

Average prices are per definition equal to the sum of average wage costs, average material costs and average profits – all per unit of production ($\frac{W}{x}$; $\frac{M}{x}$; $\frac{\Pi}{x}$;). This yields

$$P = \frac{W}{x} + \frac{M}{x} + \frac{\Pi}{x}. \tag{11.48}$$

Combining equations 11.47 and 11.48 and keeping in mind that $\bar{w} = \frac{W}{x}$ and $\bar{\mu} = \frac{M}{x}$ the following equation is derived:

$$\bar{m} = \frac{\Pi}{W + M}. \tag{11.49}$$

Based on this equation, it is possible to specify the profit share. It is positively related to the average mark-up and the relation between material costs and wage costs:

$$\frac{\Pi}{Y} = 1 - \frac{W}{Y} = 1 - \frac{W}{W + \Pi} = 1 - \frac{W}{W + \bar{m}(W + M)} = 1 - \frac{1}{1 + \bar{m}(1 + \frac{M}{W})}. \tag{11.50}$$

While the profit share increases with a higher mark-up, total profits stay the same. The reason is that total profits are independent on the mark-up. Using equation 11.43 and assuming that $\Delta\Pi = (1 - w)\Delta Y$, profits change according to

$$\Delta\Pi = \frac{\Delta I}{1 - q}. \tag{11.51}$$

Changes in profits are determined by changes in investments and the consumption rate out of profits alone. An increase in the mark-up without

[27] The following representation is based on (Hein, 2004, chapter 8).

a change in investments or the consumption rate out of profits leads to a higher profit share but not higher total profits. The underlying intuition is as follows: An increase in the mark-up keeps the nominal wage constant and increases prices. This leads to a decrease in real wages. The decreasing real wages lead to a reduction in demand for consumption goods of workers (sector 3) equal to the combined change of wage reductions from all three sectors ($W_1 + W_2 + W_3$). Profits in sector 3 hence decrease. At the same time, profits in sector 1 and 2 increase. The effects cancel each other out so that overall profits stay the same. The real wages have decreased though.

11.5.1.3 Determinants of Investments

Thus far, it has been shown how the economy works in general, how distribution is determined and what role the degree of monopoly plays. It has been argued that investments play a vital role in Kalecki's economic theory. In particular, they determine the level and growth of production. Therefore, it is vital to understand what determines the level of investments. Kalecki has spent a significant amount of work on this issue. The following summary is based on one of his later contributions (Kalecki et al., 1987, chapter 12).

There are five major components for determining the level of investments. The decisions to make investments is equal to the investments in the future (I_{t+1}). Investments are determined according to[28]

$$I_{t+1} = \mathit{\Lambda} S_t + \mathit{\Pi} \frac{\Delta \Pi}{\Delta t} - \Sigma \frac{\Delta K}{\Delta t} + e \frac{\Delta Y}{\Delta t} + o. \tag{11.52}$$

The five central determinants of investments are:

1. Firms' savings (S): Firms' savings induce the firms to increase their investments. This is due to (1) the effect that savings themselves are likely to be used for investments and (2) because it increases equity and therefore the conditions to borrow additional funds improve. It is represented by the term $\mathit{\Lambda} S_t$.
2. Change in profits ($\Delta\Pi$): Profits either increase because a larger share of a firms' activities becomes profitable or specific activities become more profitable than before. This causes opportunities for profitable activities in the future and hence induces investments. It is covered by the term $\mathit{\Pi}\frac{\Delta\Pi}{\Delta t}$.
3. Change in the capital stock (ΔK): An increase in the capital stock dampens the total amount of investments. The reason is that more capital stock implies fewer opportunities to invest profitably. Kalecki gives the example of new firms entering a specific market. If they

[28] For a derivation see Kalecki et al. (1987), chapter 12.

invest, this makes investments of other firms less profitable, as the market is already satisfied. It is represented by the term $-\Sigma\frac{\Delta K}{\Delta t}$.
4. Investments in inventory due to higher production (ΔY): Investments in inventories are proportionate to the increase of the production level, hence they are represented by the term $e\frac{\Delta Y}{\Delta t}$.
5. Additionally, a constant (o) is included. It represents changes in the inducement to invest over time and incorporates in particular three aspects. (1) The speed of technological change influences investment decisions. (2) Long-term changes in the level of the interest rate can alter the profitability of investments. (3) Long-term changes of earnings from company shares can also have an effect on investment decisions.

11.5.1.4 The Business Cycle

At this point, several of the central components of Kalecki's theory can be combined in order to develop his business cycle theory and his theory of economic growth.[29] The central difference between the two is that additional factors that change over time need to be taken into account when analysing economic growth. The most important is technological change (see section below).

For the analysis of the business cycle, Kalecki combines three concepts. The first is his theory of investments as developed in the former section. Equation 11.52 is reproduced:

$$I_{t+1} = \Lambda S_t + \Pi\frac{\Delta\Pi}{\Delta t} - \Sigma\frac{\Delta K}{\Delta t} + e\frac{\Delta Y}{\Delta t} + o.$$

Second, his general economic framework is used to determine the relationship between profits and investments (see equation B.7, appendix A):

$$\Delta\Pi = \frac{\Delta I}{1-q}.$$

Third, the investment multiplier from equation 11.43 connects the change in output with a change in investments:

$$\Delta Y = \frac{\Delta I}{(1-w)(1-q)}.$$

Additionally, it is argued that savings equal investments, as explained in appendix A: $S = I$. Combining the four equations yields

$$I_{t+1} = \Lambda I_t - \Sigma\frac{\Delta K}{\Delta t} + \frac{1}{1-q}(\Pi + \frac{e}{1-w})\frac{\Delta I}{\Delta t} + o. \tag{11.53}$$

[29] The following is based on Kalecki et al. (1987), chapter 13.

Investment decisions at present $(t+1)$ depend on primarily four mechanisms:

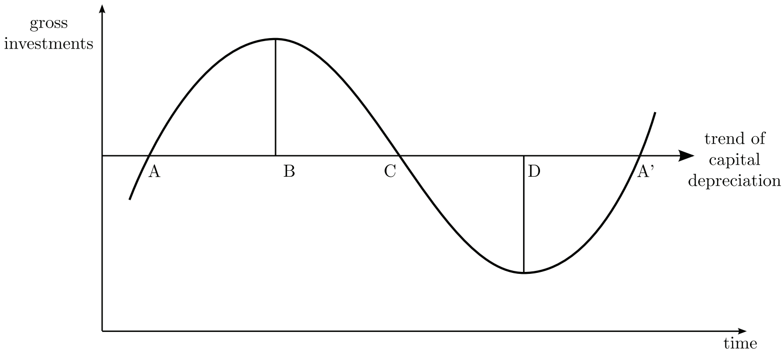
1. The level of investments in the past have a positive influence but smaller than one ($\Lambda < 1$).
2. An increase in the capital stock in the past dampens investment decisions. Kalecki argues that this mechanism is much smaller than the first (Σ is close to zero).
3. If investments have increased in the past, this has led to an increase in profits as well, which increases firms' incentives to invest in the future $(\frac{1}{1-q}(\Pi + \frac{e}{1-w}) > 0)$.
4. Finally, long-term developments such as technological change influence investment decisions (o).

The existence of the business cycle depends on a certain combination of these factors (Kalecki does not elaborate on what this means in mathematical terms). It is depicted in figure 11.5. The argument starts from a situation (point A in the figure) in which investments are positive, just sufficient to balance out the mechanisms of depreciation and have risen compared to the investments of the last period. This means that investments will increase, due to mechanisms (1.) and (3.). Investments stay positive in the next period (starting at point B), but they decrease because of the increase in the capital stock (mechanism 2.). This dampening mechanism at some point (C) becomes larger than the positive mechanisms. In this situation, mechanism (3.) becomes negative: The experience of lower profits decreases the incentive to invest. This leads to a downward trend in investments, due to the combined effects of mechanisms (2.) and (3.) which are larger than (1.) and bring investments below the rate which is necessary to balance out the effect of depreciation. As result the size of the capital stock declines. At some point (D) the mechanism (2.) becomes positive. The positive effects of mechanisms (1.) and (2.) exceed mechanism (3.). In other words: The capital stock is so low that investments become profitable although profits have been low in the past. From this point on, investments increase again, with all three mechanisms having positive effects until the starting point is reached again (point A').

11.5.1.5 Economic Growth Without Technological Change

Kalecki develops his analysis of the business cycle along the assumption that on average, investments are just sufficient to balance out the effect of capital depreciation. This is done for analytical purposes, and he claims himself that his analysis of the business cycle can be extended to a theory of economic growth. The reason is that the long-term growth trend is nothing else but the result of a chain of short-term situations: "In fact, the long-run trend is but a slowly changing component of a chain of short-

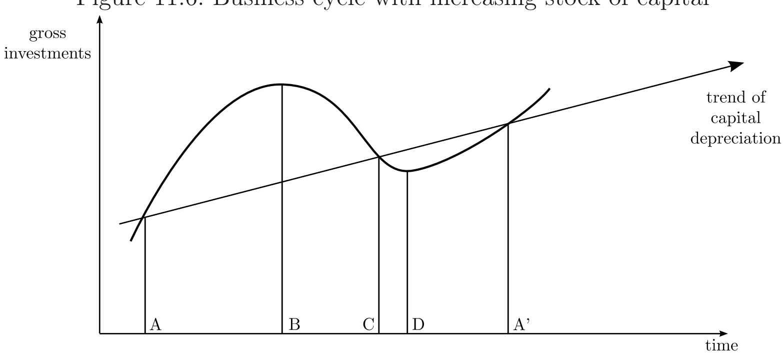
Figure 11.5: Business cycle with constant stock of capital



Adapted from Kalecki et al. (1987, p. 183).

period situations; it has no independent entity" (Kalecki, 1968, p. 263). This is why his theory on economic growth is very similar to his business cycle theory. Therefore, the reasoning from the business cycle theory can also be made for a constantly growing economy, with fluctuations in the rate of capital accumulation. This process is depicted in figure 11.6.

Figure 11.6: Business cycle with increasing stock of capital



Adapted from Kalecki et al. (1987, p. 186).

As in the setting with average zero growth rates, in the expansionary phase the positive effects of high levels of investments (1.) and increasing rates of profits (2.) outweigh the effect of capital expansion (3.). Again, at some point the effect of (3.) becomes larger than (1.) and (2.) and investments decrease. The central difference in a growing economy is that the turn does not follow at such a low point that the capital stock shrinks in a downturn as much as it grows in the upturn.

11.5.1.6 Economic Growth With Technological Change

Kalecki has written on economic growth and technological change in several articles (Kalecki, 1962, 1968, 2013). He (1962) argues that without technological change, the dynamics of a capitalist economy lead to fluctuations around a given level of production. No long-term growth of production would take place.[30] The business cycle, economic growth and technological change are therefore tightly connected. The basic reasoning primarily depends on his understanding of the business cycle as the long-run trend is the outcome of many short runs. The central additional component to connect the business cycle with a theory of economic growth is technological change.

The availability of inventions foster investments, as firms expect additional profits from applying more efficient technologies. As the total amount of profits is determined by other factors, the additional profits need to come at the expense of other profits.[31] Those firms which invest in more efficient technologies earn higher profits, while those using old facilities earn lower profits. The costs of those firms who use the old technologies increase by a factor (α) that represents the productivity increase of the new technologies. The costs therefore increase by $\alpha(Y - \Pi)$. This term represents the decrease of profits of the firms that do not innovate and at the same time the additional profits of the firms that do innovate. The higher $\alpha(Y - \Pi)$, the higher is the incentive to innovate.

Based on this line of argument, Kalecki (1968) develops a relatively complex investment function:

30 Kalecki refers to Harrod's work who emphasizes (see also section 11.2) the instability of economic growth due to the "basic dynamic 'antinomy' " (Harrod, 1951, p. 262). The contradiction is that the amount of funds supplied (by savings) depends on the "level of real income", while the amount of funds required (for investments) depends on the "rate of increase of real income" (Harrod, 1951, p. 262). Harrod argues that these instabilities lead to fluctuations around a trend line of economic growth. This reasoning is very similar to that of Kalecki. However, there is a central difference between Kalecki and Harrod. Kalecki argues that the "basic antinomy" does only explain fluctuations. In order to develop a theory of economic growth, additional factors – most importantly technological change – are needed.

31 Note that these profits are called *extra profits* in Marx's analysis. They depict another theoretical aspect that Kalecki adopted from Marx.

$$I_{t+1} = eI_t + r(\frac{\mathit{\Gamma}\Delta\Pi_t + \alpha(\frac{1}{h} - 1)\Pi_t}{\Theta} - I_t). \qquad (11.54)$$

Various factors determine the level of investments: First, there are several constants that are not of prime interest here: e is the share of savings that stays in firms, Θ is a "normal rate of profit", r is the "intensity of the reaction of the entrepreneurs" (Kalecki, 1968, p. 268) if the actual rate of profits deviates from the normal one. $\mathit{\Gamma}$ captures the fraction of profits earned by new investments as a share of the profits of all investments. Second, investments depend on the investments (I_t) and profits (Π_t) of the previous period and the change in profits ($\Delta\Pi_t$). This is the same reasoning already familiar from Kalecki's business cycle theory.

The third aspect is the new and "characteristic feature of this formula for investment decisions [...] [It] accounts explicitly for the stimulus to investment due to higher productivity of labour in the new plant enabling them to capture profits from old equipment" (Kalecki, 1968, p. 269). It is represented by the term $\alpha(\frac{1}{h}-1)\Pi_t$. α signifies the increase in productivity due to the new technology and h is the profit share. Investments are therefore higher if new technologies have a significant impact on productivity and if the profit share is lower.

New technologies are a cause for investments, capital accumulation and economic growth. As they are a factor that is not influenced by other developments of the economy in the short run, it increases the rate of economic growth both in expansionary and contractionary periods. New technologies are therefore the major reason for positive growth rates over time in Kalecki's growth theory.

11.5.2 The Theory and Economies Without Growth

The conditions for a zero growth economy within Kalecki's theory are developed along the same steps that were used to explain the theory.

11.5.2.1 Zero Growth in the General Model

The first condition for zero growth (without technological change) is that investments are equal to capital depreciation. This condition is already known from previous sections, in particular from Domar's analysis (section 11.3). The change in the capital stock is the difference between investments and depreciation (δK). By setting it equal to zero the following condition is derived:

$$I = \delta K. \qquad (11.55)$$

The central difference between Kalecki's condition and the one from previous sections is that here it refers to the *average* level of investments. The reason is that zero growth can entail a business cycle around a certain level of production as argued below.

The second condition refers to the relation between profits, savings and investments in a zero growth economy. Kalecki divides the economy into three sectors. The determination of total production has been explicated in equation 11.35 and is reproduced here:

$$Y = \text{sector } 1 + \text{sector } 2 + \text{sector } 3 = I + C_K + C_W.$$

The income of each sector can be divided into wages (W) and profits (Π). Combining equations 11.36 and 11.38 yields

$$Y = W_1 + \Pi_1 + W_2 + \Pi_2 + W_3 + \Pi_3. \tag{11.56}$$

As argued above, it is known that C_W is equal to total wages

$$C_W = W_1 + W_2 + W_3, \tag{11.57}$$

and that C_K is equal to the consumption out of profits

$$C_K = q(\Pi_1 + \Pi_2 + \Pi_3). \tag{11.58}$$

By combining equations 11.56, 11.57 and 11.58 the following relationship is derived:

$$I = (1 - q)(\Pi_1 + \Pi_2 + \Pi_3) = (1 - q)\Pi. \tag{11.59}$$

According to this second central condition for zero growth economies, the amount of profits that are saved ($(1 - q)\Pi$) need to be equal to investments. This condition includes that capitalists spend exactly the amount on investments and consumption which they earned via profits in the previous period: “If capitalists always decided to consume and to invest in a given period what they had earned in the preceding period, the profits in the given period would be equal to those in the preceding one” (Kalecki, 2013, p. 46). Even more significant is the fact though that they need to invest exactly the same amount that they do not spend on consumption.

Combining the two conditions, the following picture emerges: Investments need to equal capital depreciation, implying a relatively low level of investments (compared to growing economies). At the same time, investments need to be of the same size as savings by capitalists. This either implies a high consumption rate of capitalists or low total profits. The relation between capital depreciation, profits and capitalists' consumption rate is derived by combining equations 11.55 and 11.59:

$$(1-q)(\Pi) = \delta K. \tag{11.60}$$

Note also that this condition implies zero net savings, as gross savings are equal to capital depreciation.

11.5.2.2 The Role of the Functional Income Distribution and the Degree of Monopoly

The commanding factor in Kalecki's theory are investments. They are influenced by the level of income and savings, the change in profits, the change in capital stock and technological change. Income distribution and the degree of monopoly play no role in determining investments.

They also do not influence investments via impacting profits. Increasing the degree of monopoly and the profit share does not increase profits but redistribute from wages to profits and keeps total profits constant (see section 11.5.1.2). Therefore, any degree of monopoly and any functional income distribution is compatible with a zero growth economy in Kalecki's theory.

11.5.2.3 Investments in Zero Growth Economies

In order to generate zero growth, investments have to stay relatively constant over time and to be on average equal to the depreciation of the capital stock. Therefore, the determinants of investments need to be in such a combination that this level of investments is achieved.

There are several possible developments how lower investments can be induced. (1) A larger share of profits can be distributed outside the firms, so that firms' savings decrease. (2) Profit opportunities can decline, for example because markets are saturated or less new products are being invented. (3) Investments can become less profitable due to a large existing capital stock. (4) Technological change plays a decisive role: Slower technological change can also lower investments. This final point is discussed in more detail below.

It is theoretically difficult and probably practically impossible to determine the exact combination of factors' values in order to generate zero growth.[32] Nevertheless, it has been possible to identify the qualitative

[32] By putting equations 11.55 and 11.60 into the investment function 11.54 and setting $\Delta\Pi_t = 0$ and $I_{t+1} = I_t$, the following condition for a steady state is derived: $1 + r - e = \frac{r\alpha\left(h^{-1}-1\right)}{(1-q)\theta}$. While this equation describes the necessary parameter relations for zero growth, it is includes many possible parameter constellations, due to the large number of parameters involved.

conditions necessary to generate a constant capital stock – which is a central condition for zero growth without technological change.

11.5.2.4 The Business Cycle in the Zero Growth Economy

Kalecki's analysis is particularly interesting for the conditions of a zero growth economy, because he combines a business cycle theory with his general theory of the economy and with a growth theory. Contrary to most other theories covered in the present work, Kalecki's theory therefore allows to investigate under what conditions fluctuations around a certain level of production can be possible without continuous growth or shrinkage in the long run.

In fact, Kalecki argues that in case of a constant state of technology the economy does not grow in the long run (Kalecki, 1962). Therefore, his theory can directly be used to show, under what conditions the economic system displays only fluctuations around a certain production level and no long term changes. Following equation 11.53, investments are determined by:

$$I_{t+1} = \mathit{\Lambda} I_t - \Sigma \frac{\Delta K}{\Delta t} + \frac{1}{1-q}(\mathit{\Pi} + \frac{e}{1-w})\frac{\Delta I}{\Delta t} + o. \tag{11.61}$$

In a zero growth economy, investments are equal to the depreciation of the capital stock: $I_t = I_{t+1} = \delta K$. Kalecki introduces the term i that depicts the deviation of investments from average capital depreciation: $i_t = I_t - \delta K$. Based on this assumption, he develops the following equation that represents the business cycle around a constant capital stock:[33]

$$i_{t+1} = \mathit{\Lambda} i_t - \Sigma \frac{\Delta K}{\Delta t} + \frac{1}{1-q}(\mathit{\Pi} + \frac{e}{1-w})\frac{\Delta i_t}{\Delta t}. \tag{11.62}$$

As Kalecki et al. (1987) argue, for certain combinations of the parameters, this leads to a fluctuation along a horizontal line (compare figure 11.5).

11.5.2.5 Technological Change and Zero Growth

According to Kalecki's theory, firms introduce new technologies in order to decrease production costs and make additional profits. This mechanism fosters investments. These investments lead to the introduction of new technologies that are used alongside the old ones. The investments at the same time increase production capacity and consumption demand, and therefore foster economic growth. The expansion leads to an increase in the use of labour and materials, despite the fact that the new technologies use less labour and materials per unit.

33 For the derivation see (Kalecki et al., 1987, p. 180 – 182).

From the previous sections it is already known that investments need to equal savings out of profits in a zero growth economy (when there is no savings out of wages). Additionally, it has been argued that investments need to stay constant over time and have to be equal to capital depreciation on average.

This situation might change in a zero growth economy, depending on the impact of technological change on the capital coefficient. If technological change keeps the capital coefficient constant (which is assumed in the majority of growth theories), investments still need to equal capital depreciation. If the capital coefficient increases, investments need to be higher and if the capital coefficient decreases, investments need to be lower than capital depreciation.

This relationship can also be depicted formally. Equation 11.54 entails the determinants of investments, including technological change:

$$I_{t+1} = eI_t + r\left(\frac{n\Delta\Pi_t + \alpha(\frac{1}{q} - 1)\Pi_t}{\Theta} - I_t\right). \tag{11.63}$$

The capital coefficient is $v = \frac{K}{Y}$. The relation between output, the capital coefficient and the capital stock is

$$Y_t = \frac{1}{v_t}K_t. \tag{11.64}$$

It is assumed that the average capital coefficient increases over time due to technological change, which is a function of α that increases with α (α represents the influence of technological change on the capital coefficient):

$$v_{t+1} = v_t + f(\alpha). \tag{11.65}$$

Additionally, the capital stock changes over time. It is the sum of the old capital stock plus investments, minus depreciation:

$$K_{t+1} = K_t + I_{t+1} - \delta K. \tag{11.66}$$

Total output in period $t+1$ is therefore determined according to

$$Y_{t+1} = \frac{1}{v_t + f(\alpha)}(K_t + I_{t+1} - \delta K). \tag{11.67}$$

Production in time t (Y_t from equation 11.64) is set equal to production in time $t+1$ (Y_{t+1} from equation 11.67). Additionally, I_{t+1} is replaced according to equation 11.63. It is also assumed that profits stay constant in a zero growth economy: $\Delta\Pi_t = 0$. The resulting equation is:

$$\frac{f(\alpha)}{v_t} = \frac{(e-r)I_t + \frac{\alpha r \Pi_t}{\Theta}\left(\frac{1}{q}-1\right)}{K_t} - \delta. \tag{11.68}$$

The left side of the equation is the percentual increase of the capital coefficient due to technological change. It depends on the impact of technological change on the capital coefficient per time period ($f(\alpha)$) and the current capital coefficient (v_t). The right side is the percentual change of the capital stock. It depends on the level of the capital stock (K_t), the rate of depreciation (δ) and the level of investments, determined due to $(e-r)I_t + \frac{\alpha r \Pi_t}{\Theta}\left(\frac{1}{q}-1\right)$. The level of investments depends on the prior levels of investments (I_t), several parameters (which can be assumed to be constant in a zero growth economy) and the impact of technological change on overall productivity (α).

If technological change does not change the capital coefficient $f(\alpha)$ is zero and the left side of the equation is also zero. This means that the proportional investments (to the capital stock) need to be countervailed by depreciation, so that the right side is also zero. In this case, investments therefore need to be equal to depreciation.

If, on the other hand, technological change increases (decreases) the capital coefficient, $f(\alpha)$ is positive (negative) and the investments need to be larger (smaller) than depreciation in order to facilitate constant production.

11.5.2.6 Results

Five major results emerge from the analysis of Kalecki's theory. First, investments need to equal capital depreciation but can fluctuate around that level over the business cycle. Second, savings out of profits have to be entirely used for investments. As a consequence of result one and two, savings out of profits need to be comparatively low. Third, distribution plays no major role concerning zero growth.

Fourth, whether the necessary (low) level of investments is obtained depends on a variety of factors such as low savings of firms, low profit opportunities, a high the level of the capital stock and slow technological change. Fifth, a business cycle around a constant level of production is feasible within Kalecki's framework. This is certainly true when the state of technology does not change. It is also likely when technological change takes place in the manner envisioned by Kalecki. Whether it also holds for different types of technological change lies outside the scope of Kalecki's theory.

Finally, technological change is also crucial in Kalecki's theory, as it was for Keynes'. Two types of technological change have been discussed. (1) In case it does not change the capital coefficient, investments need to exactly balance out capital depreciation (as argued in result one). As this type of technological change depicts an incentive to invest, other factors influencing investments need to lower it, so that the capital stock stays constant (see result four).[34] This type of technological change additionally decreases labour and material demand. While this is good news from environmental perspective, it requires a response to prevent unemployment, for example a reduction in average working hours. (2) In case the technological change decreases the capital coefficient, the capital stock would need to decrease over time. One way to achieve this would be to even further lower investments. This is problematic though, as they are necessary to implement new technologies (which are desirable from an environmental perspective). Another way is to increase capital depreciation. Existing capital would need to be dismantled. In this manner, it is possible to combine a fast introduction of new technologies with zero growth.[35][36]

An intermediate conclusion is that in Keynes' and Kalecki's analyses (which have been developed in most detail here), the dynamics between technological change and other factors influencing economic growth are of central importance. The next two sections on Kaldor and Robinson will shed further light on this issue.

11.6 Kaldor: Technical Progress Function

Nicholas Kaldor's contributions to economic development (1961; 1940; 1957) emphasize the role of technological change and distribution for the

[34] The analysis of Keynes' theory delivered a much more comprehensive and convincing answer to the question, how investments can be kept low despite of technological change. The reason is that Keynes developed a more sophisticated understanding of the primary determinant of investments – (expected) aggregate demand. Davidson's analysis in section 12.1 elaborates on this point.

[35] Larger investments not only increase the capital stock but also increase aggregate demand based on the investment multiplier. As long as investments stay constant over time, this is compatible with a zero growth economy though.

[36] Such a type of technological change is likely to be supported by increasing the price of materials and decreasing the price of labour. The reason is that new technologies are implemented in order to decrease costs within Kalecki's theory. Unemployment is less of a problem under such technological change, as the labour coefficient is higher than under the first type.

growth process. Therefore, first his growth theory and in particular the role of the *technical progress function* is examined. This is followed by an analysis of how distributional aspects facilitate the adjustment of savings to investments within the growth process. Afterwards, these two aspects are investigated under zero growth conditions.[37]

11.6.1 The Theory

11.6.1.1 Growth and the Technical Progress Function

In Kaldor's work (1957; 1961) the central concepts are the profit rate, the capital coefficient and technological change, which is analysed as a technical progress function.

The technical progress function depicts a positive relation between capital accumulation and production per worker. The effects of technical progress and *capital deepening*[38] are seen as inseparable and therefore the impact of introducing new techniques is regarded as part of the effect of capital accumulation. Capital accumulation has decreasing marginal returns, however, due to the fact that those innovations with the highest productivity gains are implemented first (Kaldor, 1961) and that capital deepening only increases labour productivity up to a certain level of capital intensity (Kaldor, 1957). Technological change is therefore partly endogenized. While it depends on the speed of capital accumulation for a given technical progress function, a shift of the function is due to exogenously given technological change (Hein, 2004).

The other two central concepts are the profit rate and the capital coefficient. The profit rate (p) is equal to the profit share (h), divided by the capital coefficient (v):

$$p = \frac{h}{v} = \frac{\frac{\Pi}{Y}}{\frac{K}{Y}}. \tag{11.69}$$

[37] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: Apart from Kaldor's contributions, the following discussion is based on Hein (2004) and Kromphardt (1993). Section 11.6.1 is primarily a reproduction of his theory. The application of the model to zero growth in section 11.6.2 includes rearranging and recombining the equations of the existing theory.

[38] Capital deepening signifies the increase of capital per labour. Capital widening, on the other hand, is a rising capital stock that uses more labour, so that the capital intensity stays constant.

The capital coefficient is equal to the capital intensity (k), divided by the labour coefficient (l):

$$v = \frac{k}{l} = \frac{\frac{K}{L}}{\frac{Y}{L}}. \tag{11.70}$$

As capital accumulation increases the capital stock and introduces more productive technologies, it also increases the capital intensity and at the same time decreases the labour coefficient. The effect on the capital coefficient is therefore ambiguous (see equation 11.70). In case that investments have a stronger effect on capital intensity than on the labour coefficient, they increase the capital coefficient (and the other way around). A higher capital coefficient decreases the profit rate (in equation 11.69). The lower profit rate decreases the incentive to invest and hence, decreases investments. This lowers the capital coefficient, so that its prior increase is countervailed and the capital coefficient stays constant over time (Hein, 2004).

The overall relation with economic growth is that the stronger the effect of new technologies is on labour productivities, the more incentive entrepreneurs have to invest, which in turn speeds up the introduction of new technologies.

11.6.1.2 Distribution and Growth

Kaldor (1955) also prominently develops theories on how the (functional) income distribution is related to economic growth and in particular on the distribution's role for the relation between savings and investments.

Income is divided into wages (W) and profits (Π):

$$Y = W + \Pi. \tag{11.71}$$

Savings are divided into savings out of wages (determined by the size of wages and the savings rate for wages (s_w)) and savings out of profits (due to the size of profits and the savings rate for profits (s_p)):

$$S = s_w W + s_p \Pi. \tag{11.72}$$

The savings rate is therefore

$$s = \frac{S}{Y} = s_w \frac{W}{Y} + s_p \frac{\Pi}{Y} = s_w \frac{Y - \Pi}{Y} + s_p \frac{\Pi}{Y} = s_w + (s_p - s_w) \frac{\Pi}{Y}. \tag{11.73}$$

Kaldor argues that savings adjust to investments because of investments' effect on the functional income distribution. The reasoning is as follows:

An increase in investments leads to higher demand and outlets. As demand for products rises, so do the prices and profits: "A rise in investment, and thus in total demand, will raise prices and profit margins" (1955, p. 95). Nominal wages increase less than goods prices in the short run, so that the profit share increases. The savings rate for profits is by assumption higher than the savings rate for wages. Therefore, the initial increase in investments leads to an increase of the overall savings rate – investments cause savings.

The mechanisms explained so far only guarantee that savings develop in the right direction. In order to see, under what conditions the savings equal exactly investments, it is assumed that they are equal:

$$I = S. \tag{11.74}$$

By combining equations 11.73 with 11.74, the necessary relation between the share of profits ($\frac{\Pi}{Y}$) and the share of investments ($\frac{I}{Y}$) is deduced:

$$\frac{\Pi}{Y} = \frac{1}{s_p - s_w}\frac{I}{Y} - \frac{s_w}{s_p - s_w}. \tag{11.75}$$

In order to have a balanced growth path, the share of profit needs to be higher for a higher share of investments. Kaldor thus shows under which conditions the induced savings equal the additional investments.

In summary, Kaldor develops a theory in which distribution and growth are intertwined. While the profit share impacts upon the growth rate, growth also influences the profit share. Additionally the state of technology and technological change play central roles in influencing growth and therefore also distribution.

11.6.2 The Theory and Economies Without Growth

11.6.2.1 Zero Growth and Technological Change

In Kaldor's theory, investments lead to capital accumulation and the introduction of new technologies. Together, these two effects lead to increases in per capita income. The central question is thus how this mechanism needs to change in order to facilitate a zero growth economy. There are two scenarios.

First, when the technical progress function is as described by Kaldor, investments necessarily lead to per capita growth. Investments thus need to be zero in order to have no capital accumulation and no innovations. As technological change depends on investments, no investments also imply no technological change. Therefore, also the capital coefficient v stays constant.

Including depreciation[39] changes the analysis. In this case, zero investments would lead to declining production as the capital stock would decrease. Zero growth takes place when investments exactly offset depreciation so that the capital stock stays constant. The labour productivity ($\frac{Y}{L}$) and the capital intensity ($\frac{K}{L}$) increase by the same proportion due to technological change (see equation 11.70). Therefore, the capital coefficient v stays constant. As the capital stock is constant as well, production stagnates and less labour is employed. As in previous theories, reductions in average working hours can in principle solve the problem of unemployment.

The second scenario refers to the case in which the technical progress function can take different forms. There are in principle many possibilities how such technological change can be shaped. The most interesting here is technological change that decreases the resource coefficient instead of the labour coefficient. When this type of technological change keeps the capital coefficient constant, it is similar as the first scenario, only that reductions in working hours are not necessary in order to prevent unemployment, as the labour coefficient stays constant. The use of natural resources would decline over time.[40] As Kaldor's theory does not entail an explicit integration of natural resources, this scenario cannot fully be developed based on his theory, though.

11.6.2.2 Distribution and Zero Growth

Thus far, it has been argued that investments need to be zero or low (when depreciation is taken into account) in a zero growth economy. Next, it is investigated what size profit and wage shares need to have in order for savings to equal investments. The relation between profit and wage shares is investigated for the case without and with depreciation.

When there is no depreciation investments need to be zero. The necessary profit share is given by (see equation 11.75)

$$\frac{\Pi}{Y} = -\frac{s_w}{s_p - s_w}. \tag{11.76}$$

Under the assumption that both savings rates are positive and $s_p > s_w$, profits therefore need to be negative. The intuition behind this is that zero investments necessitates zero savings. Positive savings out of wages in this case need to be accompanied by negative savings out of profits,

[39] Kaldor introduced the role of capital depreciation in a later model (Kaldor and Mirrlees, 1962).

[40] This is similar to the arguments regarding resource-augmenting technological change in the neoclassical analysis – see section 9.2.

which is only possible when profits are negative. The other possibility would be to change the savings behaviour. If for example, savings out of wages and savings out of profits would be zero, profits could stay positive.

Taking depreciation into account, the size of the appropriate profit rate depends on the size of depreciation. Their relation is investigated by examining the necessary size of depreciation (δK) and gross investments (I) (which are of equal size) in order to have zero profits. Setting profits equal to zero in equation 11.75 yields

$$s_w Y = I = \delta K. \tag{11.77}$$

When investments and depreciation are equal to the savings out of wages, no profits may take place. Otherwise, investments and savings are not identical. When investments are higher (lower) than savings out of wages, profits need to be positive (negative).

11.6.2.3 Results

The first result is that in Kaldor's theory, technological changes poses (as it did in Keynes' and Kalecki's theories) a challenge to a zero growth economy. Technological change requires investments and therefore, it goes hand in hand with capital accumulation and growth. As long as the kind of technological change assumed by Kaldor is in place, zero growth is only possible with slow technological change (accompanied by low investments) or large depreciation. In order to obtain larger depreciation, governmental intervention (to dismantle certain industries) plays a necessary and crucial role.

The second result is new, compared to previous analyses. It concerns the relation between profits, investments and savings. Profits need to be low in Kaldor's framework. This is necessary for investments to be low, as high profits foster investments. Also, it is a prerequisite for low savings, so that investments and savings are identical. As long as savings out of profits are larger than savings out of wages and the capital coefficient stays constant over time, profits need to be low or even zero or negative (depending on capital depreciation and the other specific parameter values).

11.7 Robinson: Biased Technical Change

Joan Robinson is another very influential early Keynesian economist. Her publications were chronologically parallel to Kaldor's. Her major contributions on economic growth have been *The accumulation of capital* (1956) and *Essays in the theory of economic growth* (1962).[41]

11.7.1 The Theory

Robinson's analysis has many similarities with the other Keynesian authors discussed so far. It has a particular resemblance to Kalecki's theory. For the issue at hand, her explicit discussion of different types (in her terminology *biases*) of technological change is of most relevance. Therefore, her theory is explained shortly and the role of technological change is discussed in more detail.

11.7.1.1 The Model Without Technical Progress

Robinson's model of the economy entails one sector in which consumption goods (sector 1, C) and one in which capital goods (sector 2, I) are produced. In each sector, workers earn wages ($W_{1,2}$) and entrepreneurs receive profits[42] ($\Pi_{1,2}$):

$$\text{sector } 1 = C = W_1 + \Pi_1, \tag{11.78}$$

$$\text{sector } 2 = I = W_2 + \Pi_2. \tag{11.79}$$

The wage and profit shares in each sector are determined by the levels of money wages and prices. Money wages determine costs and their level is primarily due to the ability and willingness of workers to assert wage increases. Prices are determined by the ability and willingness of the respective entrepreneur to demand higher prices than the costs. Entrepreneurs, on the one hand, have the incentive to demand higher prices in order to make larger profits per good. On the other hand, they can also increase profits by expanding their market share – this requires low prices though. Entrepreneurs set prices based on these contrary incentives. The difference between revenues and costs are the quasi-rents (profits).

[41] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following explanation is primarily based on Robinson (1956). The theory in section 11.7.1 is a reproduction of the existing theory. In section 11.7.2 the existing theory is interpreted in order to investigate zero growth conditions. Additionally, the analysis of Robinson's framework is extended to include natural resources as production factor.

[42] Robinson distinguishes profits and quasi-rents. The difference between revenues and costs is called *quasi-rents*. Profits are the quasi-rents minus the investments needed to keep the capital stock constant (due to depreciation). The implications of this difference are not further analysed here, though, as it is not important for the investigation at hand.

All wages (from both sectors) are spent on consumption goods. All profits (from both sectors) are used for investments. In Robinson's words: "[T]he sales value of commodities per annum is equal to the wages bill for capital goods, and quasi-rents obtained from the sale of consumption goods is equal to the wages bill for capital goods" (Robinson, 1956, p. 75). Therefore, the two sectors are determined according to

$$C = W_1 + W_2 \quad \text{and} \quad I = \Pi_1 + \Pi_2. \tag{11.80}$$

Robinson (1956) argues for an inter-causal relationship between investments and profits. On the one hand, entrepreneurs need to make profits in order to be able to invest. On the other hand, only when entrepreneurs overall invest, they make profits. The reasoning is as follows: Investments increase the capital goods sector and therefore directly increase profits there. Additionally, wages rise in the capital goods sector, which increases demand in the consumption goods sector. Consequently, profits also increase in the consumption sector. In her words: "If they [the entrepreneurs] have no profit, the entrepreneurs cannot accumulate, and if they do not accumulate they have no profits" (Robinson, 1956, p. 76). This inter-causal relationship determines whether the economy grows.

The size of investments and therefore of economic growth depends crucially on the size of profits. Robinson (1956) argues that in the state of tranquillity[43] the profit share determines the speed of capital accumulation and economic growth. The reason is that a higher profit share implies higher profits (for a given level of production). When all profits are invested, this also means higher investments (compare with equation 11.80).

At the same time, in the short run, an expansion of wages can lead to accelerated capital accumulation. An increase in money wages in both sectors causes an increase of demand in the consumption sector (see equation 11.80). This induces entrepreneurs in the consumption sector to expand production. This has two effects: First, employment rises, which increases wage income and the demand for consumption goods further. Second, entrepreneurs in the consumption sector order capital goods in order to increase production. This leads to more production in the investments sector, which in turn increases employment there. The larger employment leads to larger wages, higher consumption demand and a further expansion of sector 1. Overall, both sectors have therefore increased in size.

[43] Robinson's (1956) concept of the state of tranquillity is similar to the usually used concept of the steady state: "[W]e speak of an economy in a state of tranquility when it develops in a smooth regular manner" (p. 59).

Robinson (1956) henceforth emphasizes two mechanisms that determine capital accumulation and economic growth. On the one hand, large profits are necessary to finance investments. On the other hand, higher wages imply more consumption demand and thereby expansion of production. Changes in the wage and profit shares therefore have ambivalent effects on economic growth. Which effect prevails depends on the specific circumstances of the particular situation.

11.7.1.2 The Model With Technological Change

Robinson (1956) is one of the few Keynesian authors who allows for different types of technological change[44] in her theories. In particular, she argues that technological change can be neutral, capital-saving or capital-using. Her analysis of technological change and her understanding of capital is complex and different from other understandings. For example, she distinguishes four different types of capital, which all refer to a different concept.[45] The following explanation is therefore restrained to the issues important to the subject at hand – in particular the different types of technological change.

a Different techniques and types of technological change

At any point in time, entrepreneurs can choose between different techniques in their production process. These different techniques differ in the costs for capital goods and the amount of wages that need to be paid in the production process. In other words: Different techniques require different amounts of physical capital and labour.

Additionally, it is assumed that at a certain point in time, an old and a new kind of each technique exist. The new technique is more cost efficient than the old one. This is why firms invest in the new technique, so that it gradually replaces the old one.

In Robinson's (1956) approach, technological change alters the labour productivities in the two sectors. When the productivities change at the same pace, technological change is neutral. When the increase in productivity in the investment sector is lower (higher) than in the consumption sector, the technological change is capital-using (capital-saving).

The reasoning is as follows: If technological change is of such type that it increases the production per worker in the consumption sector but not in the investment sector, fewer workers are needed in the consumption sector

[44] Robinson (1956) uses the term "technical progress" (p. 164).

[45] See Robinson (1956, pp. 114 – 123) for a detailed explanation of different types of capital in her analysis.

in order to use the equipment delivered by the investment sector.[46] That leads to unemployment in the consumption sector. Part of the unemployed are employed in the investment sector. Supply of capital goods increases, which allows for higher production in the consumption sector. In effect, production in both sectors has increased. This type of technological change is called capital-using.

If, on the other hand, productivity increases faster in the investment sector than in the consumption sector, there is an oversupply of capital goods and a scarcity of workers who can use it (in the consumption sector). This leads to an increase in wages and a relocation of some workers from the investment to the consumption sector. The relative share of workers producing capital goods has therefore decreased. This type of technological change is called capital-saving.

b Effects of biased technological change

Robinson (1956) argues that the outcome of capital-saving and capital-using technological change on capital accumulation depends on the reactions of entrepreneurs. Dependent upon these reactions, biased technological change causes a switch of technique. The effects of capital-saving and capital-using technological change are investigated in turn.

In the case of capital-using technological change, productivity increases are larger in the consumption sector than in the investment sector. The entrepreneurs in the consumption sector have two possibilities to react to this situation: They can either keep the monetary value of investments constant. In this case, employment in the consumption sector decreases, as less labour is needed per unit of production and per unit of physical capital. The other possibility is that entrepreneurs in the consumption sector increase investments to such a level that employment stays constant. Robinson (1956) argues that the latter is more likely, as "[w]hen the capitalist rules of the game are being played with vigour and success, most entrepreneurs are continually trying to expand their businesses" (p. 168). The result is that demand for labour is low and demand for capital goods is high. This decreases wages and increases the price for capital goods. As result, entrepreneurs choose a different type of technique that uses less capital and more labour.

As argued above, capital-saving technological change is caused by an increase in productivity in the capital goods sector (relative to the consumption goods sector). The higher productivity has the effect of lowering the price of capital goods. Entrepreneurs in the consumption sector therefore face lower prices for the capital goods they need for production.

46 It is implicitly assumed that the larger labour productivity in the consumption sectors goes along with a constant capital coefficient.

According to Robinson (1956) they can either choose to buy the same amount of capital goods (or more precisely, to buy capital goods that entail the same production capacity as in the previous period) or to spend the same amount of money on capital goods. Robinson (1956) argues that the latter is more likely: "most entrepreneurs, presented with the opportunity of expanding capacity without any new investment of finance, are pleased to embrace it" (p. 166). The effect is that productive capacity in the consumption sector rises and the demand for labour increases. This drives up wages. When the increase in wages is significantly high, the choice of technique is altered. A technique that uses less labour and more capital is chosen.

The overall result is therefore that the effect of the bias is partly compensated for by switching the technique. As a first effect, capital-using (-saving) bias leads to a relocation of workers into the capital (consumption) goods sector. However, a secondary effect is that a different technique is used that uses less (more) physical capital.

11.7.2 The Theory and Economies Without Growth

11.7.2.1 Zero Growth Without Technological Change

In Robinson's (1956) theory without technological change, investments need to equal the depreciation of capital stocks in order to generate zero growth. The necessary conditions are similar as in prior theories. Savings out of profits need to be of equal size as capital depreciation. Assuming a given level of production, the profit share is therefore decisive. As it depends on the ability of workers to claim sufficient wages and entrepreneurs to determine prices, these factors need to be in the appropriate relation for profits to equal depreciation.

Robinson (1956) also points out one central apparent obstacle for a zero growth economy. When the profit share is low (in order for investments to solely balance out depreciation), the wage share is high. This implies high demand and therefore additional incentives for entrepreneurs to invest. Therefore, there seems to be a contradiction between two central conditions for zero growth: Both the profit share and the wage share need to be low in order to facilitate a zero growth economy. As both cannot be low at the same time, one will always spur investments. Either profits lead to investments because entrepreneurs reinvest or consumption leads to investments because potential profits are anticipated. A possible solution to this problem is to have a high(er) rate of capital depreciation. This would allow for investments to be higher and at the same time keep the level of production constant. This issue is discussed further in chapter 14.

11.7.2.2 Zero Growth With Technological Change

The conditions for zero growth are different when taking into account technological change. The cases of capital-using and capital-saving technological change are investigated in turn, followed by a combination of the two.

Capital-using technological change is driven by increases in labour productivity in the consumption sector. Robinson (1956) argues that entrepreneurs are likely to react with increasing investments so that one part of the released employment is compensated by more production in the consumption and the other part by more production in the capital goods sector. In a zero growth economy, capital-using technological change must not lead to higher investments. The reason why Robinson (1956) regards an expansion of investments as likely is that firms have the incentive to make profits and compete for market shares. There are two approaches to tackle this issue.

First, within Robinson's theory, entrepreneurs have less incentive to expand production when they do not anticipate to be able to sell their products. Consumption demand therefore needs to be low. Possible reasons are a redistribution of labour in order to prevent unemployment despite less demand for labour[47] and to keep government expenditures constant. Second, within the discussions on economies without growth, the role of the type of business entities is also stressed. Firms that are collectively instead of privately owned are argued to be less likely to expand production (see section 3.6 and also 12.3).

Capital-saving technological change implies increasing labour productivity in the capital goods sector. In this case, Robinson (1956) argues that investments increase because entrepreneurs are likely to use the cheaper price of capital goods for expansion. In a zero growth economy, the expansion of investments also needs to be prevented in this case. A possible condition is to raise the price of capital goods, for example by an increase in taxes. As in the prior case, additionally, working hours reductions can to be implemented in order to avoid unemployment. When investments (counted in physical units) do not increase, less employment is needed in the capital goods sector. Working hours reductions can therefore either be implemented solely in the capital goods sector or in both sectors. In the latter case, workers would migrate from the capital goods into the consumption sector.

Technological change can also take place in both sectors at the same time. Whether it is capital-using or capital-saving only depends on where

[47] Compare with the analysis of Keynes' theory (section 11.1), where a very similar result is found.

it is faster. In a zero growth economy, both effects need to be taken into account. Technological change in the consumption sector needs to be responded to (in the manner argued above for capital-using technological change) and *at the same time* technological change in the investment sector has to be handled (as also argued above concerning capital-saving technological change), in order to facilitate a zero growth economy.

11.7.2.3 The Choice of Techniques

Robinson (1956) also covers different choices of technique. Techniques with different sets of production factor proportions are chosen based on the price of capital and labour. Therefore, Robinson allows for different *directions* of technological change, based on different production factor prices. When, for example, the price of physical capital increases relative to the price of labour, firms are likely to switch to a different type of technique that uses less capital and more labour.

Concerning economies without growth, this aspect is of crucial importance. It allows for technological change along the lines of the second scenario from the existing concepts for economies without growth (see chapter 4) and scenarios two and three from the neoclassical part (see chapter 9). These scenarios have in common the fact that technological change leads to a constant labour and a decreasing resource coefficient. Robinson's theory is not fully equipped to analyse such a scenario, as she only takes into account the production factors labour and capital. Assuming that a higher capital coefficient goes along with a higher resource coefficient leads to the following analysis.

In order to support a decreasing resource coefficient and a constant labour coefficient, labour needs to be relatively cheap and capital to be relatively expensive. Robinson (1956) argues that this happens automatically when labour productivity increases faster in the consumption sector than in the investment sector. But it can also be consciously initiated, in particular by use of tax instruments.

Within Robinson's model, making physical capital relatively expensive to labour has the following effects: Firms in both sectors switch to technologies with higher labour and lower capital coefficients. This has two effects. First, it decreases the demand for capital goods. This leads to a reallocation of workers from the capital to the consumption goods sector. Second, it increases the demand for labour, so that employment and wages rise.

Overall, the economy is therefore characterized by a constant labour coefficient, a decreasing capital coefficient and a lower share of the capital (and a higher share of the consumption) goods sector in production.

11.8 Results and Discussion

11.8.1 Summary of Conditions

It is a challenge to summarize the previous theories. First, because of the large number, and second because each of them is based on a slightly different overall view on the economy. This is why the following summary may loose some analytical precision. At the same time, the integrated analysis of the theories leads to a more coherent and detailed analysis of conditions for economies without growth. The summary is structured around major aspects of Keynesian analyses.

11.8.1.1 Aggregate Demand, Aggregate Supply and Effective Demand

In the fundamental Keynesian theories, the interplay between aggregate demand and aggregate supply and the resulting effective demand are at the centre of most analyses. This stands in stark contradiction to the neoclassical theories, which focus on the supply side. Accordingly, the necessary conditions for economies without growth from Keynesian perspective concern both the demand and the supply side (while it only concerned the supply side in the neoclassical part). This issue is most articulated in the theories of Keynes and the Neoclassical Synthesis.

For Keynes, the relationship between aggregate demand and supply and along with it the concept of effective demand are central. The condition for zero growth is that effective demand is constant. This necessitates a stable economic cycle consisting of a constant aggregate supply that leads to a stable amount of wage income, generating constant consumption demand, which in turn gives firms the incentive to keep supply constant. As argued above, under certain conditions this also leads to constant investments – even when technological change is taken into account. To reconcile technological change that decreases the labour coefficient with no unemployment requires governments to keep spending constant and to facilitate labour hours reductions.

In the Neoclassical Synthesis Model, the analysis is similar, though simpler. Two separate sets of factors determine aggregate demand and supply. When they do not change or several changes balance each other out, zero growth takes place.

11.8.1.2 Investments

Domar prominently points out the dual character of investments. Investments have capacity and demand effects. In a zero growth economy, both need to be zero. Taking capital depreciation into account, investments therefore need to balance out capital depreciation (to keep production capacity constant) and stay constant over time (to keep aggregate demand constant):

$$I = \delta K. \tag{11.81}$$

A central question for a zero growth economy is therefore how the level of investments can be kept equal to capital depreciation. There are two points of departure. First, capital depreciation can be increased. Regarding the discussions on economies without growth, this is a very relevant aspect. Dismantling dirty industries (and building cleaner ones in their place) is part of many strategies.[48] Second, investments can be kept lower than in growing economies. Keynesian authors provide a large number of factors involved in this issue, including animal spirits, firms' savings, the profit rate and the level of the interest rate. But two of them are of particular importance for this analysis. First, expected revenues need to be kept low in order to prevent large investments. Here, consumption and government expenditures are of central importance (see also the following sections). Second, the availability of technological innovations depicts an incentive to invest. This can also be kept in check by controlling expected revenues (see below on technological change).

11.8.1.3 Consumption

Consumption is the second central determinant of aggregate demand, apart from investments. It is less central in theories on economic growth. Nevertheless, it plays an important role in determining expected revenues and thereby influences investments and economic growth. The central determinants of consumption are the wage income and the personal income distribution. In a zero growth economy, consumption needs to stay constant. The following condition for zero growth economies combines constant consumption with low economic inequalities: Employment and the resulting wage income stay constant (with reductions in average working hours for certain types of technological change, see below). In order to keep consumption at a certain level and at the same time decrease inequality, income redistribution needs to be implemented side by side with a decrease in the propensity to consume (due to a change in preferences).

11.8.1.4 Savings

In most Keynesian theories, savings are an outcome rather than a cause for economic dynamics. In particular, investments lead to an equivalently high amount of savings (this reasoning is most articulated in Keynes' and Kalecki's analyses). When capital depreciation is not taken into account,

48 See section 3.6 and section 13.2.

savings are zero (as are investments). This implies that net savings are zero, while gross savings are positive, when capital depreciation is included. These gross savings are lower in zero growth, than in growing economies, as investments are also lower.

The condition of zero savings refers to aggregated savings. Therefore, some actors can save and other can dissave. For example, working-aged people can save, while retirees dissave. This is important to note in order to prevent the (wrong) interpretation that no actor can save in a zero growth economy.

11.8.1.5 Profits

In Keynesian thought, profits are determined by the level of consumption (out of profits) and investments, rather than the other way around. In most of the theories covered, it is either assumed that profits are entirely saved or at least that the savings rate out of profits is larger than the savings rate out of wages. If this is true, profits need to be low in a zero growth economy in order not to generate high savings. These low profits are caused primarily by low levels of investments. When the profits are higher than appropriate for the level of production, the level of production declines.[49]

11.8.1.6 Labour

The natural growth rate of Harrod describes the relationship between labour and economic growth from a Keynesian perspective. The level of production and the labour coefficient determine the amount of labour demand. The level of population and how much people want to work on average, determine the amount of labour supply. Usually, supply lies above demand, as Keynes points out.

In a zero growth economy with technological change (that decreases the labour coefficient) and a stable population, the average working time per worker therefore needs to decrease when unemployment is to be prevented. The percentual reduction of working time matches the percentual decrease of the labour coefficient.

11.8.1.7 The Role of the Government

The central role of the government is to influence aggregate demand. First, this is influenced by government spending on final goods. Second, the government can redistribute after tax income in order to influence the

[49] The reason is that high profits mean high savings, which implies low consumption and therefore low expected future revenues, which decreases investments. The resulting level of production is lower than before, absolute profits are equal, while wages have decreased (following Kalecki's reasoning).

level of consumption. In a growing economy, these measures are primarily a response to a persistent lack of aggregate demand. Due to technological change, employment decreases, which leads to a reduction in wage income and consumption. This effect needs to be countervailed by fiscal spending in order to guarantee full employment. In zero growth economies with the same type of technological change, the government instead needs to facilitate sufficient working hours reductions and additionally guarantee a constant amount of aggregate demand by adjusting government expenditures accordingly (on average it needs to stay constant). This provides a necessary condition for zero growth and prevents unemployment.

11.8.1.8 Stability

Within the theories discussed, zero growth economies can be stable regarding the level of production but lead to unemployment, unless the mentioned governmental measures are implemented. In Keynes' analysis, production can stay at a constant level but this leads to unemployment due to technological change. In Harrod and Domar's models, zero growth economies (as growing economies) can but do not have to be stable – it depends on the parameters assumed. In the Neoclassical Synthesis Model, zero growth is stable. Even when single factors change, this only alters the level of production only once. Kalecki's theory even suggests that a business cycle around a stable level of production is possible – at least when technological change is not included.

11.8.1.9 Technological Change

Technological change has two major effects within the theories covered. First, the availability of new technologies is an incentive for firms to invest in order to generate additional profits. This increases aggregate demand. Second, technological change decrease the amount of employment and hence the level of wage income. This decreases aggregate demand. In zero growth economies, the response needs to be working hours reductions accompanied by government expenditures that keep the final goods demand stable (as argued before).

A remaining question is whether investments are still likely to increase due to the incentive based on technological change. It has been argued that this does not have to be the case, when firms *expect* the final goods demand to stay constant. Then, they are likely to invest in replacements of their production capacity rather than extensions. This additionally presupposes the absence of technically given economies of scale. Whether this is realistic has not been able to investigate based on the theories at hand. The issue is further examined in part IV, as similar arguments are at the center of Marxian theories on economic growth.

11.8.1.10 Choice of Techniques

Most Keynesian theories assume technological change that keeps the capital coefficient constant and decreases the labour coefficient. Environmental concerns or natural resources as input factors play almost no role. Sometimes (for example in Kalecki's theory) materials are regarded as an input. In these cases, it is assumed that technological change also decreases this factor coefficient.

In some theories (in particular in Robinson's), firms can choose among different types of technologies with different sets of factor coefficients. The determinants of the choice are the set of available technologies and the prices of the factors. The higher the price of a production factor, the more likely firms choose production methods that make less use of it.

This opens up an interesting perspective for zero growth economies. The price for materials (natural resources) can be increased and the price of labour decreased. The increase in materials' prices also increases the price of capital goods. As a result, technologies with high labour and low material coefficients are used. When this is combined with the above listed conditions for zero growth, working hours reductions become less important or have to be undertaken to a smaller degree. Less use of materials also leads to less environmental impact.

11.8.2 Critical Assessment of the Fundamental Keynesian Theories

Keynesian theories have been criticized on many occasions and from a variety of theoretical perspectives, ranging from neoclassical authors (see for example Hazlitt (1995)) to ecological economics (with a focus on the issue of growth, see Spash and Schandl (2009b)). Here, the focus is on four issues that are most relevant for the issue at hand. Most points somehow refer to the Keynesian understanding of technological change.

First, the assumption of the majority of theories that *no* substitution between production factors for a given state of technology can take place, appears unrealistic. While the neoclassical assumption of absolute substitutability has also been criticized above, it seems similarly controversial that no substitution between production factors can take place at all.

Second, many of the theories only allow for one type of technological change that keeps the capital coefficient constant and decreases the labour coefficient. In the long run, factor relations therefore can change, but only by a predetermined type of technological change. While some authors, in particular Robinson, allow for different directions of technological change, these analyses have not entered into other Keynesian theories.

Another (third) aspect is also related to the type of technological change. It is assumed that labour productivity increases due to innovations. But as has been argued in section 2.2, ecological economists point out that the increase in labour productivity has been largely due to increasing use of energy (or more precisely useful work). As environmental inputs are almost entirely left out of the analysis, the role of energy cannot be investigated based on the Keynesian theories covered here.[50] Chapter 13 covers some Keynesian theories that include environmental aspects.

Finally, the monetary and financial sectors are covered insufficiently. Some authors, in particular Keynes, incorporate monetary concerns into their frameworks. Keynes' analysis has been criticized by several authors. In particular, his assumption of governmentally determined money supply and his analysis of the liquidity preferences as money demand instead of money supply have been criticized. These issues are further discussed in chapter 12.

[50] Even in Kalecki's analysis, in which materials are a production cost, it is not coherently analysed where they are produced. The argument that the sector is vertically integrated seems not convincing, as then all costs would be labour costs and profits.

Chapter 12

Monetary Theories

The second chapter on Keynesian theories entails contributions that ascribe an important role to monetary aspects. The choice for these theories has several reasons. First, within Keynesian theories, monetary approaches have received an increasing attention over the last decades (Fontana, 2003). Second, whether money is given an important role has been a central difference between Keynesian and neoclassical approaches since Keynes' work, in particular building on Keynes' (1930) first major book, *A treatise on money* (Dow and Dow, 1989). Third, the question whether the existing monetary system is compatible with zero growth has been a central debate on economies without growth (see section 3.6). Authors discussing this issue often use Keynesian frameworks (see chapter 10).

This chapter encompasses four sections. In the first, the theory of Paul Davidson is used to investigate zero growth economies. His extension of Keynes' analysis to the long run has a strong focus on monetary aspects, as the title of his probably most influential book *Money and the real world* (Davidson, 1978) indicates. Second, a theory developed by Karl Betz, an author of the school of Monetary Keynesianism, is examined. This school has developed a Keynesian macroeconomic framework similar to Davidson's. Betz' contribution in particular entails a coherent macroeconomic model that explains a macroeconomic equilibrium without reference to a labour market. In the third section, the work of Hans-Christoph Binswanger is examined. This author is – compared to the other authors covered – not a prominent figure in Keynesian economics. His work is included here nevertheless, because it is well known in the post-growth and degrowth discourses. Also, he is one of the few authors who analyses explicitly whether zero growth is possible within the existing economic system. Third, a stock-flow consistent model by Wynne Godley and Marc Lavoie is introduced. Such types of models have recently become highly influential in Keynesian discussions. These are also the specific set of theories used to examine whether the monetary system is compatible with zero growth (see chapter 10).

12.1 Davidson: Revenue Expectations and Monetary Constraints

In Keynes' *The general theory of employment, interest and money* (2006) aggregate demand determines output and employment in the short run. In *Money and the real world* (1978) Paul Davidson transforms Keynes' analysis into a theory of the long run. Effective demand is also at the heart of Davidson's approach. But contrary to Keynes' short-term analysis, Davidson focuses on the role that investments (and not consumption) play for effective demand and growth, as "growth in effective demand [...] ultimately depends on increases in that process which generates additional income – namely gross investment" (1978, p. 112).

In Davidson's theory, the short run influences the long run and they therefore cannot be separated. Hence, he does not abstract from the business cycle but includes it in his model. This also explains the importance of financial issues in Davidson's theory. As finance plays a major role in the business cycle, it needs to be part of a growth theory as well: A "theory of economic growth must encompass the analysis of the business cycle [...]. Discussions of recession and boom, however, are sensible only after the peculiarities of money and finance have been placed in their proper prospective in the analysis" (Davidson, 1978, p. 137).[1]

12.1.1 The Theory

Davidson's theory resembles in many aspects other Keynesian approaches, in particular Keynes' theory. This is why the following representation focusses on the specialities of Davidson's approach. First, firms behaviour is crucial in his analysis. They determine investments and thus economic growth (section 12.1.1.1). However, firms invest within a given macroeconomic setting. This setting influences investments via the conditions for demand and supply of capital goods (section 12.1.1.2). The most important of such conditions is the firms' expectations on future revenues. As these expectations refer to the long run, continuous investments are needed in order to fulfil high profit expectations (section 12.1.1.3). Davidson combines this theory of expectations with monetary aspects of the economy. Investments require additional finances that need to be pro-

[1] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is based on Davidson (1978). The theory in section 12.1.1 is a reproduction of the existing theory. In section 12.1.2 the existing theory is interpreted in order to investigate zero growth conditions.

vided for by the banking and financial system. Only then can continuous capital accumulation and economic growth take place (section 12.1.1.4).

12.1.1.1 Firms' Behaviour

Entrepreneurial behaviour is of crucial importance in Davidson's theory. Entrepreneurs decide upon the amount of investments, which determines the development of the capital stock and therefore the development of aggregate supply. At the same time investments are the most important factor for aggregate demand. They directly expand the demand for capital goods. This leads to higher wages and additional demand for consumption goods. Hence, investments and the entrepreneurial behaviour that determines them are central to the explanation of economic growth and the level of employment.

The subsequent issue is how investment decisions of entrepreneurs are determined. In neoclassical theories, firms' production levels depend primarily on the price of final goods and on production costs. Single firms are price takers; therefore they cannot influence the price. Concerning costs, only the running costs of production are therefore considered in neoclassical theories. The costs of investments are not taken into account: "[I]f he [the entrepreneur] does not value the entrepreneurial effort or already committed finance necessary to bring forth any level of output, then the short-run flow-supply price will, in a competitive economy, depend solely on the marginal prime costs of materials, labour, and user costs" (Davidson, 1978, p. 35). Additionally, the production at marginal costs requires "produce to order" (p. 39), meaning that the producer knows the price of the final goods, before she decides upon the amount of production and pays for production costs.

Davidson (1978) formulates a three-fold critique on this neoclassical approach. First, he claims that fixed costs are very important and cannot be ignored. Second, production takes time and therefore the producer needs to assume (but does not know for sure) a price based upon which she decides upon the production level. Third, the producer is not seen as a price taker but has some degree of market power and can therefore influence the price by the amount she supplies.

Based on this different understanding of the determinants of entrepreneurial behaviour, entrepreneurs follow a very different rationality in Davidson's theory. They try to *anticipate* the future level of demand. Based on this anticipated demand curve, entrepreneurs set the amount of production and the price. They set it so that the average total costs (including fixed costs and a mark-up that is "expected to yield a 'normal' profit" (Davidson, 1978, p. 38)) are equal to the price.

This behaviour of firms takes place within macroeconomic conditions.

The cost of fixed costs, the price of final goods, the demand for final goods and the ability to price above unit costs all depend on macroeconomic conditions. These conditions are subject of the following sections.

12.1.1.2 Demand and Supply of Capital Goods

There are different understandings of what the terms investments and capital goods mean. Davidson (1978) distinguishes between investments in real production on the one hand and financial assets on the other. The term *investments* hence only refers to the former and is synonymous with purchases of capital goods. Investments determine capital accumulation and economic growth. Their level depends on the interplay between demand and supply of capital goods.

a Demand for capital goods

Davidson's (1978) analysis of investment decisions is similar to Keynes' (2006). The demand for capital goods is determined by the amount of expected additional revenues and the level of running (or working) costs associated with the additional production of consumption goods. The revenues minus the running costs are *quasi-rents*. The higher the expected quasi-rents, the higher is the demand for capital goods: "[T]he demand for fixed capital can be viewed, [...] as solely due to the desire of entrepreneurs to use them to obtain the expected quasi-rents over their useful lives" (Davidson, 1978, p. 69).

Davidson (1978) indicates four factors determining the demand for additional (or net) capital goods (D_K^N). (1) The "expectations about the growth in demand and the consequent future stream of quasi-rents" ($Я_e$) determine the demand as explained above. (2) The interest rate (i) has an impact, because it is part of the cost of production (as the firms are assumed to finance investments by loans) and therefore influences quasi-rents. (3) The "market price of capital goods" (p_K) influences investments, as it is also a cost factor. Finally, (4) the "number of entrepreneurial investors" (Σ) (p. 72) plays a role, as it is expected that more entrepreneurs will lead to higher competition and larger investments. Demand for additional capital goods is therefore determined according to

$$D_K^N = D_K^N(Я_e, i, p_K, \Sigma). \tag{12.1}$$

In addition to demand for additional capital goods there is also the demand for capital goods to replace the amount of capital depreciation (D_K^D). The depreciation of the capital stock is a constant proportion (δ) of the existing capital stock (K): $D_K^D = \delta K$. Therefore, overall demand for capital goods (D_K) is given by ($Я_e$, i, and Σ are assumed to be constant)

$$D_K = D_K^N(p_K) + \delta K. \tag{12.2}$$

b Supply of capital goods
The supply of capital goods (S_K) is principally governed by two factors: The already existing capital stock (K) and the additional supply by the capital goods sector (S_K^A), the "flow supply schedule of capital goods" (p. 75):

$$S_K = K + S_K^A(p_K). \tag{12.3}$$

The existing capital stock is given. The additional supply of capital goods is a function of the price of capital goods (p_K).

c Demand and supply of capital goods
An investment takes place when the price that a firm is willing to pay for the capital good is higher than the minimum price that makes a supplier of the capital good produce it: "If, at any point of time, the demand price for any reproducible physical asset exceeds the minimum short-period flow-supply price which is necessary to bring additional units of that asset forward, then these capital items will be newly produced" (Davidson, 1978, p. 70). Demand for and supply of capital goods determine the price and quantity of the capital stock. Combining equations 12.2 and 12.3 yields

$$D_K^N(p_K) + \delta K = K + S_{KA}(p_K). \tag{12.4}$$

The amount of investments is determined by the intersection between demand and supply minus the existing capital stock.

12.1.1.3 The Central Role of Revenue Expectations

Thus far, it has been argued that investments are the decisive factor determining the long-term development of effective demand and therefore also economic growth. The level of investments depends on the demand and supply of capital goods, which in turn depend on various factors.

Of the multiple determinants of investments listed above, Davidson (1978) stresses the importance of entrepreneurs' expectations. They are the decisive factor on whether the economy is in a positive or a negative feedback loop. In order to have "continuous steady rates of growth [...] entrepreneurs (a) [need to] expect constant rates of growth in effective demand over time, and (b) these expectations are not disappointed" (Davidson, 1978, p. 111).

The argument is as follows: An investment in period t_0 increases production capacity in period t_1. At the same time, it increases consumption in period t_1, as wages and profits rise and are partly used for consumption. Hence, entrepreneurs decide with their own actions whether their profits rise or fall. When entrepreneurs decide upon a high level of investments, they increase incomes and therefore also effective demand. This increases their quasi-rents. If they invest few, the income increases less (or decreases), effective demand will be low and entrepreneurs make few quasi-rents.

As investments primarily depend on the expectations of entrepreneurs, the expectations become the central determinant of economic growth. High expectations lead to large investments, which increase effective demand and thereby fulfil the high expectations. Low expectations on the other hand lead to low investments, low effective demand and therefore also low quasi-rents, so that the low expectations are fulfilled. Davidson (1978) thus describes the behaviour of entrepreneurs as a self-fulfilling prophecy.

There is a disparity between the effects of investments on production capacity and effective demand, which is important in order to understand possible reasons for inadequate effective demand. Investments increase production capacity (supply) for many time periods. The effect of investments on demand only affects a shorter time horizon, however. Therefore, investments in one period do not generate the necessary demand to fulfil the expectations related to the investments. Instead, further investments in the future are necessary to fulfil the original revenue expectations. Therefore, the positive feedback loop of high expectations, high investments and a fulfilment of the high expectations takes place as long as investments stay high over a longer time period: "[W]hile it is expectations of changes in gross profits which induce entrepreneurs to undertake net investment in t_0, actual changes in profits will depend on actual changes in investment expenditure *over time*" (Davidson, 1978, p. 114, italics added).

Davidson distinguishes two possible scenarios if effective demand in one period is lower than expected. Either the entrepreneurs interpret the lack of effective demand "to be only a temporary and random fluctuation" (Davidson, 1978, p. 117). In this case, investments stay at a high level and the economy can regain economic growth as further effective demand is generated. If, on the other hand, entrepreneurs see the low effective demand "as symptomatic of a continuing deficiency in demand in future periods" (p. 117), then investments are decreased and the economy grows less or stagnates.

The same reasoning goes for the instance when actual effective demand is higher than expected one. If it is seen as a temporary fluctuation, it has little impact on investments and growth. If, on the other hand, effective demand is expected to increase at a higher rate in future periods, this will lead to higher investments and put the economy on a track with higher growth rates.

12.1.1.4 The Introduction of Monetary Constraints

In the analyses of the fundamental keynesian theories (chapter 11), as well as in the explanation of Davidson's theory so far, there are little constraints to investments. In general, it is argued that the economy functions below full capacity, both concerning capital and labour. This is why an increase in investment demand by entrepreneurs can be served by supply at relatively constant prices. Contrary to neoclassical theories, consumption does not need to be reduced in order to allow for investments.

The analysis has so far paid little attention to the monetary side. Among the theories discussed, only Keynes and the Neoclassical Synthesis take it into account in a significant manner. For Keynes (2006), the exogenously given money supply and the liquidity preference are important in determining the interest rate and thereby influence investment decisions. In the Neoclassical Synthesis, a similar line of argument is pursued. Davidson (1978) develops a different perspective on the connection between monetary issues and investments.[2]

Firms need financial means in order to produce. They need them to finance (1) replacement costs of depreciated capital, (2) working costs (inputs and wages) and (3) additional investments. Davidson (1978) assumes that (1) is financed out of past revenues by the firms, (2) is financed by current revenues and (3) is financed by short-term borrowings. These short-term borrowings are received from banks, "who provide the money by creating additional bank deposits" (Davidson, 1978, p. 270). In order to be able to get bank loans, firms need securities. Therefore, they sell securities in placement markets to households.

In addition to the condition that firms want to invest, the second condition for economic growth to take place is that banks provide the financial means to invest:

> For accumulation to occur, two conditions must be fulfilled: (1) entrepreneurs must have the *animal spirits* which encourage the belief in additional profit opportunities and (2) entrepreneurs must be able to command sufficient resources to put their projects into execution. [...][T]he obtaining of command of resources require the co-operation of the banking system and financial markets (Davidson, 1978, p. 270).

[2] It should be noted that Keynes developed similar concepts in other publications than in Keynes (2006), which has been used in the section on Keynes (11.1). See in particular Keynes (1930).

Davidson (1978) thus emphasizes the importance of the banking and financial system. Investments and economic growth can only take place when they provide for additional financial means.

Additional investments lead to higher household income and therefore increase effective demand. The part of income that is not consumed is either held as liquid asset or is lent to firms by buying firm securities. In this manner, the demand for firm securities has increased due to higher income.

The price at which firms can sell their securities depends mainly on three aspects: (1) The share of savings the households put in securities influences the price of securities. (2) The demand elasticity of securities determines how strong the price of securities needs to change in order to encourage sufficient purchases by the households. (3) When banks decide to buy additional securities (for example, because households put increasing money into liquid assets at banks), they drive up the price.

Davidson therefore develops a very different understanding of the financial side of investments. In prior theories, the money supply has been given exogenously and investments lead to an increase in the interest rate. In Davidson's theory, on the other hand, the money supply can react to additional demand for loans endogenously, as banks grant additional loans. Whether the loans are provided and what costs for the firms are associated with them, depends on the behaviour of banks, financial actors and households.

12.1.2 The Theory and Economies Without Growth

Davidson (1978) himself describes the situation of a stationary economy. In such a "stationary state economy [...][n]ew capital goods (financed internally via the business sector's depreciation reserves) are merely replacing capital as it wears out in each time period" (Davidson, 1978, p. 269). Gross investments need to equal capital depreciation in a zero growth economy.

Davidson (1978) argues that such a stationary state economy is "mythical [...] hypothetical and unrealistic" (p. 269). He does not explicitly substantiate this claim. It seems though that he regards it as unrealistic because it would require several factors in the economy to not vary at all. Any change in factors such as profit expectations, the behaviour on financial markets, banks' activities or the invention of new products or production methods would unsettle the stationary state.

There is subsequently a difference between economies without growth as defined in section 1.2 and the stationary state economy as envisioned by Davidson. In economies without growth, economic growth is zero in the long run, but output can fluctuate in the short run. This is not possible in the stationary state economy. While a stationary state economy is unrealistic within Davidson's analysis, this is not necessarily true for economies without growth.

The central condition for zero growth within Davidson's framework is a constellation of the factors which determine investments, that leads to investments equal to capital depreciation *on average*. Regarding Davidson's analysis as outlined above, four aspects are crucial.

First, entrepreneurs need to have a lower propensity to invest. A significant part of the explanation for entrepreneurs' behaviour is to be found in animal spirits. Their role suggests that a zero growth economy requires a change in attitudes of entrepreneurs (a lower propensity to invest). Additionally, the role of competition is interesting to highlight. Davidson argues that a larger number of entrepreneurs implies also more intense competition and therefore higher investments. A lesser degree of competition would therefore also decrease investments. This issue is discussed in more detail in part IV. Also, as discoveries of products and production methods encourage investments, they need to take different – less investment intensive – forms in a zero growth economy.

Second, revenue expectations need to be low over long periods of time in order to prevent high investments. Two aspects are central here. On the one hand, households influence investment decisions by their consumption behaviour. Lower consumption can therefore contribute to lower revenues expectations. On the other hand, the government can also contribute to the expectation of constant revenues by announcing and executing constant government expenditures.

Third, capital goods can be more expensive and thereby deter investments. Higher interest rates and more expensive capital goods (e.g., induced by larger taxes on capital goods production) prevent strong investments. Additionally, a larger depreciation would make strong net investments less likely.

Finally, monetary circumstances play a role for the type and size of investments. In order to limit investments in size, banks and financial markets can be regulated to decrease loans.

Overall, Davidson's analysis is similar to Keynes', though he stresses and elaborates in particular on the roles of entrepreneurs' behaviour, expectations and the role of monetary constraints. Thereby, he improves the understanding of conditions for zero growth economies in particular concerning determinants of investments.

12.2 Monetary Keynesianism: Equilibrium Without a Labour Market

The Berlin school of Monetary Keynesianism[3] has developed a theory that is similar to Davidson's approach. In this set of theories, the macroeconomic equilibrium is explained without any reference to the labour market. Monetary markets and the market for capital goods are interlinked and together lead to a certain level of production. The level of employment is subsequently determined due to the labour coefficient.[4,5]

Monetary Keynesianism is based upon Keynes work and develops it further. While other Keynes interpretations combine it with neoclassical views (most importantly the Neoclassical Synthesis), here Keynes' theory is interpreted and adjusted in a manner that takes it further away from the (neoclassical) mainstream.

According to Park (2004), central to Monetary Keynesianism is the role of money and its economic implications. Money is not seen as primarily a medium of exchange or a store value as in neoclassical theories. Instead, its main characteristic is its function as a means of payment. This implies that money is the commonly agreed upon medium in which contracts are made and executed. Only central bank money is regarded as money in this sense. Money created by private banks through loans does not fulfil this role (entirely), as it cannot be used for the fulfilment of all contracts.[6]

Park (2004) points out four goals of Monetary Keynesianism: (1) The development of a macroeconomic equilibrium that has monetary aspects at its centre and provides a coherent explanation of an equilibrium with unemployment; (2) a monetary theory of the interest rate, based on a theory of endogenous money supply; (3) an explanation of the relation between different markets (money, goods, labour), which takes into account the hierarchy between them; and (4) the consequences of such a theory regarding monetary and fiscal policies.

3 Original quote in German "Berliner Schule des monetären Keynesianismus" (Park, 2004, p. 1).

4 The theory of Monetary Keynesianism as developed by the Berlin school is closely associated with the work by Hajo Riese. Here the framework of Karl Betz (1993, 2001) is used, who has been a student of Riese. Betz developed a macroeconomic framework for the long run.

5 Regarding the question of which aspects of the following investigation are adopted from other studies and which are novel developments of the present work: The following illustration is based on Betz (2001). The model in section 12.2.1 is a reproduction of the existing model. In section 12.2.2 the existing model is interpreted in order to investigate zero growth conditions.

6 In particular transactions in the inter-banking market are conducted using central bank money.

In Keynes' analysis, the monetary economy has two central features (Park, 2004). First, firms aim at having a larger amount of money capital at the end of the production process than they started with at the beginning of it. Keynes refers to Marx's famous formula $M - C - M'$, with $M' > M$ (compare chapter 16). The difference between M' and M is the profit, which is the driving incentive for entrepreneurial activities. Second, the monetary economy does not have a mechanism that leads to full employment. It is this second feature that the Berlin School focusses on. In how far zero growth economies are compatible with the first is discussed in more detail in the remaining monetary Keynesian theories (sections 12.3 and 12.4) and the Marxian theories (part IV).

12.2.1 The Theory

Betz (2001) argues that Keynes' theory can only explain unemployment in the short run but not in the long run. In Keynes' theory, consumption is a major determinant of effective demand. A lack in consumption and thereby overall effective demand leads to unemployment. In neoclassical theories, unemployment would be prevented by decreases in the price of labour – the wage rate. This is not possible in Keynes' theory, because wages are sticky in the short run and can therefore not adjust downwards.

Contrary to this assumption, Betz (2001) points out that a long-run theory needs to allow for price changes, as also Keynesian economists want to argue based on price-mechanisms.[7] In the long run, the low consumption rate at the same time implies high savings, that is, high demand for money. In order to be able to take account of unemployment in the long run as well, a Keynesian theory has to explain why the high demand for money does not lead to adjustments that bring about a market equilibrium without unemployment. Betz argues that Keynes' theory does not provide this, mainly due to his assumption of exogenous money supply. With a given money supply, high money demand has to lead to increasing prices and therefore decreasing real wages (nominal wages stay constant, prices rise). As a consequence, unemployment would have to decrease in the long run.

Betz (2001) sees the solution to this problem in the abolishment of Keynes' assumption of an exogenous money supply. Instead, he argues that money is created endogenously by private banks. Additionally, investments imply a willingness by the owners of tangible assets (which are at the same time capital goods) to hold money. They need to be willing

[7] Original quote in German: "da immerhin jeder keynesianische Ökonom auch preistheoretisch wird argumentieren wollen" (Betz, 2001, p. 55).

to exchange their holdings of tangible assets for money, in order to allow for production. This willingness is the limitation to investments.

12.2.1.1 A Model with Hierarchical Markets

a Intuition of the model

Betz (2001) puts the capital goods market at the centre of his theory. On the one hand, a higher interest rate leads to lower demand of capital goods. The central reason is that a higher interest rate implies a more unequal income distribution, which leads to lower demand in the goods market and hence less demand for capital goods (as the capital coefficient is given).

On the other hand, a higher interest rate leads to higher supply of capital goods. The supply of capital goods is modelled as a decision of asset owners. They decide to either hold their assets in form of tangible assets/capital goods[8] or deposits. The higher the interest rate, the higher the incentive to sell capital goods and hold deposits is.

The interest rates for both deposits and for loans (which firms take in order to buy capital goods) are primarily determined by the central bank via the refinancing rate for private banks. The central bank's interest rate policy therefore plays a decisive role. On the one hand, it can lower the interest rate so that investments increase. However, a lower interest rate at the same time implies a lower willingness of asset owners to sell the capital goods. Changes of the refinancing rate have therefore opposite effects on the demand and supply of capital goods and the central bank needs to set it so that the two are in equilibrium.

b Demand for capital goods

The model starts with a demand-driven goods market. Aggregated demand (Y_D) determines aggregate supply (Y_S):

$$Y_S = Y_D. \tag{12.5}$$

The capital and labour coefficients are given. The demand for capital goods (D_K) and labour (D_L) are therefore determined according to

$$D_K = \frac{K}{y} Y_S \quad \text{and} \quad D_L = \frac{N}{y} Y_S. \tag{12.6}$$

Aggregate demand is a decreasing function of the interest rate (i). The underlying reason is that the interest rate increases profits and therefore

[8] The assumption that the tangible assets of asset owners are at the same time the capital goods needed for production is a central and also controversial assumption of this approach.

increases income inequality, which lower aggregate demand. Betz (2001) follows Kaldor's argument that the savings rate for profits is higher than the savings rate for wages. As a higher interest rate implies a higher profit share, it leads to a higher overall savings rate (s) and thereby to lower aggregate demand (Y_D). Aggregate demand is determined according to

$$Y_D = \frac{1}{s(i)} C_A, \tag{12.7}$$

with the autonomous demand C_A and $\frac{ds}{di} > 0$.[9]

The determination of the demand for capital goods (for equation 12.6) can therefore be elaborated as a function of the interest rate:

$$D_K = \frac{K}{y} \frac{1}{s(i)} C_A, \tag{12.8}$$

with $\frac{dD_K}{di} < 0$.

c Determination of the interest rate

The theory assumes endogenous money supply due to money creation by private banks. Firms take loans from private banks in order to buy capital goods. The issuing of loans leads to money creation. At the same time, private banks borrow central bank money (from the central bank) due to two reasons. First, they need to hold and issue cash at the level requested by firms and households. Second, they have to hold central bank money due to the reserve requirements.

The interest rate at which private banks give loans to firms is primarily determined by two aspects. First, the refinancing rate (i_{ZB}, the rate at which private banks can borrow central bank money from the central bank) influences the interest rate of loans, as private banks pass on the interest they have to pay to the central bank. Second, banks add a liquidity premium (l_B) to the interest rate. It reflects the risk of failure to repay the loan and uncertainties regarding the future refinancing rate. The interest rate for private bank loans (i) is therefore determined according to

$$i = i_{ZB} + l_B. \tag{12.9}$$

This allows to refine the determination of the demand for capital. The difference is that the savings rate is primarily determined by the refinancing rate (instead of the interest rate on private loans):

9 For a more detailed derivation of this equation see Betz (2001, p. 70 – 73).

$$D_K = \frac{K}{y} \frac{1}{s(i_{ZB})} C_A, \tag{12.10}$$

with $\frac{dD_K}{di_{ZB}} < 0$.

d Supply of capital goods

Households that have assets can hold them either as tangible assets a_H or as deposits (M).[10] It is assumed that the entire sum of assets hold by households $(a_H + \frac{M}{p})$ is equal to the entire sum of tangible assets (a). Households sell part of the tangible assets to firms and receive money assets instead. The tangible assets sold to firms are the supply of capital goods (S_K):

$$a = a_H + \frac{M}{p} = a_H + S_K. \tag{12.11}$$

How much real capital the households supply is due to their demand for deposits. This demand depends on the interest rate the deposits pay (i_D) and on the risk of inflation (r_I):

$$\frac{M}{p} = \frac{M}{p}(i_D, r_I). \tag{12.12}$$

The interest rate paid on deposits depends on the refinancing rate in a similar manner as the interest rate for loans does. As a consequence, the supply of capital goods depends on the demand for deposits, which in turn is a function (among other things) of the refinancing rate:

$$S_K = \frac{M(i_D(i_{ZB}), r_I)}{p}. \tag{12.13}$$

e Equilibrium

At this point, all the necessary aspects for a market equilibrium have been developed. On the one hand, there is demand for capital, which depends on effective demand, which in turn is a function of the refinancing rate. The demand for capital decreases with the refinancing rate $(\frac{dD_K}{di_{ZB}} < 0)$. On the other hand, the supply of capital goods also depends on the refinancing rate. The supply increases with an increasing interest rate $(\frac{dD_S}{di_{ZB}} > 0)$. The equilibrium condition is

[10] Deposits are divided by the price level in order to obtain their real value.

$$D_K = D_S, \tag{12.14}$$

$$\frac{K}{y}\frac{1}{s(i_{ZB})}C_A = \frac{M(i_D(i_{ZB}), r_I)}{p}. \tag{12.15}$$

It is important to keep in mind that this is not a market equilibrium, but an equilibrium that can be arrived by appropriate actions of the central bank, in particular by setting the equilibrium level of the refinancing rate.

The equilibrium on the market for capital goods is at the same time an equilibrium in the deposit market. The demand for capital goods by the firms is equal to the amount of loans they take from the bank. The supply of capital goods by the asset owners is equal to their demand for deposits. The banks therefore give out loans to the firms, and receive deposits in the same amount by the asset-owners.

f The determination of income and employment

The equilibrium in the capital goods market determines not only the amount of capital goods but subsequently also the level of income and employment. The level of income is determined by effective demand, which has been a central component for the equilibrium in the capital goods market. The levels of capital goods and income are therefore determined simultaneously. The level of employment is simply due to the labour coefficient, which is technologically given. The market equilibrium is therefore independent on the level of employment, which makes unemployment in the long run a possible case.

g Economic growth and economic policies

The theory depicts a "stationary state" (Betz, 2001, p. 67) and is therefore not a theory of economic growth. At the same time, Betz develops long-term economic policies that support economic growth, based on the above framework. Economic policies are argued to shift the demand and supply curves of capital goods. Thereby, different policies bring the economy to alternative long-term equilibria.[11]

The government is regarded as a market actor, whose influence – as with other market actors – is restricted by the actions of other actors and by the given market framework. For example, the central bank is restricted in its ability to increase effective demand by lowering the interest rate, because a lower interest rate at the same time decreases the supply of capital goods (as laid out above). An important restriction to governmental intervention is that governments have to take into account the impacts of their activities apart from the direct effects. In particular, the

[11] Original German quote: "alternative langfristige Gleichgewichte" (Betz, 2001, p. 85).

expectations of other market actors may be change, which also changes their behaviour (Betz, 2001).

Within this framework, Betz (2001) emphasizes five important areas of economic policies concerning the long-term equilibrium:

(a) The refinancing rate by the central bank is *not* an economic policy that is appropriate to influence the level of output. The reason is – as developed in detail above – that the central bank needs to set the refinancing rate at a level so that demand and supply of capital goods are in equilibrium.
(b) At the same time, the central bank can influence the long term equilibrium by pursuing policies that increase the demand for deposits, in particular by securing trust in the stability of the currency. Higher demand for deposits (instead of tangible assets) implies a larger supply of capital goods.
(c) Regarding fiscal policy, it is true – as in other Keynesian theories – that deficit spending increases effective demand and the level of production in the short run. In the long run, a higher public deficit decreases the equilibrium level of production, though. The reason is that large deficits force the government to use part of its tax revenues for interest payments instead of using it for other expenditures. This tends to have a redistributive effect towards higher income inequality and thereby decreases consumption demand. In terms of the model above, the demand for capital goods decreases.
(d) Finally, a larger public expenditure quota leads to a higher long term equilibrium, because it has redistributive effects towards lower income inequalities.

In sum: In order to achieve equilibria with high levels of production and employment (the explicit goals of economic policies as set by Betz), the government can aim to have low or no public debt and a high public expenditure quota. Both necessitate large tax revenues and lead to large demand for capital goods. Additionally, the central bank[12] can secure trust in the currency in order to increase the supply of capital goods.

12.2.2 The Theory and Economies Without Growth

In Betz's theory, the demand for capital goods is primarily determined by effective demand and the supply by dynamics on asset markets. The final goods market, the tangible assets/capital goods market and the deposits

[12] Betz (2001) argues the central bank needs to be public in order to fulfil its purposes

market are interlinked and together lead to equilibrium levels of capital goods, final goods and employment.

One answer to the conditions for zero growth is that the various determinants of these markets need to be in such relations that both effective demand and the level of capital goods stay constant over time. Regarding capital goods, this implies that the amount of capital goods supplied by asset holders at the beginning of the production period is equal to the amount of capital goods produced (assuming that capital goods are depreciated within one period). The equilibrium level on the capital goods market therefore has to be equal to capital depreciation.

By pointing out the factors appropriate to increase the equilibrium level of production, Betz (2001) implicitly indicates the factors that are important to arrive at such a situation with zero net investments. Assuming that usually the equilibrium level is above the level of capital depreciation, economic policies would need to be used to decrease the supply and/or demand for capital goods. Concretely, (1) the trust in the currency can be weakened so that the supply of capital goods decreases, (2) the public deficit can be increased in order to bring about higher income inequalities and lower demand and (3) the public expenditure quota can be reduced in order to increase inequalities. A certain combination of these economic policies would bring about zero growth.

Clearly, these economic policies do not lead to *sustainable* economies without growth, in the sense that they have low economic inequalities and are economically stable[13] Therefore, in the following, alternative economic policies are pointed out that are more likely to combine zero growth with low economic inequalities and economic stability.

Regarding the supply side of capital goods (referring to economic policy (1)), policies can be implemented that deter the supply of capital goods, without leading to economic instabilities. For example, the selling of capital goods from asset-owners to firms can be taxed, which would decrease the supply function of capital goods.

Regarding the demand side, policies (2) and (3) both refer to the role of income inequalities in determining effective demand. There is an apparent contradiction between low consumption demand and low income inequality in zero growth economies. But there are other determinants of consumption demand that can reconcile low demand and low income inequality. In general, preferences can change so that the consumption rate is lower. While the theory does not discuss determinants of the consumption rate other than income inequality, other theories do (see e.g.,

[13] The theory does not take into account environmental aspects, therefore the environmental dimension of sustainability is left out here.

section 2.3 for the role of conspicuous consumption or section 17.1 on the role of advertising).

Two further conditions for zero growth can be deduced from this theory. First, it follows that total tangible assets/capital goods[14] has to stay constant over time. Capital goods need to stay constant for a constant production level – as long as the capital coefficient does not change. The amount of tangible assets has to stay constant so that the supply of capital goods does not change – assuming given preferences of the asset-owners.[15]

Second, the interests earned by the holders of deposits need to be used for consumption (and not be saved) in order to generate a sufficient flow of money to firms, so that they can pay back the loans with interest. The reason is that money is created by loans. As the firms have to pay back the loan plus interest payments, they need to sell their products for an amount of money above the level of money they have received as loans and spent on production. The additional demand needs to come from the owners of deposits, who receive the interest payments.[16] This issue can only be foreshadowed within this theoretical framework, as a coherent accounting framework has not been developed. The issue is further analysed in the following two theories.

12.3 Binswanger: Growth Imperative and Growth Impetus

Hans-Christoph Binswanger[17] published several works on economic growth (Binswanger, 1991, 1994, 2012). In the book *The growth spiral* (2013)[18], he develops a detailed and comprehensive theory of economic growth.[19] Binswanger includes an exceptionally large number of macroe-

14 Total tangible assets are equal to the sum of tangible assets held by private owners as storage of value and of capital goods used by firms for production.

15 In principle, the amount of tangible assets held by private households could grow infinitely, while keeping the demand for deposits constant. This seems an implausible assumption though.

16 Note that another possibility is that some actors dissave or increase debts, as discussed in more detail in the following sections.

17 Hans-Christoph Binswanger is not to be confused with Mathias Binswanger, whose work on subject well-being has already been discussed in section 2.1.3.

18 It was originally published in German under the title *Die Wachstumsspirale* (2006a).

19 Regarding the question of which aspects of the following investigation are adopted from other studies and which are novel developments of the present work: The following illustration is based on Binswanger (2013). The model in section 12.3.1 is a reproduction of the existing model. The application

conomic aspects in the analysis. Usual factors such as aggregate demand and supply, technological change and innovative activities are part of the theory. But also environmental topics play an important role with a focus on the importance of energy for the production process. Two aspects are both particularly decisive for his theory and also relatively uncommon to put into the centre of economic growth theories. First, Binswanger emphasizes the role of money supply and in particular the necessity of an increasing money supply for continuous economic growth. Second, he introduces logical time into his analysis in an uncommon manner. It is decisive for the functioning of his model that different uses of money (money creation, payment of wages, consumption of goods, revenues of firms) take place in a certain order.

Binswanger's theory is of special relevance to the present work because it explicitly investigates the question of whether an economy can function without growth. His conclusion is that a minimal positive growth rate is necessary for a stable economy. When the economy does not grow, it necessarily transfers into a dynamic of continuous decline.

In the following, first Binswanger's theory is explained. It entails both a central cause for economic growth (the growth impetus) and an argument for why the economy must grow in order to not move into continuous decline (the growth imperative). Second, it is shown under what conditions zero growth can take place within his theory. Contrary to prior theories, central economic institutions (such as the type of business entities) need to change in order to facilitate zero growth.

12.3.1 The Theory

Binswanger (2013) first lays out a complex version of his theory textually. At the end of his book, he also develops a formal model on economic growth, which takes into account a lower number of economic mechanisms. Accordingly, the representation here is also divided into a textual and a formal part.

12.3.1.1 Binswanger's Textual Theory

Binswanger (2013) touches upon issues such as the role of the environment, energy, markets, imagination, inventive activities and many others. The following representation is focussed on what is argued to be at the core of his theory. The representation starts with Binswanger's general view on economic dynamics, followed by an explanation of the interplay between profits, money and time in the process of demand and supply.

of the model to zero growth in section 12.3.2 includes rearranging and recombining the equations of the existing model.

Third, the central reason for growth, the growth impetus is explained. Fourth, it is laid out why Binswanger argues that the economy needs to grow and cannot stagnate – the growth imperative.

a The general perspective on the economy

Binswanger's (2013) theory in many respects builds upon Keynesian but also Marxian contributions. The overall view is that there is an interplay between supply and demand. On the supply side, there are firms trying to maximize profits. Here, Binswanger stresses the importance of competition and the intention of entrepreneurs to increase profits by expansion, the introduction of new technologies, cost reductions etc. (and therefore uses typically Marxian arguments). Concerning demand, he stresses the importance of a sufficient demand in order for entrepreneurs to invest and expand production (and hence uses Keynesian arguments). Another typical Keynesian feature is the understanding of the monetary economy. As in Davidson's approach, investments require additional loans, which are endogenously created by private banks.

Three actors are central to the theory. (1) Firms need money capital[20] in order to buy production inputs (labour, natural resources and physical capital). Firms obtain money capital either from existing or new equity capital (usually by selling stocks) or from borrowed capital in form of bank loans. Firms receive revenues from selling goods. These are used to repay loans, pay dividends to stockholders and finance future production. (2) Banks give loans to firms, dependent on the firms' creditworthiness that is mainly due to their equity capital. The banks earn interest rates on loans. These are used to pay wages and dividends and to increase their equity capital. (3) Households sell labour to firms and banks. They receive wages in return. Additionally, they lend money to firms and banks by buying stocks. They also buy and consume the goods produced by the firms.

b Monetary expansion and profits

Binswanger (2013) argues that firms only produce when they expect to make a profit. Profits are the difference between firms' costs (payments for natural resources, wages and interest) and revenues due to the sale of products. The expectation to be able to make profits is based on the past experience. For the system to function smoothly, it is therefore necessary that a certain profit rate is usually met. In Binswanger's words: "Firms can

[20] While Binswanger uses the term capital, here sometimes the term *money capital* is used in order to stress the difference between money capital and *physical capital*. While the former refers to financial means that firms use to acquire production factors, the latter is a production factor itself. In the following, the terms *capital* and money capital are used synonymously.

only be founded when expectations for firm profits are positive, that is, the prospects of gain are higher than the risks of losses. Positive expectations result from past experience which has shown that, on average, gains have always been greater than losses" (Binswanger, 2013, p. 118).[21]

The creation of additional money over time is a necessity for firms to make positive profits on average: "As both earnings and expenditures of firms, and thus also their difference in form of profits, are the result of monetary transaction, it follows that positive profits accrue if more money is earned than spent. This can only be if there is a constant influx of money" (Binswanger, 2013, p. 118).[22] Firms demand additional money in order to expand production and this additional money is supplied by private banks (central banks only play a marginal role in Binswanger's theory).

c The sequence of the economic cycle

The activities of the three actors, demand and supply, the creation of additional money and the generation of profits take place according to the following logic. (1) Firms use money capital (coming from firms' savings and loans from banks) in order to acquire production factors. Therefore, firms take loans and money is transferred from firms to households in form of wages. (2) Firms produce and sell the products to households. (3) Firms pay back the loans with interest and pay dividends to their shareholders.

The economy grows because firms expand their money capital and expenditures from period to period. This expansion is facilitated by bank loans. It is caused by a drive of firms to expand due to the interests of shareholders, however.[23]

d The growth impetus

First, Binswanger argues that there is an inherent incentive for savings to be invested. Financial means that firms or households do not spend in one period can either be held as money, lent to a bank or invested in a firm. Lending it to a bank is more profitable than holding it as money, as it pays interest. Investing it in a firm is even more profitable than lending it to a bank, if the expected earnings (including risk) are higher than the interest rate. According to Binswanger, "[i]n the case of paper or bank money without an intrinsic value, failure to invest leads to a loss in value" (Binswanger, 2013, p. 122). The effect is that available financial means tend to be invested in firms.

[21] Note that this reasoning is very similar to Davidson's argumentation in section 12.1.

[22] This issue is discussed in more detail below.

[23] This process is also investigated in more detail below.

Second, he argues that there is an incentive for shareholders to not demand dividends from the firms but reinvest profits into the growth of the firm. The reason is that if the firm grows the capital value of the shares of the shareholder increases and this gain in value is larger than the gain from receiving dividends: “There is an impetus for growth, because an ongoing investment process does not only lead to an increase in current profits but also to an increase in the present value of shares in relation to the expected future profits” (Binswanger, 2013, p. 119).[24] Both mechanisms combined lead to a tendency of continuous investments as long as they can be profitable. What determines whether they are profitable is discussed in the next section.

e The growth imperative

The growth imperative depicts a necessity for the economy to grow. Firms need to make – on average – a minimal profit rate, otherwise they eventually go out of business:

> There is a growth imperative because, without a continuation of the investment process, that is an increase in capital investments, firms' profits would shrink continuously so that investors would no longer find it worth-while to bear the risks associated with their investments. In the end, they would no longer be willing to finance replacement investments so that the stock of capital and therefore also both production and the incomes of the households would decrease” (Binswanger, 2013, p. 119).

Binswanger further argues that the modern market economy would cease to exist and the economy would be in danger of becoming a barter economy:

> Shorter phases with a profit rate that falls short of the minimum required profit rate may be absorbed by the economy. But, if the shrinking growth process continues for a longer period of time and there is no prospect of the economy starting to grow again, production will collapse and the economy threatens to shrink to Robinson Crusoe level” (Binswanger, 2013, p. 145).

The reasoning for the growth imperative in Binswanger's (2013) theory is the following: As argued above, profits are the difference between firms' revenues and their expenditures. Firms' aggregate expenditures determine their own revenues though, as firms' expenditures determine household income, household income determines consumption and consumption is equal to firms revenues.

[24] For a more elaborate explanation of the growth impetus see (Binswanger, 2013, pp. 121 – 127).

Binswanger argues that profits are calculated by subtracting the expenditures from period 0 from the revenues of period 1. Therefore, in order to have positive profits, firms expenditures in period 1 need to be larger than in period 0 (larger expenditures in period 1 lead to higher income, consumption and therefore revenues, so that the revenues in period 1 are larger than the expenditures in period 0, which leads to positive profits). Due to this reasoning, the economy needs to grow in order to generate positive profits for firms.

While the overall argument can be laid out as briefly as has been done so above, the reasoning entails various additional assumptions necessary for the argument to hold. The creation of additional money is only necessary for the ability to make profits if it is assumed that not all revenues are paid as income to households (but some are withhold in order to be reinvested or to be accumulated as financial assets). In order to understand the reasoning in detail, in the following section Binswanger's formal model is explained.

12.3.1.2 Binswanger's Formal Model

Binswanger (2013) formalizes his growth theory at the end of the book. As in most formalizations, the theory looses complexity. At the same time, it allows for a detailed examination of his arguments and in particular the reasoning on the growth imperative.

a Capital and investments

Binswanger starts with the concept of (money) capital. His definition of capital is very different from others. Capital ($\varUpsilon_t$) is the "total amount [...] that the firms invest in order to purchase the production services" (p. 132). The total amount of capital is divided into the capital financed by equity capital ($\varUpsilon_t^E$) and borrowed capital ($\varUpsilon_t^B$):

$$\varUpsilon_t = \varUpsilon_t^E + \varUpsilon_t^B. \tag{12.16}$$

It is assumed that there is a given ratio between equity and borrowed capital ($\varPhi$):

$$\varPhi = \frac{\varUpsilon_t^B}{\varUpsilon_t^E}. \tag{12.17}$$

As argued above, in a growing economy in each period firms invest more than in the former period. The increase in capital between two periods is called investments.[25] Investments (I_t) are therefore defined according to

[25] Note that the term *investments* refers to a very different concept here than

$$I_t = \Upsilon_t - \Upsilon_{t-1}. \quad (12.18)$$

Investments (I_t) are divided into "investments of the firms financed by equity capital" (I_t^E) (p. 132) and "investments of the firms financed by borrowed capital" (I_t^B) (p. 133):

$$I_t = I_t^E + I_t^B. \quad (12.19)$$

The different parts of investments are determined by

$$I_t^E = \Upsilon_t^E - \Upsilon_{t-1}^E \quad \text{and} \quad I_t^B = \Upsilon_t^B - \Upsilon_{t-1}^B. \quad (12.20)$$

b Revenues, costs and profits
On the one hand, firms earn revenues ($\ddot{\text{Й}}_t$) by selling products to households. On the other hand, firms need to prefinance production. All forms of payments to households (wages, dividends) combined are the overall "production costs" (Э_t^F). Equivalently, banks pay income to their employees and stockholders – "the costs for bank transactions" (Э_t^B) (p. 133). These costs include wage payments as well as dividends.

Firms make profits (Π_t^F) when revenues are higher than costs. Binswanger argues that the profits of period t are the firms' revenues from period $t-1$ minus their costs from period $t-2$:

$$\Pi_t^F = \ddot{\text{Й}}_{t-1} - \text{Э}_{t-2}^F. \quad (12.21)$$

Total firm profits (Π_t^F) are divided into "the gain assigned to the equity capital (net profit)" (Π_t), and "the interest paid on the borrowed capital" (Ц_t) (p. 133):

$$\Pi_t^F = \Pi_t + \text{Ц}_t. \quad (12.22)$$

Profits to equity capital are further divided into a part that is paid as dividends (Щ_t) and a part that is reinvested (I_t^E):

$$\Pi_t^F = \text{Щ}_t + I_t^E + \text{Ц}_t. \quad (12.23)$$

in most other theories. Usually investments are the capital goods produced and implemented in a certain period.

The profit rate (p) is defined as[26]

$$p = \frac{\Pi_t}{\Upsilon^E_{t-1}}. \qquad (12.24)$$

It is assumed that the rate of interest (i) is determined by the central bank. The interest payments ($Ц_t$) are equal to the interest rate multiplied by the amount of borrowed capital (Υ^F_t):

$$Ц_t = i\Upsilon^F_t. \qquad (12.25)$$

Furthermore, it is assumed that banks pay a given fraction (b) of their revenues (interest payments) as dividends and wages to households. These dividends and wages are the costs of the banks ($Э^B_t$):

$$b = \frac{Э^B_t}{Ц_t}. \qquad (12.26)$$

c Household income

Households earn wages and dividends both from firms and banks. Hence, household income (Y_t) consists of the costs expenditures of firms ($Э^F_t$) and of banks ($Э^B_t$) plus the dividends from both ($Ш_t$):

$$Y_t = Э^F_t + Э^B_t + Ш_t. \qquad (12.27)$$

d Economic growth

Binswanger starts with the central point, how profits are determined. Recall equation 12.21

$$\Pi^F_t = Ӥ_{t-1} - Э^F_{t-2}.$$

Combining equation 12.21 with equations 12.17, 12.20, 12.22, 12.23, 12.24, 12.25, 12.26 and 12.27 and taking into account that $Э^F_t = \Upsilon_t$ yields

$$\Upsilon^E_{t-1} = \frac{[(1-br)\Phi - p]}{(1-i)\Phi - p}\Upsilon^E_{t-2}. \qquad (12.28)$$

26 Note that it is not the ratio between profits and capital, but between profits to equity capital and equity capital. This definition differs from other theories.

Binswanger further introduces the growth rate of equity capital that is defined as

$$g^E = \frac{(\Upsilon^E_{t-1}) - (\Upsilon^E_{t-2})}{\Upsilon^E_{t-2}}. \tag{12.29}$$

Including 12.28 in 12.29 yields

$$g^E = \frac{(1-b)i\Phi}{\Phi - p - i\Phi}. \tag{12.30}$$

This is a very central equation within Binswanger's theory.[27] It shows that the growth rate of equity capital (g^E) is in a certain relation to four aspects:

1. The ratio b between banks revenues due to interest earnings and their expenditures on wages and dividends ($b = \frac{Э^B_t}{Ц_t}$). b is per definition between 0 and 1, with 1 meaning that banks pay all their revenues to households in some form. The larger b, the larger is the amount of money that stays in the banking sector and does therefore not contribute to consumption demand.
2. The interest rate (i). The larger the interest rate, the larger the payments are to banks and therefore also (for given value of b) the amount of money that is not used for consumption demand;
3. The proportion between borrowed and equity capital (Φ).
4. The profit rate of equity capital ($p = \frac{\Pi_t}{\Upsilon^E}$).

e The growth imperative

According to Binswanger it is possible to deduce from equation 12.30 that the growth rate *must be positive*. This result depends on three arguments. First, b must be smaller than one, because "the banks must make a profit in order to stay in business" (Binswanger, 2013, p. 139). Note that this profit is additional to the dividends paid to the owners of banks. Second, the interest rate (i) must be greater than zero, because "[t]he banks will only grant loans if they receive interests" (p. 139). Third, the enumerator is argued to be above zero ($\Phi - p - id > 0$). This implies that the capital that is invested in one period is larger than the profits (made in the prior period) and the interest payments combined. In Binswanger's own words: "the borrowed capital of firms [Υ^E_{t-1}], which is invested in the period $t-1$ [...], must be higher than the profit at the beginning of the period t that

[27] It is important to note that equation 12.30 implies no causal relationship but represents a relationship between the parameters that needs to hold per definition within Binswanger's (2013) theory.

remunerates the use of equity capital, plus the interest that is owed for the investment of borrowed capital during the period $t-1$" (p. 141).

12.3.2 The Theory and Economies Without Growth

Binswanger's theory takes a special role for the present investigation because it explicitly argues that zero growth is not possible within the current economic system. In the following, it is first discussed what conditions prevent the growth imperative. Afterwards, the necessary conditions to avoid the growth impetus are developed. In both cases, it is found that according to Binswanger's theory zero growth necessitates strong changes of economic institutions.

12.3.2.1 Conditions for the Absence of a Growth Imperative

The first condition for zero growth in Binswanger's theory is that investments are equal to zero. In the prior Keynesian theories, a condition for zero growth was that net investments are equal to zero so that gross investments remain positive. As long as the capital coefficient stays constant, zero net investments are necessary for a constant production level (assuming a constant capacity utilization over time). This is not the case in Binswanger's theory, because investments mean something different here. He defines investments as the increase in *money capital* between two time periods. This money capital is per definition equal to the size of production, however. Therefore, a zero growth economy requires money capital in period 0 to be equal to money capital in period 1 ($\varUpsilon_t = \varUpsilon_{t-1}$). In terms of equation 12.18 the condition is

$$I_t = 0. \tag{12.31}$$

Depreciation of physical capital is not part of Binswanger's model. It can be easily argued though that part of the money capital is used for the replacement of depreciated physical capital, so that the stock of physical capital stays constant, albeit investments (in Binswanger's sense) are zero. Whether the condition of zero investments is compatible with a stable economy within Binswanger's analysis depends on the feasibility of the second condition.

The subsequent second condition is that all profits are paid as dividends. This condition follows directly from the first. In Binswanger's model profits can either be paid as dividends or used for investments. As investments need to be zero, all profits have to be put as dividends. Therefore, equation 12.23 changes to

$$\Pi_t^F = Ш_t + Ц_t. \tag{12.32}$$

It is not entirely clear from reading Binswanger's (2013) analysis whether this condition contradicts his understanding of what is necessary for a stable economy. He points out at various occasions that profits are necessary to compensate firms for the risk they take to produce: "In order to compensate this risk, the investors require a return in the form of profit or interest" (p. 129). Therefore, there is a "minimum profit rate" (p. 136) that is necessary to induce firms to produce. The existence of profits do not contradict a zero growth economy though, as long as they are paid out as dividends. At other occasions it seems though that in Binswanger's eyes, the ability to reinvest is necessary for firms to produce: "The modern economy is based upon the continuous generation and reinvestment of profits. Shareholders will only invest if they can expect to achieve a minimal profit covering the investment risk" (p. 136). He does not elaborate on why the ability to pay dividends does not suffice as an incentive to produce. While this second condition therefore seems to contradict Binswanger's opinion, his justification brought forward for the contradiction is not convincing.

The third crucial condition for a zero growth economy is that all profits in the banking sector are also paid as dividends instead of being accumulated. When profits are paid as dividends, they are used for consumption (per assumption). The entire money earned by the banking sector is used for consumption, so that "[t]he rate at which money is removed from circulation" is equal to zero. In the model this is depicted by setting $b = 1$, as Rosenbaum (2015) suggests: In a non-growing economy, "banks do not have to increase their equity" and hence "the Binswanger models allows stable zero growth" (p. 644).[28] Equation 12.30 becomes

$$g^E = 0. \tag{12.33}$$

Whether this condition contradicts Binswanger's (2013) analysis refers to a similar aspect as for the second condition. Banks would need to be willing to pursue their enterprise without reinvesting part of their revenues and instead spend their entire revenues on wages and dividends. Again, it can be argued that the ability to pay wages to employees and dividends to shareholders is likely to suffice as incentive to stay in business. Binswanger seems to be of a different opinion though, as he argues that "[t]he banks must make a profit in order to stay in business so that $b < 1$" (p. 139). The confusion arises from the assumption of Binswanger (2013) that "equity capital of the banks must to a certain extent keep pace with the increase

[28] Rosenbaum (2015) refers to the model developed by Mathias Binswanger (2009), but the underlying mechanism is the same.

in debt (p. 131)". At the same time, he tends to model it "such that banks equity capital has to increase even if debt does not" (Richters and Simoneit, 2017, p. 12). In other words: There is no reason why equity capital of banks needs to grow in a zero growth economy.[29]

Overall, Binswanger's (2013) analysis suggests that a zero growth economy requires firms that use the same amount of money capital over time. In order for firms to at the same time make profits, it is necessary that they spend all their revenues on wages and dividends (and not on investments in the future). Additionally, banks need to spend all their revenues on wages and dividends as well (and must not accumulate wealth).[30] It is noteworthy that these results are similar to the results from the investigation of Keynes' theory (see section 11.1).

Binswanger argues that these conditions are incompatible with continuous economic activity of firms and would lead to perpetual shrinkage. On the contrary, it has been argued though that Binswanger's reasoning is not convincing. There is no clear reason why firms and banks should go out of business or at least reduce their activities when they are able to pay for costs and make profits that they use for dividends. Whether it is likely that they confine themselves to not expand their production, is a different question though and discussed in the next section.

12.3.2.2 Zero Growth and the Growth Impetus

The central question therefore is under what conditions firms choose to not invest and banks decide to disburse all revenues. The question is first investigated for firms and subsequently for banks.

There are two central reasons for firms to reinvest part of their profits within Binswanger's analysis. First, Binswanger emphasizes the impetus to invest due to shareholder interests as explained above. The second major reason is market competition, which forces firms to invest in more efficient and larger production facilities in order to stay (price) competitive. As the second argument is not discussed in detail by Binswanger, and as it is covered in part IV, here it is focussed on the first.

29 There is an alternative condition to this third condition. If $b < 1$, assets accumulate in the banking sector. But assets of one sector always imply liabilities in another. Therefore, an accumulation of assets in the banking sector requires a simultaneous accumulation of debts in another sector, for example the government. This issue is taken up in section 12.4, because there the necessary analytical tools are developed.

30 How exactly banks need to be constituted and regulated for this to be implemented, lays outside the scope of this work. Possible points to start are financial regulations and the ownership of banks. As to my knowledge, their is very little research on this question, this issue depicts a large field for future research.

Shareholders have an interest in profits being reinvested instead of receiving dividends. The reason is that reinvestments lead to larger increases in the shareholders' wealth. However, this mechanism depends on the business type. Binswanger assumes that the economy consists of firms that are driven by the maximization of their *shareholder-value*. Firms are owned by shareholders whose sole interest is to maximize the value of their shares. But as argued in section 3.6, different business types lead to different entrepreneurial behaviour. While the mechanism described by Binswanger applies to shareholder-driven firms, it applies less so to other business types. Advocates of economies without growth argue in particular for business types that are collectively owned or are legally not allowed to make profits. In such firms, the incentive to reinvest due to an increase in the value of the firm is often less strong or not existent (Reichel, 2013). Based on Binswanger's analysis, a central condition for a zero growth economy is therefore that firms are not shareholder driven but have a constitution that does not push for the continuous reinvestment of profits.

In sum, according to Binswanger's theory, some crucial economic institutions need to change. Firms' incentive to invest in expanding production needs to be prevented. One central mechanism, the shareholder interest, can be addressed by introducing other business types. Other mechanisms, most importantly market competition, have not been addressed here (this is done in part IV). The question how banks can be kept from accumulating wealth has not been possible to be answered on basis of Binswanger's theory.

12.4 Godley and Lavoie: Stock-Flow Consistent Models

Stock-flow consistent models have become very popular and influential among Keynesian economists in recent years. According to Caverzasi and Godin (2015) the approach goes back to Copeland (1949). Important figures in the development of the framework were James Tobin (Backus et al., 1980; Tobin, 1982), Wolfgang Stützel (1958) and in particular Wynne Godley (Godley, 1996, 1999, 2012; Godley and Shaikh, 2002, among others). He and Marc Lavoie recently published the book *Monetary economics* (Godley and Lavoie, 2012), "which is still the main reference for current PK-SFC practitioners" (Caverzasi and Godin, 2015, p. 162).[31]

[31] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is also based on this book and in particular on the culmination of the book's analytical framework in

12.4.1 The Theory

The basic set up of the theory has many similarities with prior Keynesian theories. Households sell labour to firms and receive wages in return. They hold assets at banks and receive the corresponding interest payments. Banks lend money to firms for production. The logic of the dynamics of the economy are similar to other approaches, but not the same. Firms produce what they expect to sell. This leads to a certain level of employment and wages. As wages are an important determinant of aggregate demand, the firms therefore to some degree generate the demand they need (similar to prior theories). Additional to wages, in this theory the development of wealth also influences consumption. Wealth develops dependent on a variety of interest payments and changes in the value of assets. There is a large number of determinants of the development of wealth (and subsequently consumption) that cannot be controlled by firms.

Government spending is of central importance regarding economic growth. It is, in addition to consumption, the second important determinant of aggregate demand. As will be seen below, the development of government spending is the central force determining the rate of economic growth.

The key feature of the approach (compared to other theories) is however that it follows a rigorous accounting method. In this manner, each asset has a corresponding liability and each monetary inflow has a corresponding outflow. For example, public debt (a liability of the government) implies at the same time that other economic actors – such as firms, banks and individuals – must hold the same amount in bills and bonds. An example for a monetary inflow are the numerous interests on assets. While each of them is an inflow (mostly to households), they also need to be paid by someone (mostly firms, banks and the government).

This approach has several advantages. First, the rigorous framework facilitates the development of a comprehensive theory of monetary relations as it guarantees the model to be coherent (it is not possible to overlook the other side of an asset or inflow). Second, it allows for a much more complex simulation of the economy. A large number of assets, liabilities, inflows and outflows is included and due to the clear framework, it is possible to examine the interactions between them.

The advantage of complexity signifies at the same time a disadvantage as well. Due to the model's complexity, it can only be simulated with the help of computer software. Therefore, it becomes difficult to clearly under-

chapters 10 and 11. The model in section 12.4.1 is a reproduction of the existing model. The application of the model to zero growth in section 12.4.2 includes an interpretation of the model's equations.

stand all the interconnections. As a result, it is (1) difficult to present the model in a short summary and (2) challenging to work out the conditions for zero growth.

The following approach is taken in order to respond to this situation. The theory is explained in three steps. First, the different stocks of the economy are laid out. Second, the different flows are described. Third, the determination of the level of production and economic growth is explained qualitatively. This approach also implies that many of the interconnections entailed in the model are not presented here.[32]

12.4.1.1 Stocks

In the model, all actors hold financial stocks – assets and liabilities. They are divided into seven types: (1) inventories (real assets), (2) high powered money (HPM, central bank money including cash), (3) checking deposits (liquid deposits generated by and held at private banks), (4) time deposits (deposits at private banks that can only be withdrawn at a set date or with prior notice), (5) bills (short-term securities sold from the government to households and banks), (6) bonds (long-term securities sold by the government to households and whose value changes over time), (7) loans (given by banks to firms).

Table 12.1: Balance Sheet Matrix

	(a) HH	(b) Firms	(c) Gov.	(d) CB	(e) Banks	Sum
(1) Inventories		$+И$				$+И$
(2) HPM	$+H_h$			$-H$ $+Ж$	$+H_b$ $-Ж$	0
(3) Checking deposits	$+M1_h$				$-M1$	0
(4) Time deposits	$+M2_h$				$-M2$	0
(5) Bills	$+Ъ_h$		$-Ъ$	$+Ъ_{cb}$	$+Ъ_b$	0
(6) Bonds	$+Ь_h \cdot P_Ь$		$-Ь \cdot P_Ь$			0
(7) Loans		$-З$			$+З$	0
(8) Balance	$-Д$	0	$+Л$	0	0	$-И$
Sum	0	0	0	0	0	0

Adapted from Godley and Lavoie (2012, p. 315).

[32] For a full elaboration, see Godley and Lavoie (2012), chapters 10 and 11.

There are five central actors in the model, with specific assets and liabilities (table 12.1 gives an overview over the assets and liabilities as explained above):

(a) Households hold various forms of assets: high powered money/cash ($+H_h$), checking deposits ($+M1_h$), time deposits ($+M2_h$), bills ($+Ъ_h$) and bonds ($+Ь_h \cdot P_Ь$). These assets sum up to the households' wealth ($-Д$).
(b) Firms own inventories ($+И$) and owe loans ($-З$) to banks.
(c) The government owes bills ($-Ъ$) to households, the central bank and banks. It owes bonds ($-Ь \cdot P_Ь$) to households. These liabilities add up to the total government debt ($+Л$).
(d) The central bank owes high powered money ($-H$) in form of cash to households and in form of central bank money to banks. At the same time, they hold their advances made to private banks ($+Ж$) as assets. Additionally, they hold bills from the government ($+Ъ_{cb}$).
(e) (Private) banks hold as assets central bank money $+H_b$, bills from the government ($+Ъ_b$) and loans given to firms ($+З$). Their liabilities are the advances from the central bank ($-Ж$), checking deposits ($-M1$) and time deposits ($-M2$).

The balance sheet matrix provides an understanding of the *stocks* of the different economic actors: "Constructing the balance sheet matrix, which deals with asset and liability stocks, will help us understand the typical financial structure of a modern economy" (Godley and Lavoie, 2012, p. 25).

12.4.1.2 Flows

There are various monetary flows between the actors. Each flow connects two stocks of two different actors (in some occasions several flows are combined below, so that more than two actors and two stocks are involved). The flows represent the different mechanisms that take place in the economy. There are twenty types of monetary flows. They stand for twenty mechanisms and corresponding monetary transfers in the economy as depicted by the model (table 12.2 summarizes these different mechanisms and corresponding flows):

(1) Consumption: Households buy products (C) from firms.
(2) Government expenditures: The government buys products (G) from firms.
(3) Change in inventories: Firms use up or accumulate inventories ($\Delta И$).
(4) Sales taxes: Firms pay taxes ($Б$) to the government.
(5) Wages: Firms pay wages (W) to households.

(6) Entrepreneurial profits: Firms transfer their profits (Π_f) to households.
(7) Bank profits: Banks transfer their profits (Π_b) to households.
(8) Central bank profits: Central banks transfer their profits (Π_{cb}) to the government.
(9) Interest on central bank advances: Banks pay interest to the central bank ($i_{\text{Ж}_{-1}} \cdot \text{Ж}_{-1}$)[33] on the advances the central bank made to them.
(10) Interest on bank loans: Firms pay interest to banks ($i_{\text{З}_{-1}} \cdot \text{З}_{-1}$) on the loans they receive from banks.
(11) Interest on deposits: Banks pay interest to the households ($i_{M-1} \cdot M2_{-1}$) on the deposits they hold in the banks' accounts.
(12) Interest on bills: The government pays interest ($i_{\text{Ъ}_{-1}} \cdot \text{Ъ}_{-1}$) to the holders (households, central bank, banks) of bills.
(13) Interest on bonds: The government pays interest (Ь_{h-1}) on bonds to households.
(14) Changes in central bank advances: The banks can change the amount of advances ($\Delta\text{Ж}$) from the central bank.
(15) Changes in bank loans: Firms can change the amount of loans ($\Delta\text{З}$) they take from banks.
(16) Changes in cash holdings: Households and banks can alter their holdings of high powered money from the central bank (ΔH).
(17) Changes in checking deposits: Households can change the amount of checking deposits they hold at banks ($\Delta M1$).
(18) Changes in time deposits: Households can change the amount of time deposits they hold at banks ($\Delta M2$).
(19) Changes in the amount of bills: The government can change the amount of bills issued ($\Delta\text{Ъ}$), which can be bought by households, the central bank and banks.
(20) Changes in the amount of bonds: The government can change the amount of bonds issued ($\Delta\text{Ь}_h \cdot P_{\text{Ь}}$), which are held by households.

The *transactions matrix* in table 12.2 is in addition to the balance sheet matrix the second central table in stock-flow consistent models.

[33] The subscript -1 indicates the previous time period.

Table 12.2: Transactions Matrix

			Households	Firms		Government	Central Bank		Banks		Sum
				Current	Capital		Current	Capital	Current	Capital	
(1)	Consumption		$-C$	$+C$							0
(2)	Government expenditures			$+G$		$-G$					0
(3)	Δ in the value of inventories			$+\Delta\text{И}$	$-\Delta\text{И}$						0
(4)	Sales tax			$-\text{Б}$		$+\text{Б}$					0
(5)	Wages		$+W$	$-W$							0
(6)	Entrepreneurial profits		$+\Pi_f$	$-\Pi_f$							0
(7)	Bank profits		$+\Pi_b$						$-\Pi_b$		0
(8)	Central bank profits					$+\Pi_{cb}$	$-\Pi_{cb}$				0
(9)	Interest on	advances					$+i_{\text{Ж}_{-1}} \cdot \text{Ж}_{-1}$		$-i_{\text{Ж}_{-1}} \cdot \text{Ж}_{-1}$		0
(10)		loans		$-i_{\text{З}_{-1}} \cdot \text{З}_{-1}$					$+i_{\text{З}_{-1}} \cdot \text{З}_{-1}$		0
(11)		deposits	$+i_{M-1} \cdot M2_{-1}$						$-i_{M-1} \cdot M2_{-1}$		0
(12)		bills	$+i_{\text{Ъ}_{-1}} \cdot \text{Ъ}_{h-1}$			$-i_{\text{Ъ}_{-1}} \cdot \text{Ъ}_{-1}$	$+i_{\text{Ъ}_{-1}} \cdot \text{Ъ}_{cb-1}$		$+i_{\text{Ъ}_{-1}} \cdot \text{Ъ}_{b-1}$		0
(13)		bonds	$+\text{Ь}_{h-1}$			$-\text{Ь}_{h-1}$					0
(14)	Change in the stocks of	advances						$-\Delta\text{Ж}$		$+\Delta\text{Ж}$	0
(15)		loans			$+\Delta\text{З}$					$-\Delta\text{З}$	0
(16)		cash	$-\Delta H_h$					$+\Delta H$		$-\Delta H_b$	0
(17)		checking deposits	$-\Delta M1$							$+\Delta M1$	0
(18)		time deposits	$-\Delta M2$							$-\Delta M2$	0
(19)		bills	$-\Delta\text{Ъ}_h$			$+\Delta\text{Ъ}$		$-\Delta\text{Ъ}_{cb}$		$-\Delta\text{Ъ}_b$	0
(20)		bonds	$-\Delta\text{Ь}_h \cdot P_{\text{Ь}}$			$+\Delta\text{Ь}_h \cdot P_{\text{Ь}}$					0
(21)	Sum		0	0	0	0	0	0	0	0	0

Adapted from Godley and Lavoie (2012, p. 316).

12.4.1.3 Aggregate Supply and Demand

The level of production is determined by the interplay between aggregate supply and demand. The argumentation starts with a decision of firms to produce. The level of production depends on expected sales and changes in inventories. Firms' decisions influence the level of household income via the wage bill. Household income combined with government expenditures determine aggregate demand, which sets the firms' actual (contrary to the expected) sales. The actual sales subsequently influence the change in inventories, as firms keep the unsold goods in storage. Thereby, the production of the next period is influenced and the economic cycle begins anew.

a Aggregate supply

The analysis starts with the decision of firms to produce a specific amount of goods (y). The prime determinant for their decision is how many they expect to sell (expected sales, $ч^e$). Additionally, it is assumed that firms want to hold a specific amount of inventories (planned inventories, $и^e$). The difference between the actual inventories ($и_{-1}$) and the desired level of inventories ($и^e$) are the second determinant of the production level:

$$y = ч^e + (и^e - и_{-1}). \tag{12.34}$$

Expected sales depend on the expected and realized sales of the last period:[34]

$$ч^e = \beta ч_{-1} + (1 - \beta) ч^e_{-1}. \tag{12.35}$$

The planned level of inventories ($и^e$) depends on the existing inventories ($и_{-1}$) and the "long-run targeted inventories" ($и^T$) (Godley and Lavoie, 2012, p. 319):[35]

$$и^e = и_{-1} + \gamma(и^T - и_{-1}). \tag{12.36}$$

The long-run targeted inventories depend on the "target inventories to sales ratio" (η^T) and the expected sales:

$$и^T = \eta^T ч^e. \tag{12.37}$$

[34] β determines the relative importance of expected and realized sales in influencing expected sales.

[35] γ determines the relative importance of planned and existing inventories in influencing long-run targeted inventories.

The target inventories to sales ratio depends on the two parameters η_0 and η_1 and the "nominal rate of interest on loans" ($i_{З}$) (p. 319):

$$\eta^T = \eta_0 - \eta_1 i_{З}. \tag{12.38}$$

Nominal sales (Ч) are equal to real sales (ч) multiplied by the price level (P):[36]

$$\text{Ч} = \text{ч} P. \tag{12.39}$$

In sum, aggregate supply is primarily determined by the sales of the past and the interest rate that determines the opportunity costs of holding inventories. Additionally, several behavioural parameters influence the level of production.

b Aggregate demand

Aggregate demand determines the actual sells of firms (ч). Aggregate demand consists of consumption (ф) and government expenditures (е):

$$\text{ч} = \text{ф} + \text{е}. \tag{12.40}$$

b.1 Consumption

The level of consumption depends on the level of expected income and on the level of wealth. Realized households disposable income (Y_r) is composed of profits (Π), wages (W), interest payments due to holdings of deposits ($M2_h$), bills (Ъ_h) and bonds (Ь_h). Profits consist of profits from firms (Π_f) and profits from banks (Π_b). The wage bill (W) is given by the amount of employment (L) and the wage level (w): $W = Lw$.[37] Interest payments from deposits depend on the amount of deposits ($M2_{h-1}$) and their interest rate (i_{M-1}). Interest payments from bills depend on the amount of bills (Ъ_{h-1}) and their interest rate ($i_{\text{Ъ}-1}$) and interest on bonds are Ь_{h-1}. Therefore, income is determined according to

$$Y_r = \Pi_f + \Pi_b + W + i_{M-1} M2_{h-1} + i_{\text{Ъ}-1} \text{Ъ}_{h-1} + \text{Ь}_{h-1}. \tag{12.41}$$

Income can also be expressed in real terms. The "realized real regular income" (p. 322) is

[36] Godley and Lavoie (2012) also include a determination of the price level and inflation. This is left out here, in order to keep the analysis simpler.

[37] The level of employment is determined by the level of production and an exogenously given labour productivity.

$$y_r = \frac{Y_r}{P} - \pi\frac{Д_{-1}}{P}. \tag{12.42}$$

Finally, it is necessary to determine the expected income, as it is decisive for consumption behaviour. It is determined by the expected (y^e_{r-1}) and the realized (y_{r-1}) income of the past:[38]

$$y^e_r = \varepsilon y_{r-1} + (1-\varepsilon)y^e_{r-1}. \tag{12.43}$$

The change in wealth held by households is equal to their incomes minus spending (consumption):[39]

$$\Delta Д = Y - C. \tag{12.44}$$

Real wealth is given by

$$д = \frac{Д}{P}. \tag{12.45}$$

Consumption depends on expected income and the level of wealth. Real consumption depends on the expected real disposable regular income (y^e_r), the size of real wealth ($д_{-1}$) and some parameters ($\alpha_{0,1,2}$):

$$c = \alpha_0 + \alpha_1 y^e_r + \alpha_2 д_{-1}. \tag{12.46}$$

Overall, consumption therefore depends on the development of income in the past and the level of wealth (which in turn is determined by the prior wealth and income of the past). Additionally several behavioural parameters play a role.

b.2 Government expenditures

Government expenditures (e) are exogenously given. Nominal government expenditures are

$$G = \mathrm{e}P. \tag{12.47}$$

b.3 A summary

The level of consumption and government expenditures determine actual

[38] ε determines the relative importance of former expected and realized income in influencing expected income.

[39] Godley and Lavoie (2012) work with slightly different equations for income at this point of the argumentation. This does not change the argument at hand though.

sales. These define the change in inventories and influence the expected sales for the next period. Subsequently, aggregate supply of the next period is determined, which in turn influences income and wealth of the next period, leading to a specific level of actual sales, and so on. There are various additional factors influencing the exact development of the economy. For example, the behaviour of various economic actors (individuals, banks, central bank) influences the several interest rates, which impacts the distribution of wealth.

12.4.1.4 The Level of Production and Economic Growth

Godley and Lavoie (2012) argue that "the model has a well defined stationary steady state to which it will tend if all the exogenous variables are held constant" (p. 342).[40] It is argued that in the stationary state, all stocks and flows are constant. This includes the stock of government debt, so that government inflows and outflows have to be of equal size. Government outflows are the sum of government expenditures (G), interest spending on bills ($i_{Ъ}Ъ$) and bonds (Ь). They need to be equal to inflows, which are due to taxes (Б):

$$G + i_{Ъ}Ъ + Ь = Б. \tag{12.48}$$

Total taxes depend on the sales tax (τ) and entire sales (Ч):

$$Б = \tau(Ч - Б) = Ч\frac{\tau}{1+\tau} = чP\frac{\tau}{1+\tau}. \tag{12.49}$$

In the stationary state, output is equal to sales ($y = ч$), so that equations 12.48 and 12.49 can be combined to

$$y* = (G + i_b Ъ + Ь)\frac{1+\tau}{P\tau}. \tag{12.50}$$

The stationary state level of production ($y*$) therefore primarily depends on the (exogenously given) level of government expenditures, the level of public debt and the tax rate.

Government expenditures also play an important role for the rate of economic growth. In the growth model by Godley and Lavoie (2012, chapter 11), economic growth is based on three aspects. First, labour productivity increases exogenously given by a certain percentage each year.

40 Richters and Simoneit (2017) argue that whether a stationary state exists in stock-flow consistent models depends on the parameter combination, in particular those determining savings (out of wages, profits and wealth).

Second, in order to keep the model in an equilibrium development, government expenditures need to increase by the same percentage. In this manner, unemployment is prevented. Third, firms' investments adjust to the additional demand from government expenditures. Instead of paying their entire profits to their shareholders, firms retain part of the profits and use it for investments. The amount of retained profits and of investments depends on the level of capacity utilization and on the interest rate.

12.4.2 The Theory and Economies Without Growth

In their book Godley and Lavoie (2012) develop several stock flow consistent models. All but the last (chapter 11) depict a stationary state with zero growth (for certain parameter values). Within these models, the conditions for zero growth economies are therefore already developed. Hence, the central conditions for zero growth within this framework are to be found in the differences between the models without and the model with growth. As pointed out above, three conditions are central for an economy with steady growth rates: increases in labour productivity, an equivalent growth in government expenditures and firms that respond to increasing demand by retaining profits in order to reinvest.

There are three central conditions for zero growth, which correspond to the conditions for growth: Labour productivity needs to stay constant, government expenditures must not change and firms need to respond to these conditions by paying all profits to their stakeholders, so that firms do not reinvest (capital depreciation is not taken into account in the model). This set of conditions to some degree correspond to the second scenario as pointed out in chapter 4 and to the second and third neoclassical scenarios in chapter 9. The type of technological change needs to change in order to prevent increases in labour productivity. As effect, no economic growth is necessary to prevent unemployment.

The first scenario from chapter 4 is that increases in labour productivity are balanced out by an equal reduction in working hours. As long as this reduction goes along with an increase in the wage rate, so that the wage bill stays constant, this is compatible with zero growth within the stock-flow consistent model, as well.

The analysis of the theory of Godley and Lavoie (2012) leads to another important insight concerning the conditions for zero growth. It shows that the existing monetary system is compatible with zero growth. The inclusion of monetary aspects and a financial system does not lead to an instability in the system with zero growth. In particular it shows that the two central arguments regarding supposed instabilities of the monetary system in zero growth economies do not have to hold. First, firms are able to make profits despite an absence of growth. Table 12.2 entails positive firm profits also in a stationary state. Second, a zero growth economy is compatible with positive interest rates. Table 12.2 entails various interest payments, whose positive values do not necessarily lead to changes in the stocks in table 12.1.

In both instances, stability requires one condition: No group of economic actors (households, firms, the government, the central bank or private banks) may accumulate assets continuously. Such a continuous increase in assets requires an equivalent accumulation of liabilities of another group of actors as can be seen in table 12.1. Because increasing liabilities lead to bankruptcy at some point, such a development has to be prevented in order to guarantee economic stability in a zero growth economy.

The framework of Godley and Lavoie (2012) also contradicts the result of Binswanger's theory in section 12.3 that monetary expansion is necessary for firms to make profits. In the models of stationary state (including zero growth), firms and banks do make profits. These are paid as capital incomes though and can therefore be used for consumption.[41] This matches the argument made in section 12.3 that banks' profit need to be paid to households ($b = 1$) and that firms must not use profits for reinvestments ($I_t = 0$).

A major difference between the models without and with economic growth in Godley and Lavoie (2012) is exactly this issue, namely whether profits are retained by firms and are reinvested. According to Godley and Lavoie (2012) in the models without growth, "producing firms and

[41] The other possibility, already mentioned in section 12.3, is that the accumulation of assets in the banking sector is accompanied by the continuous increase in debt of another sector. This point can be elaborated by use of tables 12.1 and 12.2. It is assumed that the banking system does not disburse all revenues as wages or dividends. Hence, inflows are larger than outflows in the banking sector (see table 12.2, columns on the banking sector). Banks use these to buy bills from the government sector and therefore accumulate assets (see table 12.1). Household income is lower than if all revenues had been disbursed to them. Consumption is therefore lower than it otherwise had been (see figure 12.2 column for households). This lack in consumption can be compensated by an increase in government expenditures (figure 12.2 column for government). As result, the government experiences increasing liabilities (figure 12.1 column for government) that are equivalent to the accumulation of assets in the banking sector. While this is theoretically possible, it is likely to lead to the bankruptcy of the government at some point. Compared to a growing economy, government bankruptcy takes place for lower levels of absolute public debt, when the solvency of governments depends – as usually argued – on the level of overall production.

banks distribute all of profits and have no retained earnings. [...] These important features of the real world are introduced in the growth model [...] since retained earnings, for instance, are a major characteristic of a growing corporate economy" (p. 374). In a zero growth economy, such retained earnings need to be zero, in order to keep investments zero (or low in case capital depreciation is taken into account).

The model of Godley and Lavoie (2012) shows that *if* (1) the retained earnings are zero (or equal capital depreciation), (2) the labour productivity does not increase (or is countervailed by labour hours reduction) and government expenditures stay constant, zero growth takes place. As for Binswanger's theory, the question under which circumstances these conditions can be implemented remains unanswered though. In fact, Godley and Lavoie (2012) themselves argue that usually firms reinvest, governments increase expenditures over time and labour productivity rises. The theories in part IV deliver more insights into why this is the case.

12.5 Results and Discussion

12.5.1 Summary of Conditions

The results of the monetary keynesian theories are in many respects similar to those of the fundamental keynesian theories of the previous chapter. At the same time, they shed new light on economies without growth regarding four issues.

12.5.1.1 Aggregate Demand and Expectations

All theories of this chapter especially emphasize the importance of expectations for firms' behaviour. Whether and to what extent firms increase production depends primarily on whether they *expect* to be able to sell additional products and make profits. Whether the expectations are high or low depends on past experiences changes in inventories and animal spirits.

Hence, in a zero growth economy, firms need to expect that production stays constant. The central condition for this is to keep household consumption and government spending constant. Such constant aggregate demand would shape firms' experiences and thereby their expectations for the future. Governments can foster this process by additionally announcing such behaviour.

12.5.1.2 Monetary Flows

In the theory by Godley and Lavoie it has been shown that monetary flows can be balanced in an economy with zero growth. This is the case, when all economic actors have inflows and outflows of equal size. Regarding Binswanger's analysis, this in particular signifies that firms and banks need to disburse all their profits. Firms must not retain profits as they are likely to use them to expand production. Banks have to disburse their entire revenues, because otherwise they would continually accumulate assets and the financial means are missing for consumption demand.

If some actor does accumulate assets (has higher inflows than outflows) over longer time periods, another actor needs to accumulate debt (have higher outflows than inflows). This situation is in principle also compatible within a zero growth economy. It is likely to lead to the bankruptcy of the indebted actor, though. For example, the government is more likely to bankrupt in a zero growth than in a growing economy when it accumulates debt.

12.5.1.3 The Necessity to Make Profits (on Top of Dividends)

Binswanger argues that such a zero growth environment leads to disfunctionalities in the economic system. When profits are too low, firms stop producing. Additionally, the banking system is expected to require continuous profits on top of dividends for their shareholders. These concerns have partly been responded to by relativising them. There seems no strong reason for firms or banks to go out of business as long as they can pay their costs and generate dividends for their owners.

A complementary condition to facilitate firms and banks with lower profits is to change their business types. Firms with collective ownership and banks in public ownership may not require high profit rates. This issue will come up again in part IV. There also the issue of investments due to market competition is debated in more detail, which has only been touched upon by Davidson's and Binswanger's theories.

12.5.1.4 Business Types

Business types that are not shareholder driven also respond to another central obstacle to zero growth. According to Binswanger, firms expand production to increase their shareholders' value. This incentive is alleviated or even ceases to exist when firms are collectively owned by employees or other stakeholders.

12.5.2 Critical Assessment of the Monetary Keynesian Theories

The extension of Keynesian theories with monetary concerns has brought insights into several crucial aspects concerning economies without growth. Two types of criticism can be put forward concerning the theories covered.

First, while facilitating insights into monetary concerns, the theories are relatively weak on some issues, compared to other Keynesian theories. Important examples are the investigation of determinants of effective demand, the analysis of technological change and the ignorance of environmental aspects.[42]

Second, the theories are also characterized by several weaknesses concerning their core issues. All three theories can still not cover the complexity and in particular the dynamics within the banking and the financial systems. For example, decisions are still explained highly mechanically and psychological mechanisms such as herd behaviour cannot be taken into account. Additionally, the actors included are (still) highly homogeneous. There are no different types of private banks, nor different groups of households or firms.

[42] Binswanger discusses this but does not incorporate it into his central lines of argument.

Chapter 13
Environment and Demand

Keynesian economics has been relatively silent on environmental issues: "PKE [Postkeynesian Economics] has almost totally failed to pay attention to the environment until more recently" (Spash and Schandl, 2009a, p. 49, see also Kronenberg (2010), Vatn (2009), and Mearman (2007, 2005)). There are barely any contributions by Keynesian authors on environmental issues (Berr, 2009) and it plays no role at all in the standard Keynesian textbooks (Kronenberg, 2010).[1] Investigating the question of why this is the case Mearman (2005) comes to the conclusion that "Post-Keynesians have had two main goals: attacking the orthodoxy on key issues and advocating an alternative programme. These goals have taken up nearly all the time and energy and prevented post-Keynesians from effectively developing a distinctive approach on the environment" (p. 146). Additionally, Mearman argues that the apparent conflict between environmental goals and economic growth (which is usually seen to be necessary for full employment in Keynesian analyses) has contributed to this negligence.

Recently, a debate on the introduction of environmental aspects into Keynesian theories has grown and reached a significant size though (Fontana and Sawyer, 2016). Interestingly, many of the contributions see great potential not only in including environmental issues into Keynesian analyses in general, but in combining Keynesian approaches with ecological economics in particular (Holt et al., 2009). It is argued that these two strands of theories have several aspects in common. Vatn (2009) points out three important commonalities[2]: (1) All schools include complexity and uncertainty within the systems to be investigated; (2) contrary to neoclassical economics, the behaviour of individuals is seen to be the outcome of interactions with other individuals and as strongly influenced by institutions; (3) production factors are seen as primarily complements and not substitutes (this aspect is of particular interest for the present work); and finally, (4) interests of actors and power relations within society are regarded as important features of society. Spash and Schandl (2009a)

[1] This is why this chapter is much shorter than the one on neoclassical environmental theories.

[2] Apart from Keynesian and ecological, he also includes institutional economics.

further point out that Keynesian and ecological economics see "the importance of the economy's historical path" (p. 47) in order to investigate it. All authors come to the conclusion that a combination of the two is promising. This would make Keynesian economics more relevant because it would be more capable of including environmental concerns. Ecological economics would gain by receiving a better analysis of macroeconomic issues, which it has lacked so far (Kronenberg, 2010).

While several differences have been indicated (see e.g., Kronenberg (2010)), the major source of conflict between Keynesian and ecological economics is said to lie in the question of economic growth (Mathieu, 1993). For Keynesians, economic growth is essential for a good performance of the economy, in particular in order to achieve full employment. Ecological economists, on the other hand, usually argue that continuous economic growth is incompatible with environmental sustainability. Fontana and Sawyer (2016) therefore call economic growth "a double-edged sword" (p. 2). Hence, the present work may also contribute to the combination of these two schools of thought, by pointing out under what conditions economic growth is not necessary within Keynesian frameworks, in particular concerning employment.

In the following, contributions are covered that have attempted to include environmental aspects into Keynesian macroeconomic frameworks. Those contributions that explicitly combine macroeconomic theories with environmental aspects have been chosen, while works on more general theoretical and methodological issues are not covered here. The chapter starts with an extension of the Neoclassical Synthesis from section 11.4 by an environmental constraint. Next, Jonathan Harris division of the components of aggregate demand into clean and dirty sectors is analysed. The third contribution is a recent article by Giuseppe Fontana and Malcolm Sawyer which introduces a natural depletion rate into a Keynesian macroeconomic framework.

13.1 IS-LM-EE: Environmental Constraints

One manner of introducing the environment into macroeconomic analyses has been developed by extending the IS-LM Model from section 11.4.[3] This has first been articulated by Heyes (2000). A simplified version has already been included in the influential textbook on ecological economics by Daly (2011). The central idea is similar to neoclassical models introducing an environmental factor: On the one hand, economic activity emits pollution based on the size of production and the pollution inten-

[3] The IS-LM-EE Model is, as the IS-LM Model, a combination of neoclassical and Keynesian concepts.

sity. On the other hand, the environment regenerates. When the pollution is lower than the regeneration, the economy is in a sustainable state. In Heyes' (2000) IS-LM-EE Model, the pollution intensity is connected to the mechanisms of the IS-LM Model. Most importantly, the pollution intensity depends on the interest rate. The underlying assumption is that capital goods and pollution are gross substitutes. When capital goods are more expensive (the interest rate is higher), firms use less capital and more natural resources, which leads to a higher pollution intensity.[4] Additionally, economic policy changes the pollution intensity. When pollution is more expensive (for example due to environmental taxation) firms choose cleaner technologies.

The model has been extended in several manners. Lawn (2003) introduces tradeable pollution permits in order to bring pollution to a sustainable level within the IS-LM-EE framework. Sim (2006) argues for feedback mechanisms that decrease the level of economic activity when pollution is above the sustainable level.[5]

13.1.1 The Theory

The functionings of the IS and LM curves are qualitatively the same as in section 11.4 and therefore adopted here. The IS curve describes the goods market. The central idea is that aggregate demand on the goods market is higher for lower levels of the interest rate, as it makes investments cheaper. Therefore, there is a negative relationship between aggregate demand and the interest rate. Hence, the IS curve is downward sloping (see figure 13.1). The IS function is given by[6]

$$Y_D = C(Y - T) + I(Y, i) + G. \tag{13.1}$$

Aggregate demand (Y_D) depends on consumption (C), investments (I) and government expenditures (G). The important mechanism is that investments depend on the level of the interest rate (i).

[4] It should be noted that this line of reasoning is in line with neoclassical analyses (see chapter 8) and not with the analyses of ecological economics (see section 2.2). The decisive issue is whether physical capital and natural resources are substitutes or complements.

[5] Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation of the model is based on Heyes (2000). The model in section 13.1.1 is an integration of the model in Heyes (2000) and IS-LM Model from section 11.4. The application of the model to zero growth in section 13.1.2 includes an interpretation of the model's equations.

[6] See equation 11.24 in section 11.4.1.

The LM curve covers the money market. The essential mechanism is here that an increase in aggregate demand leads to a higher demand for money and therefore (given a certain supply of money) increases the interest rate. The LM curve is therefore upwards sloping (see figure 13.1). The LM function is given by[7]

$$\frac{M}{P} = YL(i). \tag{13.2}$$

The interest rate (i) depends on the real money supply ($\frac{M}{P}$), the level of output (Y) and the demand function for money ($L()$).

Thus far, this model is the same as in section 11.4. The IS-LM-EE Model introduces an additional environmental relationship, the EE curve. It does not depict an equilibrium on a market but rather an environmental constraint. It represents the maximum level of pollution emitted by the economy that is still environmentally sustainable.

The development of environmental quality depends on pollution and environmental regeneration. On the one hand, economic activities emit pollution (E) according to the pollution intensity (Ω) and the level of production (Y). The pollution intensity depends on two aspects. First, it is influenced by "an institutional parameter capturing the state of development of environmental regulation in the economy" (Heyes, 2000, p. 5), denoted by Λ. Second, pollution depends on the interest rate (i).[8] A lower interest rate implies that capital goods are cheaper. As it is assumed that capital goods and natural resources (whose use leads to pollution) are substitutes, a higher use of capital goods implies less use of natural resources. This is why the EE curve is downward sloping in figure 13.1. The environment regenerates according to a given rate (ς) and the current environmental quality (N). The change in environmental quality is therefore given by

$$\frac{dN}{dt} = \varsigma N - E = \varsigma N - \Omega(i, \Lambda)Y. \tag{13.3}$$

The EE curve depicts the amount of pollution that can just be balanced out by environmental regeneration. The exact necessary relationship is derived by setting equation 13.3 equal to zero, which gives the EE curve:

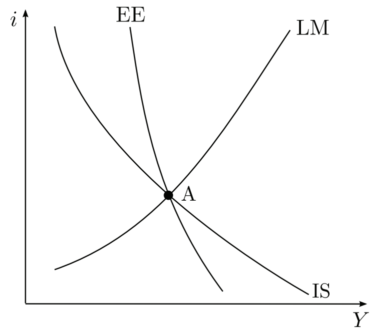
$$Y = \frac{\varsigma N}{\Omega(i, \Lambda)}. \tag{13.4}$$

7 See equation 11.25 in section 11.4.1.

8 Heyes (2000) additionally differentiates between long-term and short-term interest rates.

It has a negative slope (in figure 13.1), as an increase in the interest rate (i) increases the pollution intensity ($\Omega(i, \Lambda)$) and therefore decreases the right hand side of the equation.

Figure 13.1: IS-LM-EE I

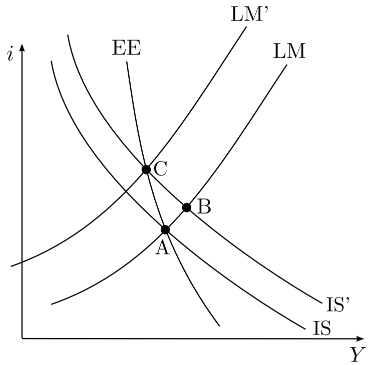


Adapted from Heyes (2000, p. 4).

Everything above/right to the EE curve is environmentally unsustainable, everything to the left/bottom is sustainable. Heyes (2000) further argues that a change of the environmental regulation (Λ) shifts the EE curve. Stronger environmental regulation shifts it to the right, as it decreases the pollution intensity and therefore a larger output is compatible with environmental sustainability.

Figure 13.1 displays the situation in which the economy is in a situation where pollution equals exactly the regenerative capacity of the environment. Heyes (2000) starts his analysis of macroeconomic policies from this situation (point A in figure 13.2). He argues that an expansionary fiscal policy would shift the IS-LM equilibrium to the right, so that it would be above environmental capacity (point B in figure 13.2). As a countermeasure, a monetary contraction could be initiated, so that production goes back to environmentally sustainable levels (point C in figure 13.2). Note that production is below the original level. The reason is that the interest rate is higher, which leads to a substitution from physical capital towards natural resources. Hence, only a lower production level is still within environmental boundaries. More generally speaking, Heyes (2000) framework suggests that a lower level of interest rate leads to less use of natural resources and hence a higher – still sustainable – level of production.

Figure 13.2: IS-LM-EE II



Adapted from Heyes (2000, p. 5).

13.1.2 The Theory and Economies Without Growth

The conditions for the economy to generate zero growth are the same as in the IS-LM Model in section 11.4 and need not be repeated here. Hence, the focus lies on the question of whether a zero growth economy is environmentally sustainable. According to the analysis of the IS-LM-EE Model, a growing economy is unlikely to be sustainable. It implies continuously outward shifting IS and LM curves, which will eventually transgress the EE curve and with it environmental limits. This could only be circumvented by continuous additional environmental regulations, which shift the EE curve outwards as well.

In a zero growth economy on the other hand (as argued in section 11.4), the IS and LM curves stay constant over time. If the intersection point between the two curves is left to the EE curve, no action is necessary – the economy works within environmentally sustainable levels. But as shown in section 2.2, this is not the case in most of the high-income countries at present time. In other words, the current intersection point of the IS and LM curves is somewhere to the right of the EE curve. Therefore, a zero growth economy would need to pursue strategies to decrease environmental impact. There are two possible measures within the logic of the IS-LM-EE Model: First, environmental impact can be decreased by implementing environmental regulation, shifting the EE curve to the right. Second, the interest rate can be lowered in order to generate a substitution of natural resources by physical capital – while keeping the level of production constant. According to the IS-LM-EE Model, this can be achieved by a combination of expansionary monetary policy and contractionary fiscal policies.

13.2 Harris: Clean and Dirty Sectors

Harris is one of the few authors who has written on the introduction of environmental aspects into a Keynesian framework. He started working on the subject earlier than others, with his first contribution (to my knowledge) explicitly on the subject in 2001 (Harris, 2001). Since then, he has published on similar topics in several occasions (Harris, 2001; Harris and Goodwin, 2003; Harris, 2008, 2010, 2013a,b).[9]

13.2.1 The Theory

At the core of Harris' theory is the idea that. Economic activities can be divided into two categories: those with high negative environmental effects (these are called *dirty* below and those with low negative or even positive effects on the environment (these are referred to as *clean*). While the former need to be limited, the latter can grow. Harris starts from the typical division of aggregate demand (Y_D) into private consumption (C), private investments (I) and government spending (G). Consumption is divided into three components, investments into four and government spending into six:

$$\begin{aligned} Y_D = C + I + G = [C_g + C_s + C_m] + [I_{me} + I_{mc} + I_n + I_h] \\ +[G_g + G_s + G_{me} + G_{mc} + G_n + G_h]. \end{aligned} \tag{13.5}$$

In table 13.1 the different components are defined. The table sorts all components according to whether they need to be limited in size (column *Limited*) or whether they can grow (column *Not limited*) according to Harris (2008, 2013a). Harris argues that only certain types of consumption, investments and government spending need to be limited, and others can grow: "While ecological principles imply limits on C_g, I_{me}, G_g, and G_{me}, the other terms in the equation can grow over time without significant negative environmental impact, and indeed with a positive effect in the case of natural capital or energy-conserving investment" (Harris, 2008, pp. 11 − 12). In other words: Only energy-intensive/dirty consumption

9 Regarding the question, which aspects of the following investigation are adopted from other studies, and which are novel developments of the present work: The following representation is based on Harris' contributions. The model in section 13.2.1 is a reproduction of the existing model. For the application of the model to zero growth in section 13.2.2, the model has been extended and several additional assumptions have been made.

(both private and governmental) and energy-intensive/dirty investments (also both private and governmental) need to be limited. Consumption that is labour-intensive and investments in energy-saving, natural and human capital can all expand without bound.

Table 13.1: Clean and Dirty Components of Production

Sector	Limited	Not limited
Private consumption	"non-durable goods and energy-intensive services" (C_g)	"consumption of human-capital intensive services" (C_s)
		"household investment in consumer durables" (C_m)
Private investments	"investment in energy-intensive manufactured capital" (I_{me})	"investment in energy-conserving manufactured capital"(I_{mc})
		"investment in natural capital" (I_n)
		"investment in human capital" (I_h)
Government consumption	"government consumption of non-durable goods and energy-intensive services" (G_g)	"government consumption of human capital-intensive services" (G_s)
Government investments	"government investment in energy-intensive manufactured capital" (G_{me})	"government investment in energy-conserving manufactured capital" (G_{mc})
		"government investment in natural capital" (G_n)
		"government investment in human capital" (G_h)
Aggregate demand	$C_g + I_{me} + G_g + G_{me}$	$C_s + C_m + I_{mc} + I_n + I_h + G_s + G_n + G_h$

All quotes are taken from Harris (2008, p. 11).

It is worth looking a bit closer at the separate mechanisms concerning consumption and investment. Two aspects are insightful regarding consumption: First, consumption needs to be shifted from energy-intensive (part of C_g and all of G_g) towards energy-unintensive (C_s and G_s) goods and services, in order to decrease the energy-use. Second, short-lived manufactured goods (the other part of C_g) need to be limited, while durable goods (C_m) can still be produced, as they are not bought so frequently.

Also concerning investments, two aspects are of importance: First, Harris argues that consumption cannot grow in the long term, due to environmental reasons. If consumption is decreased, investments need to increase in order to avoid an overall reduction in aggregate demand and subsequent unemployment (Harris, 2008).[10] In order not to increase consumption in the future, such investments must not increase potential production capacity: "If resources are shifted from consumption to investment, this implies an even greater potential for consumption growth over time. But if investment is reduced, there is a danger of rising unemployment. This dilemma can only be resolved by forms of investment that improve well-being but do not contribute to greater consumption of material goods and non-renewable energy" (Harris, 2008, p. 8). Harris is not explicit on which investments increase production capacity. In the following, it is assumed that I_{me}, G_{me}, I_{mc}, I_h, G_{mc}, and G_h increase productive capacity, while I_n and G_n do not. The idea is that investments in capital goods and human capital increase productive capacity, while investments in natural capital does not.[11]

The second aspect refers to potential environmental benefits of investments. Harris argues that energy-saving investments (in particular I_{mc} and G_{mc}) such as renewable energy plants can benefit the environment. This also leads him to the concept that the necessary transition towards a sustainable economy can be divided into two time periods. In the first period, "roughly to 2050, economic growth is inevitable" (Harris, 2013b, p. 44). The main reason is that investments in clean technologies are needed. In the second half of the 21st century, economic growth comes to an end, as clean capital is already put into place.

[10] Rezai et al. (2013) also argue that for consumption to decrease, one possibility is for investments to increase. The other possibility is that both decrease in the transition to a lower steady state. They argue though that during this transition towards a smaller economy, a low savings rate is needed and implicitly suggest that this contradicts a decrease in consumption. This logic contradicts the models of chapters 11 and 12, however. Here, it was argued that the size of savings are determined by investments. Therefore, lower or negative investments would lead to very low savings and a contraction of the economy at the same time.

[11] On a more general ground, Harris' analysis can be criticized for taking into account capacity effects but not demand effects (see Domar's model in section 11.3) of investments. As Barker et al. (2009) argue, increases in mitigation (I_n and G_n) lead to higher income, which increases aggregate demand, growth and therefore also environmental effects. This is part of a set of macroeconomic rebound effects.

Overall, he therefore comes to the conclusion that both concerning consumption and investments, some forms can still grow, while others may not:

> The idea is that we can distinguish between those macroeconomic aggregates that should be strictly limited – resource-intensive consumption and investment and energy-intensive infrastructure – and those that can expand over time without negative environmental consequences. The latter would include large areas of health, education, cultural activity and resource- and energy-conserving investment. The conclusion is that there is plenty of scope for growth in economic activity, concentrated in these categories, without growth in resource throughput, and with a significant decline in the most damaging throughput, that of carbon-intensive fuels (Harris, 2013b, pp. 34 – 35).

Harris proposes various policies based on his analysis. He discusses typical environmental policies such as ecological taxes and subsidies, in order to shift consumption and investments away from energy-intensive sectors due to price incentives (Harris and Goodwin, 2003). More uniquely, he emphasizes the role of fiscal and monetary policy though. Fiscal policy should be used for "social investment, both in human capital and infrastructure" (Harris, 2010, p. 7). These investments facilitate the production within energy-unintensive sectors. Monetary policy could also be used, in particular by offering lower interest rates for energy-saving investments (Harris, 2008).

13.2.2 The Theory and Economies Without Growth

Harris' basic distinction between energy-intensive and labour-intensive/energy-unintensive sectors is fruitful for the investigation at hand. He thereby allows to investigate how zero growth can be combined with decreases in resource and energy use in a Keynesian framework. The equation on the components of aggregate demand is rearranged so that those which need to be limited stand at the beginning and the others at the end:

$$Y_D = [C_g + I_{me} + G_g + G_{me}] + [C_s + C_m + I_{mc} + I_n + I_h + G_s + G_n + G_h]. \tag{13.6}$$

In a zero growth environment, aggregate demand stays constant $\Delta Y_D = 0$. Therefore, the shrinkage of the first part of the equation needs to equal the growth of the second part:

$$|\Delta[C_g + I_{me} + G_g + G_{me}]| = \Delta[C_s + C_m + I_{mc} + I_n + I_h + G_s + G_n + G_h]. \tag{13.7}$$

13.2.2.1 A Zero Growth Scenario

In principle, there are numerous combinations of growth and shrinkages of the various components. Here, one combination is outlined, which combines Harris' concept of sustainable development with zero growth. Harris argues that in order to achieve sustainability, consumption needs to decline. A constant capital coefficient is assumed, so that a declining consumption also implies fewer investments. The resulting decrease in aggregate demand is compensated by an increase in investments in natural capital (which has no capacity effect). In the following, the relations between the changes in consumption, productive investments and investments in natural capital are examined.

Harris argues that consumption needs to decline for sustainability. Therefore, dirty consumption ($\Delta C_g + \Delta G_g$) needs to decline more than clean consumption ($\Delta C_s + \Delta C_m + \Delta G_s$) increases: $|\Delta C_g + \Delta G_g| > \Delta C_s + \Delta C_m + \Delta G_s$. The difference between the two is denoted with X:

$$X = \Delta C_g + \Delta G_g + \Delta C_s + \Delta C_m + \Delta G_s < 0. \tag{13.8}$$

Investments in productive capacity also need to decline, in order to match the shrinkage in consumption. Clean investments grow, and dirty investments shrink. In order to have declining investments, the shrinkage in dirty investments is larger than the growth in clean investments. The difference is denoted with U. For sake of simplicity, it is assumed that dirty investments ($I_{me} + G_{me}$) have the same capacity effect as clean investments ($I_{mc} + I_h + G_{mc} + G_h$). As Harris does not take into account depreciation, here it is also excluded. The shrinkage of overall investments (U) is given by:

$$U = I_{me} + G_{me} + I_{mc} + I_h + G_{mc} + G_h < 0. \tag{13.9}$$

Furthermore, a constant capital coefficient ($v = \frac{K}{Y}$) is assumed. Hence, the capital stock needs to decrease according to $\Delta K = v\Delta Y$. The relation between the decrease in consumption (X) and the decrease in productive investments (U) is therefore determined according to:[12]

[12] The following equation assumes that one unit of investments requires one unit of final goods.

$$U = vX. \tag{13.10}$$

The result is an overall reduction in aggregate demand, which is equal to the sum of reductions in consumption and productive investments ($U + X = (1 + v)X$). In order to have constant aggregate demand, this gap needs to be filled. This is done by investments in natural capital by the private sector (I_n) and the government (G_n), which are argued to have no effect on productive capacity:

$$I_n + G_n = (1 + v)X. \tag{13.11}$$

The conditions for a zero growth economy along the lines of Harrod's argument have now been developed. Dirty consumption and investments decrease and clean consumption and investments and investments in natural capital increase. The decreases and increases cancel each other out.

13.2.2.2 Instruments and Effects

Most of the policies proposed by Harris also apply to the initiation of zero growth economies. Environmental taxes and subsidies still facilitate the sectoral change of consumption and investments from dirty to clean sectors. Fiscal policy can support infrastructure in clean sectors and monetary policy can help push clean investments. While Harris emphasizes the *increases in clean* consumption, investments and government spending, the zero growth scenario requires an even stronger focus on *decreases in dirty* consumption, investments and government spending. In particular, it is necessary to dismantle existing dirty capital stock.

Overall, Harris does not provide a coherent framework to investigate the necessary steps and changes to achieve a scenario as depicted above. The determinants of and interconnections between the different components are unclear. Therefore, it is not possible to investigate, what conditions would bring about such a scenario. Some examples: It is not explained how consumption is determined, the connection between aggregate demand and investments behaviour is not specified, multiplier effects of changes in government spending are undefined and the role of investments in natural capital for overall income and aggregate demand is unclear.

A further point worth noting is that in Harris' framework a zero growth economy implies a (one time) decrease in average income. In order to allow for investments in natural capital, other parts of the economy need to decline, when overall GDP is to be kept constant.

A final insight can be drawn from Harris' analysis concerning the issue of (un-)employment in zero growth economies. He mentions that the labour coefficient in clean sectors is higher than in dirty sectors. A shift from dirty towards clean production therefore increases employment. Such a shift can (partly) compensate for declining employment due to increases in labour productivity. Taking a sectoral change from dirty towards clean production into account, unemployment therefore is less of a problem in zero growth economies than expected. Subsequently, the reductions in working hours, which have been important in many of the previous Keynesian analysis, become less important.

13.3 Fontana and Sawyer: Environmental Depletion Rate

Fontana and Sawyer (2016) have recently developed an environmental Keynesian model. It is to my knowledge the only contribution that includes environmental aspects into a state-of-the-art Keynesian model. The model depicts an integration of environmental aspects into Keynesian thinking along the lines of chapters 11 and 12. It constitutes one of the most sophisticated attempts to include the environment into Keynesian analyses.[13]

13.3.1 The Theory

Fontana and Sawyer (2016) build their model on a general understanding of the economy as depicted in the monetary circuit theory. The monetary economy can be described as a five-step sequence: (1) Firms borrow money from banks for the production process. (2) Firms use the money to invest in physical capital, employ workers and buy production materials. (3) Workers use their wages to buy products from firms. (4) Workers decide whether to put their savings into bank deposits or financial securities (in particular firm bonds). Finally, (5) firms use their revenues to pay back credits. Within this framework, Fontana and Sawyer (2016) build an understanding of three different types of growth rates, somewhat similar to the method used by Harrod (see section 11.2).

13.3.1.1 Growth of Physical Capital and Output

Similar to Kalecki's analysis (see section 11.5), an investment function is developed. First, investments depend on the difference between the actual (я) and the desired rate of capacity utilisation (я*), which is the ratio of desired output to actual output ($\frac{Y^*}{Y}$) as a higher rate of utilization in-

[13] Regarding the question of which aspects of the following investigation are adopted from other studies and which are novel developments of the present work: The following representation is based on Fontana and Sawyer (2016). The model in section 13.3.1 is a reproduction of the existing model. For the application of the model to zero growth in section 13.3.2, the model has been extended and several additional assumptions have been made.

duces firms to expand their capacities. Second, a higher profit share (h) raises investments, as it generates higher profits. Third, "animal spirits", "technological improvements" and potential other factors influence investments (covered by a term (ϱ)). The desired investment function is given by $\frac{I^d}{K} = [\alpha(я - я^*) + \beta h + \varrho]$.[14] However, as firms depend on bank credits to finance production, not the entire size of desired investments can be realized.[15] Firms can finance part of the investments by retained profits, which depend on the share of profits retained by firms (ζ) and total profits: $\zeta\Pi = \zeta\frac{\Pi}{Y}\frac{Y}{Y^*}\frac{Y^*}{K}K = \zeta h\frac{я}{v}K$. All additional investments are only partially realized due to credit constraints from banks, represented by the term $\psi < 1$. Therefore, the realized investment function[16][17] is

$$g_y(t) = g_k(t) = \frac{I^r}{K} = \psi[\alpha(я - я^*) + \beta h + \varrho - \zeta h\frac{я}{v}] + \zeta h\frac{я}{v}, \qquad (13.12)$$

with the economic growth rate $g_y(t)$, the rate of capital accumulation $g_k(t)$ and realized investments I^r.

13.3.1.2 Growth of Employment

Fontana and Sawyer (2016) develop a supply and a demand function for labour. Changes in labour demand g_{LD} are determined by two factors. First, economic growth $g_y(t)$ as discussed above also increases employment proportionally, according to the current labour coefficient. Second, technological change $g_l(t)$ increases labour productivity and hence decreases the labour demand:[18]

$$g_{LD}(t) = g_y(t) + g_l(t). \qquad (13.13)$$

14 α and β are parameters which determine the relative weights of the factors.

15 Note that this argument refers to Davidson's reasoning on monetary constraints.

16 Fontana and Sawyer (2016) develop based on this investment function a growth function of both investments and output that also takes into account the equilibrium requirement that savings equal investments (see p. 6).

17 Due to notational issues, time is denoted as (t) instead of $_t$, which is used in the rest of this work.

18 Fontana and Sawyer (2016) include the growth of the utilization rate into the demand for labour. As it is common to assume a relatively constant rate of utilization over longer time spans, it is not included here. Furthermore, they describe productivity growth due to technological change as part of labour supply. Here, it is instead attributed to labour demand, as it determines the amount of workers needed for production for given level of production and technological change.

The change in labour supply g_{LS} is influenced by three components: (1) population growth $g_B(t)$, (2) the change of the employment rate $(g_Q(t))$, which reflects the ratio of the population that is supposed to work according to social norms and (3) the change in the average number of working hours $g_H(t)$:

$$g_{LS}(t) = g_B(t) + g_Q(t) + g_H(t). \quad (13.14)$$

The change in labour demand and the change in labour supply together determine the change of the unemployment rate $(g_U(t))$:[19]

$$g_U(t) = g_{LD}(t) - g_{LS}(t) = g_y(t) + g_l(t) - g_B(t) - g_Q(t) - g_H(t). \quad (13.15)$$

13.3.1.3 The Depletion Rate of Natural Capital

Depletion of natural capital depends on three aspects. (1) Faster economic growth (g_y) leads to a higher depletion rate. (2) The sum of all production of the economy (Y_{Cum}) over time has some impact on the depletion rate, while Fontana and Sawyer (2016) do not say of what kind this relationship is: "[T]he level of output has some impact on the depletion rate of natural capital" (p. 6). (3) Research and development (J) decreases the depletion rate. It is suggested that there is a connection between aspect (1) and (3): Economic growth leads to higher research and development, so that it is unclear whether economic growth has overall a positive or a negative impact on the depletion rate $(g_{DNC}(t))$:

$$g_{DNC}(t) = f(g_y, Y_{Cum}, J). \quad (13.16)$$

These three growth rates (of output, employment and natural depletion) are determined by different factors and therefore "in general these growth rates of output will be different" (Fontana and Sawyer, 2016, p. 7). Additionally, there is no inherent force within the economy that converges them: "physical capital, labour and natural capital cannot be readily substituted for each other, it follows that, contrary to the neo-classical theory, there would not be no [sic] automatic market forces, which would bring g_1, g_2 and g_3 [the three growth rates] into alignment with each other" (pp. 7 – 8).

19 This is not part of Fontana and Sawyer (2016)'s analysis but an extension based on their work.

13.3.2 The Theory and Economies Without Growth

Zero growth in this model is – similar as in other Keynesian models – mainly determined by investment behaviour. As the model abstracts from depreciation, investments need to be equal to zero. Looking at equation 13.12 both terms ($\frac{I^r}{K} = \psi[\alpha(я - я^*) + \beta h + \varrho]$ and $\zeta m \frac{Я}{v}$) cannot be negative, so that both need to be zero. The first term is zero either if banks do not give any credits ($\psi = 0$), or if the effects of all major determinants are zero ($\alpha = \beta = \varrho = 0$) or if all the major determinants themselves are zero ($я - я^* = h = 0$). In order for the second term to be zero, either firms need to retain no profits (ζ) or the profit rate needs to be zero ($m = 0$). In the more realistic case with depreciation, investments would need to be low. In this case, the constellation of factors and parameters mentioned would need to lead to an investment that equals depreciation.

Zero economic growth has ambiguous effects on the other two growth rates. Concerning labour demand, on the one hand it leads to lower production (compared to positive economic growth) and therefore also to lower employment. On the other hand, zero growth slows down technological change, labour productivity and hence leads to more employment. Fontana and Sawyer (2016) do not indicate any effects of the economic growth rate on labour supply.[20] Concerning the depletion rate, the effect is also ambiguous. On the one hand, a lower/zero rate of economic growth decreases the depletion rate. On the other hand, it might decrease the expenses on research and development, which foster "the use of low-carbon production techniques" (p. 6).

In conclusion, the necessary conditions for zero growth are similar as in previous theories. They refer in particular to investment behaviour, monetary constraints and firms' retention of profits. The theory has incorporated environmental aspects in a similar manner as neoclassical theories do. Pollution depends on the level of production and technological change. Whether environmental outcomes are better in a zero growth than in a growing economy cannot be determined.

20 Rezai et al. (2013) argue that if a reduction in average working hours is used in order to decrease unemployment, this may lead to increasing wages and therefore higher incentives to invest in technologies with higher labour productivity. Assuming that such technologies use more energy (the technology primarily substitutes labour by energy), this has two effects: Employment decreases and energy use increases.

13.4 Results and Discussion

13.4.1 Summary of Conditions

The three theories discussed in this chapter have contributed little new insights regarding conditions for economies to generate zero growth. Instead they have shed light on the connection between the economy and the environment and subsequently whether and how a zero growth economy can contribute to environmental sustainability. Hence, the summary of conditions focuses on such aspects. In the following it is argued that, while the IS-LM-EE Model (section 13.1) and the model by Fontana and Sawyer (section 13.3) incorporate environmental aspects into the analysis, they do not identify promising mechanisms to improve environmental outcomes. The most interesting insights can be drawn from Harris' framework (section 13.2).

13.4.1.1 Results From the Single Theories

In the IS-LM-EE Model, environmental outcomes can be improved due to two mechanisms. First, environmental regulation can decrease pollution per unit. Why this is the case and whether there are limits to this approach is not elaborated though. Second, the substitution of natural capital by physical capital can be supported by lowering the price for physical capital (the interest rate). According to a typical Keynesian line of reasoning, lower interest rates would increase investments though, whose utilization for production first of all require *additional* material inputs. Moreover, from an ecological economics perspective, this second mechanism is to be assessed critically, as physical and natural capital are regarded to be complements.

Fontana and Sawyer model the depletion rate of natural capital as an ambiguous outcome of economic growth. On the one hand, economic growth increases the rate, as it increases production. On the other hand, economic growth fosters research and development and thereby decreases the depletion per unit of production. It is not articulated, however, which aspect prevails or which conditions influence whether the one prevails or the other.

Harris' contributions, on the other hand, lead to interesting insights and strategies for zero growth economies. Two aspects are most important. First, the division into clean and dirty consumption and investments allows to investigate the effects of sectoral change. This approach has common features with the theory on Directed Technical Change with Environment of section 8.5. In both theories, a sectoral change takes place from a dirty to a clean sector. The causes are very different between the theories, however. In the Directed Technical Change with Environment theory, it is caused by price and market size effects. In Harris' framework, it takes place due to altered decisions by households (concerning consumption), firms (on where to invest) and the government (what type of governmental expenditure to pursue). It is therefore driven by demand.

Second, Harris points out that investments in natural capital can take place. These investments have no effect on productive capacity, but solely serve to improve environmental quality.[21] They therefore depict an innovative manner to improve environmental outcomes within a Keynesian framework and at the same time represent a new type of component of aggregate demand which is neither consumption nor investment (in the usual sense).

13.4.1.2 Aggregate Demand and Sectoral Change

As in other Keynesian theories, a central condition for zero growth in the theories of this chapter is that aggregate demand stays constant over time. The decisive new insight from Keynesian theories with environment is that a sectoral change in demand is necessary to improve environmental outcomes. This sectoral change concerns three aspects. (1) Consumption needs to shift from dirty to clean products. Households therefore have to fundamentally change behavioural patterns. (2) Dirty investments need to decline, while clean investments need to grow. This also represents a large change compared to prior results, where the perspective has been to deter firms from investment. Instead, firms are encouraged to engage in clean investments (to a certain level) and need to decrease investments significantly in the dirty sector. (3) Government expenditures need to shift from dirty to clean consumption. (4) Government investments need to shift from dirty to clean sectors.

Such a sectoral change has two important effects. First, it decreases environmental impact, as the clean sectors have lower pollution intensities than the dirty sectors. Second, it lowers the necessary speed of reductions in average working hours in zero growth economies. The reason is that clean sectors are argued to have a higher labour coefficient. Therefore, the sectoral change can countervail the negative effect of technological change (that increases labour productivity) on employment.

13.4.2 Critical Assessment of the Keynesian Theories With Environment

Theories on Keynesian economics that include environmental aspects are rare and hence, the understanding of the economy-environment relationship from Keynesian perspectives is still weak. The three theories dis-

[21] Note that they are therefore similar to abatement in the neoclassical theories, when abatement has no effect on technological change.

cussed in this chapter allow first insights into this relationship, but they stay far from a detailed understanding.

The IS-LM-EE Model is a fruitful attempt to introduce environmental aspects into one of the most influential textbook models. Thereby, it allows to incorporate environmental constraints in a manner understandable to many economists. The mechanisms of the theory are not convincing, however. The central mechanism refers to a substitution between physical and natural capital based on a change of the interest rate. It has been argued already that the feasibility of such a substitution is questionable in principle due to technical limitations. Furthermore, the role of a lower interest rate as *the* cause for more environmentally friendly production can be called into questioned.

Harris' makes an important contribution by distinguishing clean and dirty sectors. This is a promising starting point for Keynesian analyses of the economy-environment relationship, as it puts the demand side into the centre of the analysis. The theory is incomplete though, as Harris does not develop a coherent framework within which central Keynesian mechanisms could be taken into account. In particular, the interconnections between changes in investments, production capacity and aggregate demand are not worked out coherently. Also, the role of technological change has not been included into the analysis, although it is of central importance when it comes to production capacities, employment and most importantly pollution intensity.

The paper by Fontana and Sawyer represents another promising starting point for Keynesian analyses. Its central contribution is to show that there are no automatic mechanisms that bring economic growth, employment and a sustainable rate of depletion into alignment. At the same time, their analysis appears strong in terms of traditional macroeconomic aspects but weak concerning environmental aspects and the connection between the two. In particular, they stay within the logic of technological change that increases labour productivity by using increasing amounts of natural resources. Within such a framework, there must be a conflict between environmental concerns and full employment. As a result, they cannot analyse the centrally important role of different types of technological change. This also makes it impossible to point out constructive conditions to combine zero growth with environmental sustainability.

Chapter 14
Sustainable Economies Without Growth in Keynesian Theories

> [T]he [economic] system cannot break the *impasse* of fluctuations around a static position unless economic growth is generated by the impact of semi-exogenous factors such as the effect of innovations upon investments. It is only in such a case that cyclical fluctuations do occur around the ascending trend line (Kalecki, 1962, p. 134).

This part on Keynesian contributions has covered in total thirteen theories, categorized into seven fundamental, four monetary and three environmental Keynesian theories. Compared to the neoclassical theories, the Keynesian approaches have often been less complicated in terms of the mathematics but more complex concerning the economic mechanisms discussed. The chapter starts with an overview of the results, in particular concerning the first research subquestion. Next, several scenarios are developed, followed by the results concerning research subquestions 2 – 4. Afterwards the findings are compared to the state of research and limitations of Keynesian theories are discussed.

Throughout this chapter, references are made to single theories. At the end of the next section, a table summarizes the results from all Keynesian theories discussed.[1] It serves as a summary of the theories and as a reference point for comparison and integration of the theories throughout this chapter.

14.1 Overview

The general condition for zero growth within Keynesian theories is that aggregate demand and aggregate supply stay constant over time. At the same time, the state of technology, the composition of goods and the relation between input factors can change. In the following, first the role of aggregate demand and its relation to technological change is summarized (14.1.1). Next, the central condition for the level of investments is dis-

[1] Note that all results, conditions, limitations etc. are only based on the Keynesian theories discussed in this work, not Keynesian theories in general. The term *the Keynesian theories* hence also refers to those Keynesian theories used in this work and not all Keynesian theories.

cussed (14.1.2), followed by an integration of different theories on savings in economies without growth (14.1.3) and a discussion on an apparent contradiction between a high wage share and low investments (14.1.4). These findings lead to a summary of conditions for economies without growth based on traditional technological change with increasing labour productivity (14.1.5). These conditions are partially changed when a different type of technological change is implemented (14.1.6) and/or when sectoral change from dirty to clean sectors takes place (14.1.7).

14.1.1 Aggregate Demand, Technological Change and Working Hours Reductions

The quote above by Kalecki indicates that technological change is (also) central in Keynesian theories for economic growth and economies without growth. Without technological change, capital accumulation and growth in income come to an end, due to endogenous processes. In Keynes' terms, the reason is that the marginal efficiency of capital decreases with an increasing amount of capital equipment.[2] In Domar's terms, the fact that the investments with the highest effect on production capacity are undertaken first leads to an end of capital accumulation.[3] When the capacity effect of investments decreases with the level of the capital stock but capital depreciation is a constant fraction of that stock, capital accumulation comes to an end when capital depreciation equals the diminishing effect of investments on production capacity.

Technological innovations can prevent this situation from occurring. The availability of technologies increases the marginal efficiency of capital and therefore induces entrepreneurs to invest and introduce these cost-saving technologies.[4] The combination of investments and new technologies increases the production capacity (supply) and has ambivalent impacts on demand. On the one hand, it increases aggregate demand as investments are one central component of it. On the other hand, the new technologies imply less employment per unit of production, leading to less wage income and less consumption demand. This leads to a tendency towards a lack in effective demand, which can (and should, according to most Keynesian authors) be filled by the government – in particular by increasing government spending.[5]

In zero growth economies, on the other hand, technological change needs to be accompanied by constant production capacity (discussed in

2 See Keynes' theory, section 11.1.
3 See Domar's theory, section 11.3.
4 As argued in particular by Keynes (11.1) and Kalecki (11.5).
5 See in particular Keynes' theory, section 11.1.

detail in the next section) and constant aggregate demand. One central condition for constant demand is that a decreasing demand for labour is reconciled with constant consumption and full employment. The central measure to achieve the constant employment despite increasing labour productivity is to introduce working hours reductions (g_H)[6] at the speed of changes in the labour coefficient due to technological change (g_l)[7]:

$$g_H = g_l, \tag{14.1}$$

with $g_H < 0$ and $g_l > 0$.

In order to keep wage income constant, the hourly wage (g_w)[8] has to increase at the same speed as the decreases in working hours:

$$g_w = -g_H, \tag{14.2}$$

with $g_w > 0$.

Assuming that people do not change their propensity to consume, this would lead to a constant level of employment and a constant level of consumption. If, in addition, investments (I) and government spending (G) stay also constant, this implies constant aggregate demand:[9]

$$\Delta(C + I + G) = 0. \tag{14.3}$$

Constant investments[10], constant consumption and constant government spending hence facilitate constant aggregate demand. Not only do investments have to be constant, they also need to be equal to capital depreciation in order to keep supply constant over time. This is the issue of the next section.

14.1.2 Gross Investments = Capital Depreciation

In Keynesian theories, production is usually determined by the demand, rather than the supply side. Nevertheless, the production capacity (the supply side) needs to stay approximately constant in economies without growth. The reason is that a continuously increasing production capacity

6 g_H is the growth rate of average working hours.

7 g_l is the growth rate of the labour coefficient.

8 g_w is the growth rate of hourly wages.

9 In principle, one of the components can increase, while the other decreases. In order to keep things simple, this option is not examined in the following.

10 Note also that constant (contrary to increasing or decreasing) investments are necessary for a constant level of aggregate demand due to the demand effect, as pointed out based on Domar's theory in section 11.3.

would imply a continuously increasing output gap – assuming that aggregate demand stays constant.[11] This is regarded as implausible, as firms stop investing when they cannot sell their products.[12]

A central condition for zero growth is therefore that the production capacity stays approximately constant over time.[13] This implies that gross investments are equal to capital depreciation or in other words that net investments are zero:[14]

$$I = \delta K. \tag{14.4}$$

The level of gross investments is determined by a large number of factors and the determinants differ between theories. As investments are the primary reason for economic growth in Keynesian theories, there is a large debate on its determinants. The rate of capital depreciation can also change, while this issue is discussed far less extensively.

Generally speaking, the combination of all the factors influencing the level of gross investments and capital depreciation need to have such a constellation that the two are of equal size.[15] It is impossible to determine exact relations between all of them. At the same time, it is argued in the following that some determinants play primary roles, while others are only of secondary importance when it comes to zero growth. In the following, the role of seven issues in determining investments and capital depreciation are discussed.

a Consumption demand and expected revenues

The major determinant of the level of investments are expected revenues, which are primarily determined by expected consumption demand by households and government expenditures.[16] As past experiences are an important determinant of future expectations, consumption demand needs to stay constant over time. This resembles the argument above that aggregate demand has to stay constant. In other words: When consump-

11 A continuously decreasing production capacity is, of course, not compatible with zero growth, as aggregate demand cannot be above aggregate supply over a longer time period.

12 For a discussion of this issue see Baran and Sweezy (1966, chapter 4).

13 This result has been found based on various authors, in particular Keynes (11.1), Harrod (11.2), Domar (11.3), Kalecki (11.5), Kaldor (11.6), and Robinson (11.7).

14 At this point it is assumed that technological change is such that the capital coefficient stays constant. This assumption is changed below.

15 This result has already been pointed out in the sections on Keynes' (11.1) and Kalecki's (11.5) theories.

16 This point has been made by Davidson (12.1) and Keynes (11.1).

tion demand and government spending stay constant, it becomes more likely that investments also stay constant. But expectations do not only depend on past experiences. Additional factors can facilitate that firms expect constant demand. For example, macroeconomic institutions which guarantee that increases in labour productivity are turned into working hours reductions, rather than wage increases, would lead to the expectation that private consumption demand stays constant.[17] Also, announcements by the government that government spending will not increase would contribute to firms' expectation of constant demand.[18]

b Technological change

The availability of new production technologies that allow production at lower costs is argued to lead to more investments.[19] If the availability of new technologies always leads to (high) investments, this would contradict the condition for investments to equal capital depreciation. There are two approaches to tackle this contradiction. The first has already been indicated above. Part of the reason why technological change leads to economic growth is that the government has to support aggregate demand in order to prevent unemployment. If working hours reductions were introduced at the speed of growth in labour productivity, increases in government spending would not be necessary to avoid unemployment. The second approach concerns the question of whether the introduction of new technologies has to be accompanied by increases in production capacities. If new technologies would solely replace the old production capacities, the condition of constant production capacities would still be given. New, cost-reducing technologies are connected to expansions of production (on the firm level) if there are economies of scale. Without economies of scale and when firms expect a constant demand for their products (as argued above), firms have an incentive to introduce new technologies while keeping production capacities constant.[20]

c Costs associated with investments

Another manner to keep investments low is to make the acquisition of capital goods more expensive and thereby less attractive to firms. Several

[17] The role of consumption demand is particularly emphasized by Keynes (11.1), and Harris (13.2).

[18] The role of demand by the state is emphasized by Davidson (12.1), Godley and Lavoie (12.4) and Harris (13.2).

[19] Kalecki (11.5) makes this point and Kaldor (11.6) argues for a tight connection between investments and technological change.

[20] The issues of new technologies, economies of scale and expansion of production have been touched on by Davidson (12.1). They are discussed in more detail in the theories in chapter 16, as Marx's framework focusses on these issues.

aspects refer to the costs of capital goods. The production price plays an important role[21] and the state can also raise the costs for example by taxing producers of capital goods. A more direct form would be to tax the acquisition of capital goods directly.[22] Furthermore, the retained earnings by firms can be taxed, as they are a major determinant of investments.[23] Finally a higher interest rate leads to lower investments and the choice of less capital-intensive production methods.[24]

d Business types

Investments depend additionally on entrepreneurial behaviour. Whether entrepreneurs decide to invest depends also (in addition to all the other factors discussed) on their attitudes[25] and in particular on the business type of the firm. In particular, shareholder-owned firms have strong incentives to invest, while collectively owned firms may invest less.[26]

e Market competition

The intensity of competition, in the form of the numbers of competitors, influences the speed of technological change and the level of investments. The stronger the competition, the higher technological change and investments are.[27] This issue is only indicated by Keynesian authors. It can be more comprehensively discussed within the Marxian theories in part IV.

f The existing level of the capital stock

The higher the existing level of the capital stock, the lower the level of investments is.[28] The reason is that a higher capital stock implies fewer profitable investment opportunities. While technological change can dampen this effect (by opening up new investment opportunities) the effect is still present. This implies that the establishment of zero growth economies needs fewer changes (as compared to a growing economy) in high-income countries than in low-income countries.

[21] As argued by Keynes (11.1).

[22] As argued based on the IS-LM-EE Model (13.1).

[23] See Kalecki's theory (11.5).

[24] As argued by Keynes (11.1) and in the IS-LM-EE Model (13.1). This argument contradicts the view of the monetary Keynesian approach, which says that the interest rate needs to be set at a certain level in order to obtain an equilibrium in the capital goods market, see section 12.2.

[25] This point is argued most strongly by Davidson (12.1).

[26] Binswanger 12.3 emphasizes the incentive of shareholder-owned firms to invest. Whether non-shareholder firms exhibit different behaviour is not discussed in the Keynesian literature. However, this view is supported by authors on economies without growth, see section 3.6.

[27] As argued by Kalecki (11.5) and Binswanger (12.3).

[28] As argued by Keynes (11.1) and Kalecki (11.5).

g Speed of capital depreciation
The speed of capital depreciation is little discussed in the literature. At the same time, it plays an important role for sustainable economies without growth, as a faster capital depreciation allows for a faster introduction of new – potentially cleaner – technologies while not increasing output. This view is also put forward in existing concepts on economies without growth (see section 3.6), in which it is pointed out that dirty industries need to be dismantled at the same time as cleaner production capacity is build up.

In sum: Investments need to stay constant and be at the level of capital depreciation. In comparison with a growing economy, the most important condition for this is that consumption and government spending stay constant over time and that firms expect them to stay constant. A second important matter is technological change. Firms need to keep the level of production constant while introducing cost-reducing technologies. One central condition for this is, again, the expectation of non-growing demand for their products. This condition needs to be accompanied by working hours reductions, when unemployment is to be prevented and the wage level is to be kept constant. The existence of economies of scale can further incentivize firms to expand production. This issue and subsequent conditions for zero growth are discussed in part IV. Further possibilities to prevent positive net investments low are to increase the price of capital goods and to introduce measures that imply less competition. The fact that the capital stock is already high in early industrialized countries implies fewer necessary changes to arrive at zero net investments. Finally, the speed of capital depreciation can be increased.

14.1.3 Gross Savings = Gross Investments = Capital Depreciation

a Insights from fundamental Keynesian theories
In Keynesian approaches, investments pre-date savings. Investment decisions do not depend on savings but a variety of other reasons. Investments generate savings in these approaches. This issue is tightly related to the understanding of the monetary system. It is argued that money is endogenously created by private banks. Firms take loans in order to invest. This increases income and also savings.

Keynes (11.1) argues that investments lead to an equal amount of savings. The underlying reason is that investments lead to income, which are partly saved. As that part of income that is consumed becomes the income of another economic actor, the entire additional money that is created by the investment eventually becomes savings. Accordingly, constantly low investments in zero growth economies would generate appropriate low savings.

In Kalecki's theory (11.5), there are only savings out of profits and not out of wages. Here also, the level of investments determines savings via determining profits. His line of argument is therefore very similar to Keynes'. Kaldor allows for savings out of wages, apart from that it is similar to Kalecki's.

A condition based on Kalecki and Kaldor is that the profit share needs to be low in order to facilitate zero growth economies (with a low investment ratio). If the profit share is large, a low level of investments leads to a surplus of savings. The economy shrinks until total profits are lower and the profit share has decreased. A given (low) level of investments therefore generates the necessary (low) profit share.

An intermediate result based on the fundamental keynesian theories is therefore that savings adjust to investments. Hence, the crucial question for zero growth is only how investments can be brought to the level of capital depreciation. The issue of savings presents no problem to zero growth.

b Combining fundamental theories with stock-flow-consistent models

This stands in stark contrast to existing discussions on economies without growth, in which it is often argued that the existing monetary system contradicts zero growth. These arguments usually refer to the issue that in zero growth economies, some actors (most of the time firms) go bankrupt because their costs exceed their revenues (compare to the literature review in chapter 10).

The most sophisticated of these arguments has been formulated by Binswanger (12.3). Stock-flow-consistent models (12.4) provide an additional framework to analyse this issue. In these theories, it is crucial to clarify which actor has what type of revenues and costs. In order to connect it to the analyses by Keynes, Kalecki and Kaldor, it is helpful to briefly look again at the fundamental equations with the perspective of *who invests* and *who saves.*

First, production can be divided regarding the type of goods produced: consumption goods and capital goods (which are investments).[29] Consumption goods are bought and consumed by households (C_H), while capital goods are bought and used by firms (I_F):

$$Y = C_H + I_F. \qquad (14.5)$$

[29] Government spending is left out for purposes of simplicity.

Second, production is at the same time income, which can be divided into consumption by households (C_H) and savings by households (S_H):

$$Y = C_H + S_H. \tag{14.6}$$

This leads to the familiar identity between investments and savings, only that here it has been made explicit that the former are conducted by firms and the latter by households:

$$I_F = S_H. \tag{14.7}$$

For the moment, it is assumed that savings are conducted by those households who own the firms.[30] They possess the firms' capital stock, which changes due to investments and due to capital depreciation:

$$\Delta K = I - \delta K. \tag{14.8}$$

In growth economies, this implies that the owners of firms each period accumulate assets in the size of ΔK. In zero growth economies, on the other hand, investments are equal to capital depreciation, so that firm owners do not accumulate assets ($\Delta K = 0$). In other words: In zero growth economies, the net savings of firms (or their owners' savings) are equal to capital depreciation.

The causal logic is as follows: Firms invest at the same level as capital depreciation takes place. This generates the necessary savings (revenues above costs) in order to pay back the loans taken for investments.[31]

If it is assumed that only firms (or their owners) save, the situation is as simple as pointed out above. In principle, it is also possible that other actors (in particular households, the government or the banking sector) save. This implies though that another actor has to go in debt. The continuous saving of one group of actors therefore tends to contradict economic stability, as it requires a continuously increasing debt of another group of actors.[32][33]

30 This is similar to the common assumption that only capitalists save.

31 Note that the firms are able to pay back the loans plus interest payments under the conditions that the earners of the interest payments use this income to buy the goods from the firms (see sections 12.3 and 12.4).

32 See the theory by Godley and Lavoie (12.4).

33 Note that the situation is similar in growing economies. Here – apart from the accumulation of tangible assets – an accumulation of assets by one actor is also accompanied by an accumulation of debt by another actor. A

In order to facilitate stable economies without growth, conditions therefore have to guarantee balanced accounts of the different groups of economic actors.[34] That implies, among others, a balanced public budget[35], no asset accumulation in the banking sector[36] and accumulation of a subgroup of the households[37].

The macroeconomic conditions need to facilitate such balanced accounts. Depending on the specific circumstances, this would imply redistribution by the state from those actors who accumulate assets towards those who accumulate debt.

14.1.4 Contradiction Between a High Wage Share and Low Investments?

There seems to be a contradiction concerning two conditions for zero growth. On the one hand, profits and the profit share have to be comparatively low in zero growth economies in order to have low savings. On the other hand, wages and the wage share need to be low, because high wages imply high consumption demand, which fosters investments and economic growth.[38]

Based on the Keynesian theories covered here, two answers to this contradiction appear. First, according to several theories this contradiction does not exist.[39] Here, investments are either exogenously given, due to decisions of capitalists or determined by other factors than consumption demand. Consequently, the question is how these other factors need to be

prominent example in early industrialized countries during the past decades has been the accumulation of private assets, accompanied by increasing public debt. In growing economies, this situation may last longer without leading to a crisis, because economic growth and the expectation of future growth may increase the perceived solvency of actors, in this example the state.

34 This argument has been laid out in a comprehensive manner based on stock-flow-consistent models in section 12.4.

35 The only theory that refers to this issue is Monetary Keynesianism (12.2). There, a balanced budget increases economic growth, as it leads to lower income inequality and higher consumption demand. Under what circumstances low income inequalities are compatible with zero growth economies is discussed below.

36 As argued based on Binswanger's theory (12.3).

37 This in particular contrasts the ability of capitalists to accumulate assets, see Kalecki's theory (12.3).

38 See section 11.7 on Robinson's theory. This contradiction is also present in existing discussions on economies without growth (see chapter 3).

39 In particular, the theories of Harrod (11.2), Domar (11.3), Kalecki (11.5) and Kaldor (11.6).

in order to generate investments in accordance with zero growth. These low investments lead to a low profit share and a high wage share, which does not contradict the low investments.

In other theories, consumption demand plays an important role for the determination of investments. Consumption demand depends on the propensity to consume, which is strongly influenced by income distribution, which in turn depends on the functional income distribution between wages and profits. Here, a high wage share is therefore connected to high consumption demand.[40] In these theories, there are also other determinants of investments though (as discussed in detail above). Hence, other factors would need to negatively influence the propensity to invest in order to countervail the positive effect of a more equal distribution of income.

14.1.5 Intermediate Results: Towards Scenario I

The conditions developed so far can be summarized as follows: Investments are equal to capital depreciation. This is facilitated by a combination of multiple factors. Most importantly, though, the demand for final goods (consumption by households and government spending) stays constant over time and is expected to stay constant. This is (among other aspects) facilitated by working hours reductions that transform technologically induced increases in labour productivity into higher wages per hour and keep total wages constant. Savings are only at the level as needed for capital depreciation. This implies that no group of economic actors can continuously accumulate assets, because this would imply a continuous accumulation of debts of another group of actors. This set of conditions is reflected in a formal manner in Scenario I.

These conditions are based on the assumption that technological change is of the type assumed in most Keynesian theories: It decreases the labour coefficient (increases labour productivity), while keeping the capital coefficient constant.

Based on some of the Keynesian theories, two other perspectives on technological change can be developed – one concerning redirected technological change and one concerning sectoral change. This changes the conditions concerning the level of investments and whether working hours reductions are necessary. As it does not alter the situation concerning savings (they still need to equal the level of investments and be low), the issue of savings is not discussed separately below.

[40] These are in particular the theories by Keynes (11.1), Robinson (11.7), Davidson (12.1) and Betz (12.2).

Table 14.1: Summary of the Results From Keynesian Theories

(1) Theory	(2) Determinants of economic growth	(3) Conditions for zero growth	(4) Environment	(5) Distribution	(6) Stability
Keynes	Economic growth is due to increases in the level of effective demand, which is based on the intersection between aggregate supply and demand. Supply depends on technology and demand on investments and consumption.	Aggregate demand is constant due to constant consumption demand (based on reductions in working hours in line with technological change and constant wages) and constant government spending. Investments adjust due to low expected revenues.	Material use is mentioned, but environment is no explicit issue.	Low income inequalities tend to increase effective demand. This can be countervailed by changes in preferences, lower government spending and/or lower investments.	Zero growth leads to unemployment, which needs to be reacted upon by working hours reductions. In other respects zero growth is stable.
Harrod	Actual growth is determined by the level of investments. (Warranted growth is due to savings and natural growth is due to labour supply.)	Zero investments lead to zero growth. When capital depreciation is taken into account, gross investments have to be equal to capital depreciation.	Plays no significant role in the theory.	Plays no significant role in the theory.	Zero growth economy is as (un-)stable as growing economy, as no mechanisms automatically reconciles the different growth rates.
Domar	Economic growth entails growth in supply and demand. Increases in supply are determined by the level of investments and on average investment productivity. Increase in demand are due to changes in investments.	Zero investments lead to zero growth. When capital depreciation is taken into account, gross investments have to be equal to capital depreciation. Additionally, investments may not change over time.	Plays no significant role in the theory.	Plays no significant role in the theory.	Zero growth is stable as capacity and demand effects are of equal size.

Neo-classical Synthesis	The equilibrium between aggregate supply and demand determines the level of production. Supply depends on unemployment, labour market regulations, labour unions, firms' market power and the state of technology. Demand is determined by the income level, consumption behaviour, investment behaviour, government spending, liquidity preference and the money supply.	Either all determinants of aggregate supply and demand need to stay constant or the shift of some are compensated by an opposing shift of others.	Plays no significant role in the theory.	Plays no significant role in the theory.	Zero growth is stable. Shift of one factor only changes the level, not growth rate.
Kalecki	Investments are the central determinant. They depend on technological change, firms' savings, (changes in) profits and (changes in) the capital stock.	Investments and capital depreciation need to be of same size, either by decreasing investments or by increasing depreciation. Working hours reductions are necessary to avoid unemployment.	Material use is one input factor. It decreases per unit of production due to technological change and therefore declines in a zero growth economy.	The functional income distribution depends primarily on firms' mark-ups, which in turn depends on firms' market power and unions bargaining power.	Zero growth is stable. Business cycle fluctuations can take place around a constant level of production.
Kaldor	The availability of new technologies fosters investments and investments lead to the introduction of new technologies. Both together increase the labour productivity and the capital stock and hence determine economic growth.	Investments need to be kept at level of depreciation. Working hours reductions are necessary to avoid unemployment.	Plays no significant role in the theory.	Low savings out of profits and wages are necessary to generate low overall savings so that savings equal investments. As the savings out of profits is assumed to be high, profits need to be low.	No instabilities.

Robinson	An inter-causal relationship between investments and profits determines economic growth. At the same time, increases in wages push aggregate demand and increase growth. Additionally, technological change takes place at different speeds in the consumption and the investments sectors and fosters investments in both sectors.	Investments due to increases in labour productivity in the consumption sector can be prevented by low consumption demand (combined with working hours reductions to avoid unemployment) and low government expenditures. Investments due to increases in labour productivity in the investments sector can be prevented by increasing the price of capital goods.	Choices of technique determine the combination of production factors. Increasing the price of natural resources in a zero growth economy leads to decreasing use of them.	Plays no significant role in the theory.	Apparent contradiction between necessary low wage share to have low demand and low profit share to have low investments. Possible reconciliation is an increase in the rate of capital depreciation.
Davidson	Economic growth is determined by investments. These depend on firms' behaviour, expected revenues, the supply of capital goods and a cooperation of the banking sector.	Zero growth requires zero net investments. The determinants of investments, in particular expected revenues, need to be of such nature that investments are not above depreciation.	Plays no significant role in the theory.	Plays no significant role in the theory.	Stationarity is impossible, as some factor always changes. Zero growth (with small fluctuations) is feasible though.
Binswanger	Each period firms increase expenditures, facilitated by loans from private banks. In doing so, they generate continuously increasing income, thereby facilitating continuous profits, which are necessary for investments. Firms' expansion is primarily caused by shareholder-interests.	Firms' expansion needs to be prevented, in particular by changing the business type to avoid shareholder-interest-driven behaviour of firms. To simultaneously allow for profits, asset accumulation in the banking sector is to be prevented.	Energy is necessary for the production process. Lower growth is therefore beneficial concerning environmental aspects.	Plays no significant role in the theory.	According to Binswanger, zero growth cannot be stable. Here, it is argued though that under the conditions outlined zero growth can be stable within his theory.

Godley & Lavoie	Economic growth is based on increases in labour productivity, expanding government expenditures and subsequent investments by firms, which are financed by retained earnings.	Zero growth requires constant government expenditures, no technological change or a reduction of average working hours and a disbursement of firms' entire revenues.	Plays no significant role in the theory.	Plays no significant role in the theory.	No instabilities.
Monetary Keynesianism	The supply and demand of capital goods determines the level of production. The central bank has to adjust the interest rate to achieve an equilibrium in the capital goods market.	Capital goods market has to be in the equilibrium with zero net investments, implying low supply and demand of capital goods. Additionally, interest earnings have to be used for consumptive purposes.	Plays no significant role in the theory.	Lower income inequality tends to increase effective demand and therefore demand for capital goods. Can be countervailed by changes in preferences.	Instability appears when central bank does not set interest rate at equilibrium level.
IS-LM-EE	Economic growth takes place in the same manner as in the IS-LM Model.	General conditions are the same as in the IS-LM Model.	Environmental outcomes can be improved in a zero growth economy by (1) contractionary fiscal policy and expansionary monetary policy in order to decrease the price for capital goods and (2) environmental regulations.	Plays no significant role in the theory.	No instabilities.
Harris	Economic growth is due to increases in aggregate demand, consisting of consumption, investments and government expenditures.	Constant aggregate demand.	Sectoral change from dirty to clean sectors decreases pollution. Investments in natural capital improve natural quality further.	Plays no significant role in the theory.	No instabilities.

Fontana and Sawyer	Economic growth depends on the output gap, the profit share, animal spirits, technological change and the ability to finance investments.	Zero growth requires either no financial facilitation of investments or low values for all the other determinants of investments.	Pollution depends on economic growth, the sum of production over time and research and development (which depend on economic growth). The effect of zero growth on the environment is ambiguous, compared to growing economies.	Plays no significant role in the theory.	No instabilities.

14.1.6 Redirected Technological Change: Towards Scenario II

Robinson (and to a lesser extend Kalecki) points out that the choice of techniques depends on the relative prices of production inputs. While Robinson limits the discussion to physical capital and labour, this can in principle be extended to natural resources. The basic idea is that firms can choose between different technologies and opt for the one with the lowest production costs. Therefore, the relative price of production inputs influences the type of technologies applied and the type of technological change in the long run.

When the relative price of physical capital increases compared to the price of labour (for example, due to significantly different tax-policies), the technological change is less and more capital-saving. At some relation of factor prices, technological change leads to constant a labour coefficient and a decreasing capital coefficient. If this situation is to be combined with zero growth, the capital stock needs to decline over time – as production becomes less capital-intensive. Investments would therefore be below capital depreciation. This still implies that aggregate demand and expected revenues stay constant over time. Also the other determinants of investments would need to be in a similar constellation as in the prior case, as the increasing tax on physical capital is the major difference and reason for lower investments.

A major difference to the prior type of technological change is that no working hours reductions are needed in order to keep employment constant. The reason is that the labour coefficient stays constant over time. This also implies that the hourly wage as well as average total wage stay constant over time. This case is represented in a formal manner in scenario II.

14.1.7 Sectoral Change: Towards Scenario III and IV

A further set of conditions for sustainable economies without growth can be developed based on Harris' theory. A sectoral change of demand from dirty towards clean products (both by the government and by consumers) alters the composition of goods produced. It is assumed that the clean sector is depicted by a higher labour coefficient and lower capital and resource coefficients than the dirty sector. As a result, the sectoral change leads to more employment and less demand for physical capital and natural resources.

When such a sectoral change is combined with the traditional type of technological change from scenario I, a certain speed of sectoral change is related to constant employment without unemployment. The reason is that the sectoral change leads to increases in employment and the technological change decreases employment. This situation is depicted in scenario III.

Employment increases when the sectoral change is combined with the redirected technological change from scenario II. While the sectoral change increases employment, the technological change does not alter it. This is illustrated in a formal manner in scenario IV.

14.2 Four Scenarios for Economies Without Growth

The results from the Keynesian theories are used to develop four scenarios for economies without growth. The development of these scenarios follows a similar but not entirely identical logic as for the neoclassical theories. In the neoclassical case, different scenarios have been based on different explanations why the economy grows. Therefore, in each scenario growing economies have been depicted before developing conditions for zero growth. The scenarios following Keynesian theories on the contrary, all build upon the same understanding of economic growth. The different scenarios represent different manners to transform this growth economy into a zero growth economy.

The accompanying structure of the chapter is as follows. Initially, a reference theory is developed that illustrates central Keynesian mechanisms on how the economy works. This reference theory is used to illustrate conditions for steady growth. Afterwards, four different zero growth scenarios are developed. In scenario I, technological change with constant capital coefficient and decreasing labour coefficient is combined with reductions in average working hours, constant total wages and constant aggregate demand. In the second scenario, a redirection of technological change (based on changes in factor prices) decreases the capital coefficient and keeps the labour coefficient constant. Here, net investments need to be negative to achieve a zero growth economy. In scenario III, technological change is as in scenario I once more. But a sectoral change from dirty towards clean production increases the average labour coefficient, so that reductions in working hours are not/less necessary. Finally, scenario IV combines the redirection of technological change of scenario II with the sectoral change of scenario III. The outcome is increasing employment despite zero growth.

14.2.1 Reference Theory

14.2.1.1 Intuition and Relation to Keynesian Theories

The central condition for steady state growth is that the levels of aggregate demand and aggregate supply need to grow at equal rates. Aggregate demand consists of consumption, investments and government spending.

Consumption depends on the level of wage income[41]. When wages rise, so does consumption. Government expenditures are exogenously given[42]. Investments depend on expected future revenues. When firms experience constantly increasing consumption and government spending, they also expand production appropriately[43] Note the inter-causal relation between consumption and government spending on the one hand and investments on the other. Larger consumption and government spending lead to higher revenues, which fosters investments. Investments increase wages and thereby foster consumption[44]

Aggregate supply depends on the development of the capital stock and technological change. In the reference theory, it is assumed that technological change keeps the capital coefficient constant and decreases the labour and the material coefficients. This is based on the understandings on technological change of almost all Keynesian authors[45] The reason for the constant capital coefficient are opposing effects of technological change on capital intensity and labour productivity. On the one hand, new technologies increase the capital intensity, which leads to a higher capital coefficient. On the other hand, new technologies also increase labour productivity, which decreases the necessary capital per production (for a given capital intensity). The effect of technological change on the capital coefficient is therefore ambiguous. Based on empirical observations of the past, the capital coefficient is assumed to stay constant[46].

Technological change decreases the amount of employment per production, by decreasing the labour coefficient. This negative effect on employment can be balanced out by an expansion of production. In order to generate constant employment, the rate of economic growth needs to equal the rate of shrinkage of the labour coefficient[47].

Technological change also influences the environment. Earlier contri-

[41] This argument is based on the discussions on the theories by Keynes (11.1) and Kalecki (11.5).

[42] This argument is based on the discussions on the theories by Godley & Lavoie (12.4).

[43] This argument is based on the discussions on the theories by Keynes (11.1), Davidson (12.1) and Binswanger (12.3).

[44] This argument is based on the discussions on the theories by Keynes (11.1) and Robinson (11.7).

[45] This argument is based on the discussions on the theories by Keynes (11.1), Kalecki (11.5), Kaldor (11.6), Robinson (11.7), Godley & Lavoie (12.4) and Fontana & Sawyer (13.3).

[46] This argument is based on the discussions on the theories by Kaldor (11.6).

[47] This argument is based on the discussions on the theories by Keynes (11.1) and Fontana & Sawyer (13.3).

butions[48] include the costs of materials into their analysis. Technological change decreases the amount of materials needed. Material use and the subsequent environmental impact therefore depend on technological change on the one hand and the development (growth) of production on the other.[49]

14.2.1.2 A Formal Model

a Aggregate demand and supply

Aggregate demand (Y_D) consists of the three components consumption (C), investments (I) and government spending (G):

$$Y_D = C + I + G. \tag{14.9}$$

Therefore, assuming that the relative sizes of the three components stay constant over time, the growth rates of each of them (g_C, g_G and g_I) are equal to the growth rate of aggregate demand (g_{YD}):

$$g_{YD} = g_C = g_I = g_G. \tag{14.10}$$

Aggregate supply (Y_S) is equal to the proportion between the capital stock (K) and the technologically determined capital coefficient (v), as long as the capacity utilization stays constant:

$$Y_S = \frac{K}{v}. \tag{14.11}$$

Therefore, the growth rate of supply (g_{YS}) needs to be equal to the growth rate of the capital stock (g_K) minus the growth rate of the capital coefficient (g_v) to keep the capacity utilization constant:

$$g_{YS} = g_K - g_v. \tag{14.12}$$

b Labour demand and supply

Labour demand (L_D) is determined by the labour coefficient (l), which is technologically given, and the level of production (Y):

$$L_D = lY. \tag{14.13}$$

48 This argument is in particular Kalecki (11.5).

49 This argument is based on the discussions on the theories by Fontana & Sawyer (13.3).

Changes in the labour coefficient depend on technological change, which in turn is a function of investments. The growth rate of labour demand (g_{LD}) is determined by the growth rate of the labour coefficient (g_l) and the growth rate of production (g_Y):

$$g_{LD} = g_l + g_Y. \tag{14.14}$$

Labour supply depends on three aspects: the population size (B), the labour participation rate (Q) and average working hours (H):

$$L_S = BQH. \tag{14.15}$$

The growth rate of labour supply (g_{LS}) is hence according to the growth rates of population (g_B), the labour participation rate (g_Q) and average working hours (g_H):

$$g_{LS} = g_B + g_Q + g_H. \tag{14.16}$$

In the following, it is assumed (as throughout this work) that the size of population stays constant and the labour participation rate does not change either. Equation 14.16 therefore simplifies to

$$g_{LS} = g_H. \tag{14.17}$$

c Material use

Pollution depends on material use. It is assumed that pollution is in a given proportion to material use, so that only the level of the latter is discussed in the following. Material use is in a certain relation (μ_r)[50] to production that changes due to technological change:

$$M = \mu_r Y. \tag{14.18}$$

The growth rate of pollution and material use are therefore determined by the rate of change of the material coefficient and the rate of economic growth:

$$g_M = g_{\mu_r} + g_Y. \tag{14.19}$$

50 μ stands for the monetary costs related to material use in Kalecki's theory (see section 11.5). μ_r, on the other hand, determines the *real* amount of materials used per unit of production.

d Positive growth

In a growing economy, aggregate demand increases due to expansions of its three components. Entrepreneurs expect higher revenues, so that they continuously expand investments ($g_I > 0$). This leads to higher wages and higher consumption over time ($g_C > 0$). In order to prevent unemployment, the government also expands spending ($g_G > 0$). As argued above, the three components need to grow at the same rates in order to generate stable growth. This rate is at the same time the growth rate of aggregate demand (g_{YD}):

$$g_{YD} = g_C = g_I = g_G > 0. \qquad (14.20)$$

Assuming constant capacity utilization, aggregate supply needs to grow at the same speed. As the capital coefficient does not change due to technological change ($g_v = 0$), the capital stock needs to grow at the same rate as aggregate demand:

$$g_{YS} = g_K = g_{YD} > 0. \qquad (14.21)$$

The growth rate of the capital stock depends on investments and capital depreciation. Investments are therefore certainly above capital depreciation. The exact necessary size of investments depends on the capital coefficient and the rate of depreciation. It is assumed that average working hours stay constant, so that the labour supply does not change:

$$g_{LS} = g_H = 0. \qquad (14.22)$$

In order to have a constant level of employed people, labour demand therefore needs to stay constant as well. This is the case when the growth rate of the labour coefficient is equal to the rate of economic growth (only with opposite signs, compare equation 14.14):

$$g_Y = -g_l. \qquad (14.23)$$

Material use depends on the size of the effect of technological change on material intensity. When it decreases faster than production increases, pollution declines (compare equation 14.19):

$$g_{\mu_r} \gtreqless g_Y. \qquad (14.24)$$

14.2.2 Scenario I: Standard Technological Change

14.2.2.1 Intuition and Relation to Keynesian Theories

Almost all Keynesian theories assume a the type of technological change that keeps the capital coefficient constant and decreases the labour coefficient. In the case of such technological change, zero growth requires several conditions which are interlinked.

On the supply side, zero growth necessitates investments that replace the production capacity, which gets lost due to capital depreciation. Such investments are smaller than in growing economies but stay constant over time. A level of investments that does not expand production capacity requires relatively low expected future revenues. To be precise, aggregate demand needs to be expected to stay constant, so that firms only attempt to build up a capital stock that can deliver a constant level of goods. Actual aggregate demand therefore needs to stay constant, as expectations are strongly influenced by experience, in order to facilitate constant aggregate supply.

Aggregate demand additionally has to stay constant because this is the other central condition for invariable effective demand. The three components of aggregate demand therefore also have to remain steady. Investments stay constant based on the argument above. Government spending does not change due to appropriate decisions of the government. Finally, consumption also must not grow or shrink. This requires a constant level of income, in particular wage income. This is facilitated by working hours reductions. A redistribution of labour based on reductions in average working hours, combined with an increase in hourly wages that equals the increase in labour productivity leads to constant absolute wages and constant employment at the same time.

The causal chain runs from aggregate demand towards investments and aggregate supply. The government takes a central role. It can convincingly promise to keep its spending constant and at the same time set labour market conditions that facilitate reductions in average working hours. For zero growth to take place, entrepreneurs and consumers have to react in certain manners. First, both together need to facilitate continuous reductions in working hours. Second, entrepreneurs need to restrict the introduction of new technologies to a replacement (and not an expansion) of production capacities. As argued above, a change in the prevalent business type from a shareholder-driven to a collectively owned form would support such decisions.

14.2.2.2 Conditions for Sustainable Economies Without Growth in Scenario I

In a zero growth economy, aggregate demand and its components (consumption, investments and government expenditures) stay constant:

$$g_{YD} = g_C = g_I = g_G = 0. \tag{14.25}$$

The capital stock needs to stay constant, as technological change does not alter the capital coefficient ($g_v = 0$). The condition is therefore that (compare with equation 14.21)

$$g_K = 0. \tag{14.26}$$

Compared to a growing economy, investments therefore either need to be relatively lower or the depreciation rate higher, or a combination of both, so that gross investments equal capital depreciation.

Labour demand decreases at the same speed as the labour coefficient declines due to technological change[51] (the reason is that the rate of economic growth is zero, compare to equation 14.14):

$$g_{LD} = g_l. \tag{14.27}$$

In order for labour supply to equal labour demand, labour supply has to decrease as well. Average working hours have to decrease at the same rate as the labour coefficient decreases:

$$g_H = g_l. \tag{14.28}$$

Material use declines as economic growth is zero and material intensity falls:

$$g_M = g_{\mu_r}. \tag{14.29}$$

The central conditions for this first scenario are therefore a restriction of investments to the level of capital depreciation and reductions in working hours. The environmental impact solely reduces due to technological change.

[51] Technological change still takes place, as investments are positive. An exact proportion between technological change and investments is not specified in most theories. Usually, it would be argued though that technological change is slower when investments are at a lower level.

14.2.3 Scenario II: Redirected Technological Change

14.2.3.1 Intuition and Relation to Keynesian Theories

Robinson (and less explicitly Kalecki) argue that technological change depends on the relative prices of the production factors. Firms can choose among a set of different technologies (techniques). Each technology implies unique proportions between the production factors (labour, capital and materials). The higher the price of one factor, the lower the factor's coefficient is in the technology the firms choose. The type of technological change assumed in the previous scenario is therefore the outcome of certain relative factor prices. If these are changed, the path of technological change is redirected.

One possible – and for economies without growth constructive – manner is to decrease the price of labour and to increase the price of materials and capital. Such conditions lead to a decrease of the capital coefficient, a faster decrease of the material coefficient (compared to scenario I) and less decline in the labour coefficient (also compared to scenario I). The Keynesian theories discussed do not provide a framework to specify the size of price changes that are necessary to generate a certain development of the factor coefficients. In the following, a possible scenario is described, in which prices are changed in such a manner that the labour coefficient stays constant. This also leads to a decline in the capital coefficient and an accelerated reduction of the material coefficient.

The change of relative prices and the subsequent redirected path of technological change have succeeding effects on the economy and therefore imply altered conditions for economies without growth. First, average working hours need to stay constant, in order to keep the level of employment steady. Second, a continuously decreasing capital coefficient implies a continuously decreasing capital stock. Therefore, investments have to be below capital depreciation. Also, the capital goods sector shrinks over time as the capital coefficient declines. This implies that consumption and government spending make up a growing part of production.

14.2.3.2 Conditions for Sustainable Economies Without Growth in Scenario II

Aggregate demand is constant as in scenario I. Investments are lower and consumption and government spending are larger than in scenario I, however. The growth rates of the three components of aggregate demand nevertheless stay constant over time:

$$g_{YD} = g_C = g_I = g_G = 0. \tag{14.30}$$

Technological change decreases the capital coefficient at the rate $g_v < 0$.

In order to achieve constant aggregate supply, the rate of decline of the capital stock needs to decrease at the same rate as the capital coefficient declines, as production stays constant (compare to equation 14.21):

$$g_K = g_v < 0. \tag{14.31}$$

This implies either that gross investments are lower, or capital depreciation is higher, than in scenario I. The labour coefficient stays constant. Therefore, labour demand does not change over time (compare to equation 14.14):

$$g_{LD} = g_l + g_Y = 0. \tag{14.32}$$

In order to have equal labour demand and supply, the supply therefore needs to stay constant as well. Average working hours have to stay the same (compare to equation 14.17):

$$g_H = 0. \tag{14.33}$$

Pollution declines as in scenario I, according to the speed of technological change:

$$g_M = g_{\mu_r}. \tag{14.34}$$

The environmental effects of scenario II (compared to scenario I) are ambivalent. On the one hand, technological change should reduce material use due to its higher price. On the other hand, the technological change is slower for the same level of capital depreciation, as net investments are lower. Which effect prevails cannot be answered with the present theoretical basis.

14.2.4 Scenario III: Standard Technological Change and Sectoral Change

14.2.4.1 Intuition and Relation to Keynesian Theories

Harris argues for a sectoral change that shifts production from dirty to clean sectors. Such a sectoral change makes sense environmentally, because the material coefficient of production in clean sectors is lower than in dirty sectors.[52] Concerning zero growth economies, a second difference

[52] Note that this assumption is different to the original contributions by Harris and also to the assumptions in the theories of Directed Technical Change with Environment of section 8.5. In both, it is assumed that clean sectors have zero pollution.

between the two sectors is similarly important. Harris argues that the labour coefficient is higher in clean than in dirty sectors. Therefore, a sectoral change increases employment.

Aggregate demand in a zero growth economy still is constant with sectoral change. The composition changes, however. All three components – consumption, investments and government spending – gradually change from dirty to clean sectors. It is assumed that the capital coefficients are equal in both sectors. Therefore, the capital stock needs to stay constant as in scenario I. The development of labour demand is unclear, as there are opposing effects on it. On the one hand, sectoral change increases the demand for labour. On the other hand, technological change decreases the labour coefficient and subsequently labour demand. Depending on the relative sizes of these two effects, average labour hours need to increase or decrease, in order to facilitate zero growth.

14.2.4.2 Conditions for Sustainable Economies Without Growth in Scenario III

Aggregate demand consists of clean and dirty consumption (C_c, C_d), investments (I_c, I_d) and government spending (G_c, G_d):

$$Y_D = C_c + C_d + I_c + I_d + G_c + G_d. \tag{14.35}$$

The increase in each of the clean parts is accompanied by a decrease of its dirty counterpart of equal size:

$$\frac{dC_c}{dt} = -\frac{dC_d}{dt} \quad \text{and} \quad \frac{dI_c}{dt} = -\frac{dI_d}{dt} \quad \text{and} \quad \frac{dG_c}{dt} = -\frac{dG_d}{dt}. \tag{14.36}$$

The sizes of overall consumption, investments and government spending hence do not change and neither does aggregate demand:

$$g_C = g_I = g_G = 0 = g_{YD}. \tag{14.37}$$

As it is assumed that the capital coefficient is equal in both sectors, the capital stock stays constant as in scenario I:

$$g_K = 0. \tag{14.38}$$

The labour coefficients of the clean (l_C) and the dirty (l_D) sectors are different. Therefore, the labour demand changes (compare with equation 14.13) to:

$$L_D = l_C(C_c + I_c + G_c) + l_D(C_d + I_d + G_d) = l_C Y_c + l_D Y_d, \quad (14.39)$$

with Y_c representing demand in the clean Y_d denoting demand in the dirty sector. As consumption, investments and government expenditures increase in one sector to the same extent as they decrease in the other, the changes of production in the two sectors are of equal size and have opposite signs. The speed of sectoral change ($\frac{d\Omega}{dt}$) is therefore given according to:

$$\frac{d\Omega}{dt} = \frac{dY_c}{dt} = -\frac{dY_d}{dt}. \quad (14.40)$$

Furthermore, it is assumed that the labour coefficients decline at the same speed in both sectors due to technological change. This common speed is denoted with $\frac{dl}{dt}$:

$$\frac{dl}{dt} = \frac{dl_C}{dt} = \frac{dl_D}{dt}. \quad (14.41)$$

Derivating equation 14.39 and including equations 14.40 and 14.41 gives the change in labour demand:

$$\frac{dL_D}{dt} = Y\frac{dl}{dt} + (l_C - l_D)\frac{d\Omega}{dt}. \quad (14.42)$$

The growth rate of labour demand is therefore

$$g_{LD} = g_l + \frac{(l_C - l_D)}{L}\frac{d\Omega}{dt}. \quad (14.43)$$

The condition for labour demand to stay constant, is accordingly

$$g_l = -\frac{(l_C - l_D)}{L}\frac{d\Omega}{dt}, \quad (14.44)$$

The labour demand does not change when the (negative) growth rate of the labour coefficients (g_l) is in a certain proportion to the speed of sectoral change ($\frac{d\Omega}{dt}$). The relation depends on the difference between the labour coefficients in the two sectors (l_C and l_D). The intuition behind this is as follows: When the labour coefficient in the clean sector is much larger than in the dirty sector, the sectoral change does not have to be that fast in order to compensate for the negative effect of technological change on labour demand.

Labour supply is given as before. When working hours are not reduced, labour supply is constant and the condition for steady employment is given by equation 14.44. When the sectoral change does not suffice to compensate for the decrease of labour demand due to technological change, reductions in average working hours ($g_H < 0$) can bring labour demand and supply to be equal. The relation is given by

$$g_l + \frac{(l_C - l_D)}{L}\frac{d\Omega}{dt} = g_H. \tag{14.45}$$

Material use develops along similar lines as labour demand. Recall that material use depends on the size of production and the material coefficient (see equation 14.18). The determination of material use differs from the previous scenarios, as the clean and dirty sectors have different material coefficients. Material use (M) is now determined due to the sizes of production in the clean and the dirty sectors (Y_c and Y_d) and the respective material coefficients (μ_{rC} and μ_{rD}):

$$M = \mu_{rC} Y_c + \mu_{rD} Y_d. \tag{14.46}$$

As for the labour coefficients, it is assumed that the material coefficients decline by the same rate in both sectors:

$$\frac{d\mu_r}{dt} = \frac{d\mu_{rC}}{dt} = \frac{d\mu_{rD}}{dt}. \tag{14.47}$$

Equation 14.46 is derivated to time and equations 14.40 and 14.47 are used in order to obtain the change in material use:

$$\frac{dM}{dt} = Y\frac{d\mu_r}{dt} + (\mu_{rC} - \mu_{rD})\frac{d\Omega}{dt}. \tag{14.48}$$

The growth rate of material use is therefore

$$g_M = g_{\mu_r} + \frac{(\mu_{rC} - \mu_{rD})}{M}\frac{d\Omega}{dt}. \tag{14.49}$$

Material use declines due to two factors. The first is the rate at which material use per unit of production decreases (g_{μ_r}). Second, the sectoral change leads to less use of materials. Its effect depends on the relative difference in the material intensity of the two sectors ($\frac{(\mu_{rC} - \mu_{rD})}{M}$) and on the speed of sectoral change ($\frac{d\Omega}{dt}$).

14.2.5 Scenario IV: Redirected Technological Change and Sectoral Change

14.2.5.1 Intuition and Relation to Keynesian Theories

A fourth possible scenario is that the technological change depicted in scenario II is combined with a sectoral change along the lines of scenario III. Scenario IV therefore depicts a combination of mechanisms developed by Robinson and Kalecki on the one hand and Harris on the other. Sectoral change is initiated by changes in the behaviour of consumers, entrepreneurs and the government. The redirected technological change takes place due to changes in factor prices, which are implemented by economic policies. The result is increasing employment despite zero growth.

14.2.5.2 Conditions for Sustainable Economies Without Growth in Scenario IV

Aggregate demand is divided into clean and dirty components as in scenario III (see equation 14.35 and 14.36). Following the reasoning of scenario II, investments take a lower share of production. Investments are below capital depreciation, so that the capital stock declines at the same rate as the capital coefficient decreases (compare equation 14.31).

The determination of labour is a combination of scenario II and III. As in scenario II, the labour coefficient stays constant. As in scenario III, the coefficients are different between the different sectors. Labour demand is determined according to

$$L_D = l_C Y_c + l_D Y_d. \tag{14.50}$$

As in scenario III, it is assumed that the increase in production in the clean sector is equal in size to the decrease in production in the dirty sector (see equation 14.40). The labour coefficients l_C and l_D stay constant, however. By derivating equation 14.50 the change in labour demand is calculated:

$$\frac{dL_D}{dt} = (l_C - l_D)\frac{d\Omega}{dt}. \tag{14.51}$$

The growth rate of labour demand is hence according to

$$g_{LD} = \frac{l_C - l_D}{L}\frac{d\Omega}{dt}. \tag{14.52}$$

The labour coefficient of the clean sector is larger than the labour coefficient of the dirty sector ($l_C > l_D$). Hence, labour demand increases in this scenario ($g_{LD} > 0$). The economic reason is that technological change does not decrease the amount of labour needed (but keeps it constant) and the sectoral change increases the labour demand. In order to keep labour demand and supply equal, average working hours therefore need to *increase*:

$$g_{LD} = g_{LS} = \frac{l_C - l_D}{L}\frac{d\Omega}{dt} = g_H > 0. \tag{14.53}$$

Pollution declines according to the same equation (14.49) as in the previous scenario. Whether pollution declines faster in scenario III or IV is unclear. The reason is the same as for the comparison between material use in scenario I and II. On the one hand, the redirected technological change leads to a faster decrease of the material coefficient. On the other hand, lower investments imply a slower speed of technological change.

14.2.6 Summary and Discussion

The first three scenarios reflect three different strategies how to decrease material use. In the first, increasing labour productivity is not used for economic growth but to reduce average working hours. In the second scenario, technological change is redirected – by use of price incentives – to decrease the inputs of materials and capital instead of decreasing labour. In the third scenario, sectoral change shifts production from clean to dirty products. These three strategies can be combined. Scenario IV illustrates one possible combination, with a focus on the second and third strategies.

Environmental outcomes are different across scenarios. One central question is how strongly the size of investments influences the development of the material coefficient. As argued above, this determines which of the scenarios delivers better results. When technological improvements are only weakly dependent on high levels of investments, scenarios II and III generate better environmental results than scenario I. Scenario IV generates the best results.

It has been shown in all four scenarios how full employment can be achieved. In scenario I, it is due to working hours reductions. In scenario II, it is based on redirected technological change that does not decrease the labour coefficient. In scenario III, the reason for full employment despite decreasing labour coefficients is the sectoral change towards sectors with higher labour coefficient. Scenario IV generates increasing employment due to the combined mechanisms of scenario II and III. One possible manner to generate constant employment in scenario IV instead is to induce a technological change that decreases both the labour and the resource coefficients.

The conditions for zero growth economies of section 14.1 apply (in general) to all four scenarios. The underlying logic of all scenarios is that certain conditions (constant consumption and constant government spending) lead to constant final goods demand. This fact combined with additional factors lead to investments that solely replace (and do not expand) existing production capacities by new ones.

One difference between the scenarios is the level of investments. They are lower in scenario II and IV than in I and III. The reason is the redirected type of technological change, which needs fewer capital goods. A sensible reason is a higher rate of capital depreciation (for example, caused by dismantling dirty capital goods by government intervention). In this manner, investments can still take place at a significant level and facilitate technological change in scenarios II and IV. As the level of production stays constant in all scenarios, questions regarding the relation between consumption and savings are the same in all scenarios (compare with section 14.1.3).[53]

14.3 Environment, Distribution and Stability

In the following, the results for the other three research subquestions are briefly summarized (compare with table 14.1).

14.3.1 Environment

In most Keynesian theories, the environment plays no role. At the most, it is accommodated indirectly, by including material costs into the analysis (this is particularly present in Kalecki's and Robinson's work). There are a few recent contributions that attempt to incorporate the environment into Keynesian analysis. The most promising have been discussed in chapter 13, which propose four manners to decrease environmental impact. First, production can be decreased, as the material coefficient is given. Second, changes in factor prices can induce the introduction of more environmentally friendly technologies (see section 11.7). Third, natural resources can be substituted by physical capital (see section 13.1). Fourth, a sectoral change can shift production towards clean sectors (see section 13.2). Finally, increasing efforts in research can decrease pollution intensity (see section 13.3).

Based on the standard type of technological change, there is a trade-off between environmental concerns on the one hand and full employment on the other. Economic growth is needed to achieve full employment, but this contradicts environmental sustainability. The reference theory and the four scenarios illustrate different ways of reconciling this contradiction, as discussed above. This analysis has shown that – as long as

53 This requires that the profit share is equal across sectors.

large investments do not strongly increase the reduction of the material coefficient due to technological change – the scenarios for zero growth economies generate better environmental results than growing economies.

14.3.2 Distribution

There seems to be a contradiction when it comes to the role of distribution in economies without growth: "It is a somewhat paradoxical result that lower growth could involve a higher ratio of consumer expenditure (lower savings) to output" (Fontana and Sawyer, 2015, p. 82).

On the one hand, within Keynesian frameworks it is usually argued that low inequality fosters economic growth. This argument goes back to Keynes' theory (see section 11.1). Low income inequality implies a higher propensity to consume, which increases consumption. Therefore, it leads to higher aggregate demand, which increases output directly and additionally fosters investments, thereby pushing economic growth.

On the other hand, the results of the investigation of Keynesian theories are that distribution either plays no role or that income inequality needs to be lower than in growing economies. The reason is that lower investments mean also lower savings, which implies a higher consumption share ($\frac{C}{Y}$). Following common Keynesian assumptions, such a higher consumption share requires a lower level of income inequality. For example, within Kalecki's framework, a higher wage share (and therefore a lower profit share) leads to higher consumption. Or, in Keynes analysis, lower inequality increases consumption.

The contradiction is resolved by taking into account what is cause and what is effect. In growing economies, investments increase both capacities and income. A higher propensity to consume here increases revenues and fosters investments. In a zero growth economy, investments need to be low. The low investments cause lower profits and lower savings. Thereby, the consumption share increases. If consumption increases in the situation of a zero growth economy the necessary condition for zero growth is that investments do not respond to the higher aggregate demand. The increased consumption therefore leads to a higher capacity utilization. This leads firms to increase prices, which – as long as wages stay constant – increases the profit share and decreases the wage share. As a result, income inequality is increased and the consumption share declines.

14.3.3 Stability

Keynesian analyses indicate two types of potential instabilities in a zero growth economy. First, it can lead to unemployment and thereby require actions due to social or political reasons that antagonize zero growth. In particular, governments may increase spending in order to increase aggregate demand so that more employment is generated. Keynesian theories offer two alternative routes. Either unemployment is prevented by a redistribution of working hours (see scenario I), or the technological change is redirected (see scenario II).

The second instability refers to potential downward or upward spirals. According to Binswanger (2006a), the economy is characterized by a self-reinforcing chain of events that either leads to economic growth or economic shrinkage. On the contrary, in this present work it has been argued that under certain conditions – in particular when interest revenues are used for consumption – the economy can be stable without growth. But there are also feedback loops in other Keynesian theories which may contradict zero growth. The general mechanism is that any increase/decrease in investments or consumption demand triggers an increase/decrease of the other and can thereby lead to reinforcing upwards or downwards feedback loops.[54] At the same time, there are also countervailing mechanisms. For example, an increase in investments increases the capital stock and thereby deters further investments.[55] A deviation from the constant level of production – under the conditions for sustainable economies without growth outlined above – could therefore lead to a self-reinforcing process away from that level or to a business cycle around that level. Which outcome appears more likely depends on the theory used.[56]

14.4 Insights in the Light of Existing Literature

Three central results from the existing literature have been confirmed. First, an increasing capital stock leads to a decreasing investment/production ratio and thereby to a decreasing rate of economic growth (based on Keynes' and Kalecki's theories). Second, the finding that investments need to be low (based on Kaleckian theories) is confirmed. Third, in a zero growth economy, interest payments need to be used for consumption in order to reconcile zero growth with a positive interest rate.

These results from the existing literature are extended in five major areas. First, the discussion of the broad set of theories has led to a more detailed set of determinants of investments that must be in certain constellations to facilitate the necessary low level of investments.

[54] These are particularly present in Keynes' (11.1) and Domar's (11.3) theories.

[55] This is the major reason for an end of the business cycle in Kalecki's theory (11.5).

[56] This issue has not been the focus of this investigation and further investigation into it is necessary to gain a more detailed understanding.

Second, the interplay between aggregate demand and aggregate supply has been investigated in detail. In particular, the necessary relations between technological change, investments, working hours reductions, the wage level and consumption demand have been discussed. This is a crucial condition for zero growth within Keynesian theories.

Third, the role of savings in zero growth economies has been added to the discussion. While it has already played a role in stock-flow-consistent approaches, these are relatively weak in explaining the causes for savings. The investigation on appropriate savings for zero growth has been facilitated by combining the analyses of traditional Keynesian with stock-flow-consistent models.

Fourth, the issue of redirected technological change has been added to the debate. Regarding the fact that a major reason to implement economies without growth is to improve environmental outcomes, this issue is of crucial relevance for sustainable economies without growth.

Fifth, the proposal of sectoral change has been connected to the analysis of zero growth economies. This also seems a promising approach in order to derive meaningful conditions for sustainable economies.

14.5 Limitations to Insights From Keynesian Theories

Compared to neoclassical theories (compare with section 9.5), Keynesian theories are superior in three respects. First, their causal explanations for economic growth are more convincing. In particular, their explanation of investments and technological change (as the two driving forces behind economic growth) appear to be more realistic than the neoclassical ones. Second, Keynesian analyses encompass not only the supply side but an interplay between aggregate demand and supply. Due to the importance of demand for issues of economic growth and zero growth, this constitutes an important advantage. Third, Keynesian theories are helpful in discussing a large number of issues related to zero growth. Among others, it has been possible to investigate the role of consumption, government spending, the monetary system and firms' behaviour. These seem to be crucial issues of zero growth economies, due to their importance for economic growth and as they are discussed repeatedly in the existing literature on concepts for economies without growth (compare to section 3.6).

At the same time, some crucial issues are not possible to investigate exhaustively on the base of Keynesian theories. Maybe the most important issue is the question of how investments can be of such nature that they (only) replace old capital goods by new ones, without expanding production capacity. The central argument has been that when firms expect constant aggregate demand, they have no incentive to expand capacities.

While this is true from the point of view of all firms combined, it does not seem to hold for single firms. One reason is that – in case of economies of scale – individual firms have an incentive to expand production capacity in order to outcompete other firms. This issue has been mentioned by Davidson and Binswanger. As they do not develop a coherent argument on it, it has not been possible to coherently include it in the analysis.

A similarly important issue relates to the incorporation of environmental aspects into the analysis. As mentioned before, Keynesian contributions on the economy-environment relationship are still rare. This is why the inclusion of environmental aspects in the scenarios in chapter 14 are based on rather weak foundations. Two manners to decrease environmental outcomes in zero growth economies have been put forward. First, a redirection of technological change due to changes in factor prices. While Robinson delivers a framework for this argument, her framework was intended for capital goods and labour and not natural resources. The second manner is sectoral change. Here, Harris is the only author working on this topic, and as argued in section 13.2 his contributions are weak with regard to macroeconomic dynamics.

Finally, some important issues are not taken into account by Keynesian theories at all. As with neoclassical theories, Keynesian approaches are not capable of analysing the role of economic activities outside the market. A second blind spot refers to the interests of economic actors. In economies without growth, profits and savings would be far lower than before. This is not in the interest of several economic actors. At the same time, it has been argued that the conditions for economies without growth imply strong changes in the behaviour of economic actors such as firms, governments and consumers. The Keynesian theories do not provide a framework to investigate in how far the changes contradict the interests of the corresponding actors and therefore whether the changes are feasible to be implemented. The next part on Marxian theories brings insight to at least some of the limitations to Keynesian theories.

Part IV

Marxian Theories

Chapter 15
Introduction

Even more than Keynesian theories, Marxian theories are influenced by the work of one author – Karl Marx. Marx (1990, 1992, 1991)[1] builds in many respects on classical theorists but also introduces significant changes by criticizing classical economics (Samuels et al., 2003). Historically, his work originates from a similar time as early neoclassical contributions. However, the two approaches are very distinct in nature and in many respects even difficult to compare. This is because they work with entirely different concepts, and the concepts often have the same name, making things even more complicated. More recently, Marxian economics was marked by diverging theoretical developments in Soviet and Western countries in the course of the 20th century (Howard and King, 2014). In this present study, only Western contributions are taken into account.

Marxian Compared to Neoclassical and Keynesian Theories

Marxian approaches vary from the former two approaches in multiple manners. The following list focuses on the most relevant issues concerning economies without growth:

1. *The value-theory:* In neoclassical and Keynesian theories, economic factors (such as labour, physical capital, natural resources, demand, supply etc.) are either expressed in real or in nominal terms. In Marxian theories[2], factors are often expressed in terms of their value (Klitgaard, 2013). The size of value is determined based on the labour theory of value that Marx adopted from the classical economists. As a consequence, in Marxian theories not the economic growth of nominal or real GDP is important but rather growth in value, which is closely related to the accumulation of capital (capital is "value in motion" (Harvey, 2010, p. 90)).
2. *A systemic approach:* Marxian theories are even less formalized than Keynesian theories and arguably entail an even larger number of aspects. These attributes of Marxian theories go hand in hand with

[1] These three volumes of the *Capital: Critique of Political Economy* were first published in 1867, 1885 and 1894.

[2] The term *Marxian theories* refers to the theories discussed in this part. It is not to be confused with the term *Marx's theory*, which refers only to the contributions by Karl Marx, in particular Marx (1990).

Marx's systemic approach. Marx analyses capitalism as an economic and social system, where all factors are interconnected. These connections are of dialectic (and not of causal) nature and entail various contradictions (Harvey, 2010). Marx's theory therefore results in a complex understanding of the dynamics of capitalism. One aspect of the capitalist system is that it continuously expands. Changing the system so that it generates zero growth therefore implies changes to several aspects of the system. Contrary to the results of the neoclassical and Keynesian chapters, the outcome cannot be a pure list of conditions, but the perspective of a system that no longer expands.

3. *The determination of the size of production:* In neoclassical theories, the decisive aspect is the supply of production factors. In Keynesian theories, effective demand is essential, with a particularly important role of investments. In Marxian theories, capital accumulation[3] is determined by the dynamics of the entire system. This includes the accumulation (and therefore supply) of production factors, but also effective demand is of crucial importance. Marxian theories of capital accumulation therefore entail some features that also exist in neoclassical theories, some that are also present in Keynesian theories and others that are not included in either of them (e.g., the role of competition).
4. *The relation between the short and the long run:* As in Keynesian theories, there is no clear distinction between the short and the long run.[4]
5. *The relationship between investments and savings:* This is an important example for a systemic rather than a causal approach. In neoclassical theories, there is a causal connection running from high savings to low interest rates and subsequently high investments. In Keynesian theories, high investments lead to higher income and subsequently higher savings. In Marxian theories, on the one hand profits (which are savings) are reinvested and are therefore a prerequisite for capital accumulation (as in neoclassical approaches). At the same time, the larger is effective demand (with investments being an important

[3] Note that capital accumulation is connected to, but not the same as economic growth. Capital accumulation relates to the accumulation of *value*, while economic growth relates to the growth of real production. In the following, it is assumed that zero capital accumulation is equal to zero economic growth.

[4] This statement applies to the theories discussed here, which relate to the functioning of the existing economic system (and not historical dynamics that may lead to a transformation of the economic system in the long run).

component of it), the larger the profits are. As profits are saved, investments thus generate savings.

6. *Substitution of production inputs:* Marxian theories do not use the category production factor (physical capital and labour) but the central category is capital (constant and variable capital). The development of capitalism is characterized by an increasing relation between constant to variable capital (or an increasing organic composition of capital). The relation between production inputs therefore changes over time rather than at a given time (as in Keynesian theories). As will be seen below, this type of technological change crucially depends on the availability of cheap energy.
7. *Political economy:* It is a unique feature of Marxian theories that issues related to political economy are included in the analysis. This means that economic dynamics and the subsequent power relations influence governmental decisions and vice versa.

State of Research on Economies Without Growth

Compared to neoclassical and Keynesian theories, there is a large number of publications that address explicitly *whether* zero growth is possible within the capitalist economic system. All authors using a Marxian framework within this debate come to the conclusion that capitalism and zero growth are incompatible. To my knowledge, no attempts have been made to develop conditions for zero growth economies from Marxian perspectives. The summary starts with a debate between three authors on the feasibility of zero growth in capitalism, followed by independent analyses by prominent Marxian authors.

a A discussion on the feasibility of steady state economies

From 2010 to 2012, an insightful discussion took place on whether zero growth is possible. It started by an article by the Marxian author Smith (2010), followed by steady state proponent Lawn (2011) and resulted in a Marxian response by Blauwhof (2012). While Lawn argues that steady state economies (commonly equated with zero growth in this debate) is compatible with capitalism, the other two authors argue for the opposite.

The first central issue in this debate is whether firms are likely to choose not to grow within a capitalist competitive market. Smith (2010) gives three reasons, why firms are compelled to grow: (1) increasing labour productivity due to division of labour compels "producers to find more markets for [... their] growing output" (Smith, 2010, p. 31); (2) economies of scale force firms to increase production to stay competitive; and (3) shareholders execute pressure on managers to strive for firm growth in order to "maximize portfolio gains" (Smith, 2010, p. 31). Lawn (2011), on the other hand, gives several reasons why businesses are not coerced to grow: (1) As economies of scale are limited, firms at some point reach optimal scale. (2) Price competition does not exist or is at least less fierce if firms have significant market power. (3) Firms are not forced to grow but only to make profits. Apart from selling more products, profits can also be made by increasing (labour- and/or resource-) productivity and by improving the quality of products.

Blauwhof (2012) responds to Lawn's three possibilities to make profits. The first (selling more products) is out of question, as it would lead to additional growth – or increasing unemployment. The second (increasing labour productivity) could only be realized if the increased productivity was used to increase profits but not increase wages (otherwise it would lead to growth), which would signify an increasing profit share (and a decreasing wage share): "when growth is impossible, further accumulation of profits by capital can only have the effect of continuous transfers of income from wages to income from property" (Blauwhof, 2012, p. 259). The third possibility (improving the quality of products) can also not lead to increasing profits on a macroeconomic level, as it is not possible for all firms to make additional profits due to higher quality if the overall production has to stay the same.

The second – directly related – issue refers to the question what this means on the macro level. According to Lawn (2011), even if single firms decided to grow, this does not have to lead to macroeconomic growth: "any form of business expansion that might occur would [...] result in either fewer, larger firms in some industries or industry displacement" (p. 14). Blauwhof (2012) argues that this would require the full consumption of all profits that go beyond the amount needed to replace depreciation.[5] He regards this as very unlikely within the existing ownership structures.

It seems that the central difference between the two lines of argument are different understandings concerning profits. Lawn (2011) seems to be of the opinion that it is possible to make a certain amount of profits in a non-growing economy and that these suffice for the economy to function within current ownership structures. This reflects a neoclassical understanding, as profit accumulation is no important aspect there. Smith (2010) and Blauwhof (2012) argue that a low level of constant profits is incompatible with capitalism, as most capital owners want their assets to continuously increase in size. Additionally, they argue that due to political economy, the subsequent interests of capital owners also prevent the permanent implementation of a legislation that would prevent further capital accumulation.

5 Note that the same result has been found based on Keynesian theories in chapter 14.

b Competition and profit-maximization as growth imperative

Prominent Marxian authors come to similar conclusions. The most extensive analysis on the issue has been conducted by Magdoff and Foster (2011), whose central text passage on zero growth is worth quoting in length. They point out that zero growth is theoretically possible when all profits above replacing the depreciation of equipment are consumed:

> Let's suppose that all the profits that corporations earn (after allowing for replacing or repairing worn-out equipment and buildings) are either spent by capitalists on their own consumption or given to workers as wages and benefits, and consumed. As capitalists and workers spend this money, they would purchase the goods and services produced, and the economy could stay at a steady state, no-growth level [...]. Since there would be no investment in new productive capacity (beyond replacement), there would be no economic growth, no additional profits generated. In other words, there would be no capital accumulation (Magdoff and Foster, 2011, p. 56).

But there are several central reasons why this situation will not take place within capitalism. First, capitalists have a strong incentive to prevent any conditions that lead to a zero growth economy, exactly because it implies a limit on accumulating their assets (Magdoff and Foster, 2011): "What capital strives for – the purpose of its existence – is its own expansion. Why would capitalists [...] simply turn around and spend the economic surplus at their disposal on their own consumption or (less likely still) give it to workers to spend on theirs" (p. 56).

Second, Harvey (2010) and Li (2008) argue that capitalists are coerced to reinvest profits due to price competition. The main reason is that investments are needed for the introduction of cost-reducing technologies. Firms that do not invest and innovate can therefore not offer their products at competitive prices in the long run. Subsequently, Harvey (2010) also comes to the conclusion that "the idea of a capitalist mode of production in a stable, nongrowth state is improbable if not downright impossible" (p. 253).

Third, Altvater (2005) argues that any attempts to introduce sufficiency at a large scale will be prevented by capitalist dynamics. He argues that commercials (which increase consumption demand) and competition (which leads to investments) sufficiency.[6]

Thus, all Marxian authors come to the conclusion that zero growth

[6] Original quote in German: "Konsum fördernde Werbemaßnahmen und der Sachzwang der Wettbewerbsfähigkeit in der Produktion werden dafür sorgen, dass der Verbrauch und die Belastung von Ressourcen nicht an den Grenzen der Suffizienz Halt machen" (Altvater, 2005, pp. 212 – 213).

is not possible within capitalism. There are no studies on what conditions would facilitate economies without growth, however.[7] The following chapters contribute to filling this research gap.

Outline

The part is structured in four chapters. The first chapter covers Marx's fundamental contributions to Marxian theories. It is (among many aspects) based upon the assumption of competitive capitalism. In theories with monopolistic market structure in the next chapter, the perspective changes from competitive to monopoly capitalism. The third chapter examines Marxian theories that include environmental aspects. Finally, the fourth chapter summarizes the results and develops two scenarios for sustainable economies without growth.

[7] A likely reason is that Marxian authors argue for a socialist economic system instead of capitalism and are not that interested in the question of economic growth.

Chapter 16
Fundamentals

Karl Marx is one of the most influential and at the same time most controversial authors in economic theory. He has contributed to various disciplines of social sciences. Here, the focus is on his work on the economic system as developed in the books *Capital I-III* (Marx, 1990, 1992, 1991). While there is much to be said about the background of this work, a few comments have to suffice at this point.

First, many aspects of Marx's analysis build upon the concepts of prior classical economists (compare to section 2.3.1). For example, the value theory elaborates on prior labour-value theories, in particular that of David Ricardo. Another example is the integrated analysis of *political economy*, which integrates political and economic aspects.

Second, his work is intended to be a critique of classical political economy. He attempts to reveal the problems and contradictions of capitalism *within the logic of classical political economy*: "Marx is engaged in a critique of classical liberal political economy. He therefore finds it necessary to accept the theses of liberalism [...] in order to show that the classical political economists were profoundly wrong even in their own terms". Most importantly, he also "accepts the liberal utopian vision of perfect markets" (Harvey, 2010, p. 52). This implies that all exchanges in the economy are exchanges of equivalents, that is, of two goods with the same value.[1]

Third, Marx's *method of enquiry* is to start at the "essential aspects of the problem" (Sweezy, 1942, p. 15). For Marx, the essential aspect of the capitalist society is class struggle and therefore he starts with the examination of the relationship between labour and capital: "the relationship of capital and wage-labour determines the whole character of the mode of production" (Marx, 1991, p. 1019). The analyses of all other economic aspects build upon the analysis of this relationship (Sweezy, 1942).[2]

[1] The theories of chapter 17 establish a significantly different Marxian theory by changing this assumption.

[2] Regarding the question of which aspects of the following investigation are adopted from existing work and which are novel developments of this present study: The following representation of Marx's theory is based on Sweezy (1942), Harvey (2010), Heinrich (2005), Hein (2004), Mandel (1974a,b) and of course Marx's (1990; 1992; 1991) own work. In the following, explicit reference to specific works is only done for aspects that are not common ground among different authors. The theory in section

16.1 Marx: The Accumulation of Capital

The following presentation of Marx's economic theory is restricted to those components that are crucial in order to understand the processes leading to economic growth and to economies without growth.[3] The presentation starts with analytical foundations (16.1.1), followed by an explanation of capital accumulation (16.1.2) and an investigation of contradictions and conflicts associated with capitalism (16.1.3).

16.1.1 Analytical Foundations

Marx starts his analysis with a discussion of three types of value – use value, value and exchange value – and their relation to socially necessary labour time (16.1.1.1). This allows an explanation of how exploitation in the production process leads to the ability to generate surplus value (16.1.1.2). Based on the production process, the sizes of profits, wages, consumption and savings can be determined (16.1.1.3). All these analyses lead to the development of conditions for simple reproduction (16.1.1.4).

16.1.1.1 Value and Socially Necessary Labour Time

Marx (1990) starts his theory with an analysis of commodities, which are products that are produced for and sold on the market. Commodities entail different forms of value. First, each commodity has a use value. This is the specific use one receives from the commodity – for example food has the use value of nourishing or clothing has the use value of keeping people warm. Second, commodities entail value, which is due to the amount of labour time incorporated in them. Third, commodities have an exchange value that represents the relative values between different goods in prices.

The amount of value of a specific commodity is not determined by the specific amount of labour used for that commodity, but by the *socially necessary labour time* to produce that type of commodity. For example, the value of a bread is not determined by the amount of labour used to produce that specific bread, but due to the average amount of labour necessary for the production of one loaf of bread at a specific point in time and in a specific society. The socially necessary labour time therefore depends on social circumstances and in particular on the state of technology.

16.1 is a reproduction of the existing theory. The application of the theory to zero growth in section 16.2 includes various extensions and interpretations of Marx's theory. Both the argumentation and the equations are novel contributions by this present study.

3 A comprehensive presentation of his theory is outside the scope of the work at hand. For more detailed summaries see in particular Sweezy (1942) and Harvey (2010).

Labour is a special commodity in Marx's framework. On the one hand, the application of labour power for a specific time – e.g., one hour – creates a specific amount of value. On the other hand, labour is sold by the worker due to the *value of labour power*. The value of labour power is determined by the amount of labour that is necessary to reproduce it. In other words: The value of labour power is defined by all the commodities (food, shelter, education etc.) that are necessary to reproduce the worker (more specifically, it is determined by the socially necessary amount of labour that is necessary to produce these commodities). An important feature in Marx's theory is that the value produced by a worker and the value of labour power itself do not need to be of equal size. Usually, the former is larger than the latter and the difference is the surplus value. This is explained in more detail in the next section.

16.1.1.2 The Production Process, Exploitation and Surplus Value

Marx (1990) describes the production process as follows. Capitalists[4] buy the commodities they need for production, called *productive capital*. These are the *means of production* (physical capital and natural resources) and *labour power*. In the production process, these are used to produce commodities. These commodities have a larger value than the sum of the value of inputs. This is possible because the value product created by a worker is larger than the value of labour power.

Figure 16.1 describes this process. M is the money capital needed for the acquisition of the productive capital (C). In the production process (P), the productive capital is used for the production of commodities, whose value (C') is larger than the value of the productive capital ($C' > C$). Selling these commodities therefore realizes more money capital than was originally used to initiate the process ($M' > M$):

Figure 16.1: The Production Process – Capital as Value in Motion

$$\boxed{M - C \;...\; P \;...\; C' - M'}$$

Adapted from Heinrich (2005, p. 134).

Another way of looking at this process is to use the concept of *capital*. According to Marx (1990), "capital is money, capital is commodities". The

[4] The division into workers and capitalists does not primarily refer to specific people but the function people fulfil within the capitalist system.

money capital (M) as well as the productive capital (C), the commodities produced (C') and the money earned by selling them (M') are all forms of capital, "constantly changing from one form into the other" (p. 255). This is why Harvey (2010) argues that "[c]apital is [...] value in motion" (p. 90).

There are two different types of productive capital: First, constant capital is the value of the means of production (in mainstream terminology, these are physical capital, intermediate goods and material inputs). Second, variable capital is the value of labour power (similar to labour in mainstream terminology). The values of constant and variable capital depend on the socially necessary labour time to produce them. The total value of production (w), hence can be divided into the value of constant capital (c), of variable capital (v) and of the difference between the value product that is created by labour power and the value of labour power, which is the surplus value (s):

$$w = c + v + s. \tag{16.1}$$

A central prerequisite for this process to take place is that the worker is free in a double sense:

> For the transformation of money into capital, therefore, the owner of money must find the free worker available on the commodity-market; and this worker must be free in the double sense that as a free individual he can dispose of his labour-power as his own commodity, and that, on the other hand, he has no other commodity for sale (Marx, 1990, p. 272).

The worker is able to sell her labour power and at the same time, she does not possess physical capital, which she could use in order to produce commodities herself. Both types of freedom are necessary for capitalists to find people who are willing to work. The first freedom allows them to work. The second freedom forces them to work, as otherwise, they would not be able to finance their living expenses because they own no means of production themselves.

16.1.1.3 Monetary Magnitudes: Profits, Wages, Consumption and Savings

Marx' analysis is based on his labour theory of value. Values are strongly connected to the prices of commodities and the monetary amounts of wages, profits etc. There is a long debate (entitled *transformation problem*) on the issue, how values and prices are connected. The issue has been discussed by Marx and later by various authors (see Sweezy (1942, pp. 109 – 130) and Hein (2004, p. 62 – 68) for summaries). The issue is not discussed here, as it provides little insight for present investigation.

For the purpose of this study, it is enough to point out several important connections. Wages (W) are strongly connected to the variable capital (v), as workers use their wages in order to buy the goods necessary for their reproduction. In a similar manner, profits (Π) are related to surplus value (s), as usually capitalists receive them. According to Harvey (2010) the distribution of value product ($v+s$, value added in the production process) between wages and profits depends most importantly on the socially defined subsistence level of wages. Wages tend towards this subsistence level, due to the existence of the reserve army (see below). Under certain historical circumstances (in particular in case of strong workers unions and high rates of capital accumulation), workers can be able to bargain for higher wages.

Overall consumption depends on wages and the share of profits used for consumption. It is assumed that workers use all wages for consumption – in other words they do not save. Capitalists consume part of their profits and save the other part. As a consequence, consumption primarily depends on the level of wages and on the consumption by capitalists. Savings primarily depend on the behaviour of capitalists and in how far capitalists are coerced to use profits for reinvestments (see below).

16.1.1.4 Simple Reproduction

At this point, the necessary analytical concepts have been developed to lay out Marx's system of simple reproduction. It represents the theoretical situation of an economy with constant production and no technological change. Marx (1992) divides the economy into two sectors. The first sector produces the means of production, the second produces consumption goods. Each sector consists of constant capital, variable capital and surplus value:[5]

$$\text{sector 1: } w_1 = c_1 + v_1 + s_1, \tag{16.2}$$

$$\text{sector 2: } w_2 = c_2 + v_2 + s_2. \tag{16.3}$$

It is assumed that there is no fixed capital, so that the means of production are exhausted in each period. Therefore, the supply of the means of production needs to be equal to the demand for them, which is equal to the amount of constant capital used in the two sectors:

[5] The following illustration is adopted from Sweezy (1942, p. 162 – 163).

$$c_1 + v_1 + s_1 = c_1 + c_2. \tag{16.4}$$

On the other hand, the production of consumption goods needs to be equal to the demand of consumption goods. It is assumed that workers use the entire wages for consumption (equal to the value of variable capital) and capitalists use the entire profits for consumption (equal to the surplus value):

$$c_2 + v_2 + s_2 = v_1 + s_1 + v_2 + s_2. \tag{16.5}$$

Each of the two equations can be reduced to the following one:

$$c_2 = v_1 + s_1. \tag{16.6}$$

The value of the means of production needed in sector 2 has to be of the same size as the value product $(v + s)$ of sector 1. As it is assumed that the entire value product is used for consumption, this is equal to the consumption demand from sector 1. In the case of simple reproduction, the flows from one sector to the other are therefore of equal size. Sector 2 receives the constant capital needed for production and sector one receives the consumption goods needed for the reproduction of its workers and capitalists' consumption.

Note that a crucial necessary assumption for simple reproduction has been that all wages and all profits are used for consumption. This implies at the same time that none of them are used for capital accumulation. This assumption is lifted in the next section.

16.1.2 Capital Accumulation and Economic Growth

Capitalist societies are characterized by capital accumulation and economic growth, in particular because of competition and the reinvestments of profits (16.1.2.1). Competition is also central in explaining technological change, the subsequent change in the organic composition of capital and the existence of a reserve army of labour (16.1.2.2). The role of technology allows us to distinguish between absolute and relative surplus value (16.1.2.3). All these concepts enable an advancement from the simple to the extended reproduction (16.1.2.4).

16.1.2.1 Competition, Profits and Capital Accumulation

The framework of simple reproduction is merely an analytical tool and not regarded as a realistic situation for a capitalist economy. As Harvey (2010) puts it: "the idea of a capitalist mode of production in a stable, nongrowth state is improbable if not downright impossible" (p. 253). According to Marx's theory there are a number of interrelated features of capitalism that drive the system continuously to expand – or more precisely to accumulate.

In simple reproduction, all profits are used for consumption – as are wages. But according to Sweezy (1942), the main purpose of capital is its expansion, and this is achieved by reinvesting profits. There are two major reasons, why surplus value is reinvested and not consumed by capitalists. First, capitalists are interested in reinvestment in order to accumulate wealth. Harvey (2010) argues that "[c]apitalists, Marx avers, are necessarily interested in and therefore motivated by the accumulation of social power in money-form" (p. 257). Or as Marx (1990) puts it: The capitalists' "motivating force is not the acquisition and enjoyment of use-values, but the acquisition and augmentation of exchange-values" (p. 739). It is important to note though that this is not due to the attitude of capitalists, but the function the capitalists take within the capitalist system. He has to reinvest the surplus due to the following reason.

Second, capitalists are coerced to reinvest because of price competition. Capitalists stand in competition with each other and can only sell products when they are able to offer them at the market price. Capitalists have both an *incentive* and an *imperative* to apply newly available technologies that allow production at lower costs.

The incentive is that those capitalists who introduce the cost-reducing technologies can earn *extra profits*, that is, profits above the normal profit rate: "The innovative capitalist gains an extra profit, extra surplus-value, by selling at or close to the social average while producing at a rate of productivity far higher than the social average" (Harvey, 2010, p. 167). These capitalists can sell the products at the prior price, while having lower costs – until the other capitalists also introduce the new technologies and the average price falls.

The imperative to apply new technologies rests upon the fact that when an increasing share of capitalists introduce the new technologies, the market price falls. The capitalists who do not introduce cost-reducing technologies are not able to offer products at the reduced price and are therefore pushed out of the market (Harvey, 2010). Price competition is therefore the prime reason for continuous accumulation.

16.1.2.2 Technology, Organic Composition and Reserve Army of Labour

Technological change brings about a change in the organic composition of capital. The organic composition of capital (q) is the ratio between constant capital (c) and productive capital, which is equal to the sum of constant and variable capital ($c + v$):[6]

$$q = \frac{c}{c + v}. \tag{16.7}$$

Marx (1990) argues that new technologies are depicted by an increase in the organic composition of capital. This implies an increase of constant capital and a reduction of variable capital per value produced. A central implication is therefore that less labour time is needed in the production process per unit of value. Therefore, technological change leads to unemployment, which makes sure that there is a constant *reserve army* of people who are willing to work.

Harvey (2010) further explains an inter-causal relationship between the type of technological change and the number of unemployed people. When there are few unemployed people, the wage level is likely to rise, which incentivizes capitalists to introduce technologies. This decreases the level of employment and lowers wages, which in turn leads to fewer incentives to introduce s technologies. Over time, capital accumulation increases the demand for workers again, which increases the wage and starts the mechanisms anew.

16.1.2.3 Absolute and Relative Surplus Value and the Length of the Working Day

The introduction of technological change allows us to distinguish between two forms of surplus value: absolute and relative. Marx defines the two as follows:

> I call that surplus-value which is produced by the lengthening of the working day, *absolute surplus-value*. In contrast to this, I call that surplus-value which arises from the curtailment of the necessary labour-time, and from the corresponding alteration in the respective lengths of the two components of the working day, *relative surplus-value* (Marx, 1990, p. 432).

Absolute surplus value arises due to the fact that a worker produces more value than the value that is necessary for her reproduction. Absolute surplus value can be increased by a “lengthening of the working day”, which either means more working hours per day or an “intensification of labour”, in particular due to an increase in “rapidity” (Marx, 1990, p. 533) of the labour process. Relative surplus value on the other hand “arises from the curtailment of the necessary labour-time” (p. 432) for

6 The following representation is taken from Sweezy (1942, p. 66).

the reproduction of the worker. According to Harvey (2010), the prime reason for relative surplus value is an increase of labour productivity in the production of consumption goods for workers. This decreases the value of those goods and therefore the value of labour power. Consequently the difference between the value of labour power and the value the worker creates increases (and the difference is equal to the surplus value).

16.1.2.4 Extended Reproduction

Due to price competition, capitalists are coerced to reinvest profits. This changes the simple reproduction scheme to extended reproduction. The extended reproduction scheme examines the conditions for a path of balanced capital accumulation. In particular, the proportions between the two sectors and the transfers from one to the other have to be in certain relations.

It is still assumed that workers use all wages for consumption. Capitalists now save part of their profits, which is used for the acquisition of additional commodities of production (constant and variable capital), in order to expand production in the respective sector. The total surplus value (s) is divided into four parts: a part of capitalists' consumption that has the size of their consumption of the last period (s^c), the increase in capitalists' consumption in this period (Δs^c), accumulation that takes the form of variable capital (s^{av}) and accumulation in the form of constant capital (s^{ac}):[7]

$$s = s^c + \Delta s^c + s^{av} + s^{ac}. \tag{16.8}$$

For the two sectors, equations 16.2 and 16.3 therefore change to the following:

$$\text{sector 1: } w_1 = c_1 + v_1 + s_1^c + \Delta s_1^c + s_1^{av} + s_1^{ac}, \tag{16.9}$$

$$\text{sector 2: } w_2 = c_2 + v_2 + s_2^c + \Delta s_2^c + s_2^{av} + s_2^{ac}. \tag{16.10}$$

Due to the same logic as in the case of simple reproduction, a balanced growth path can be obtained. Again, the supply of means of production (sector 1) is set equal to the demand for its commodities:

$$c_1 + v_1 + s_1^c + \Delta s_1^c + s_1^{av} + s_1^{ac} = c_1 + s_1^{ac} + c_2 + s_2^{ac}. \tag{16.11}$$

[7] The following representation is adjusted from Sweezy (1942, pp. 163 – 165).

The second manner is to set the production of consumption goods equal to all demand for consumption goods:

$$c_2 + v_2 + s_2^c + \Delta s_2^c + s_2^{av} + s_2^{ac} = v_1 + s_1^c + \Delta s_1^c + s_1^{av} + v_2 + s_2^c + \Delta s_2^c + s_2^{av}. \tag{16.12}$$

Both equations 16.11 and 16.12 can be reduced to the following equation:

$$c_2 + s_2^{ac} = v_1 + s_1^c + \Delta s_1^c + s_1^{av}. \tag{16.13}$$

The equation is to be interpreted economically in the following manner: The left hand side represents the demand for constant capital by the consumption goods sector. The right hand side is the demand for consumer goods from the capital goods sector. The two demands need to be of equal size, so that the flows between the sectors cancel each other out.

The exact relations between the different components of the extended reproduction scheme, in particular the relations of the components of surplus value, depend on the type and speed of technological change (or the change in the organic composition of capital). This, in turn, is determined by all the "concrete conditions under which the capitalist mode of production progresses: birth in a non-capitalist setting; transfers of capital from one sector to the other; role played by credit; fluctuations of money prices, etc." (Mandel, 1974a, p. 328). The extended reproduction scheme is therefore only a framework, a starting point to investigate the conditions of capitalist development. In the next section, it is shown that the concrete conditions of capitalism entail a number of contradictions which lead to non-balanced developments of capital accumulation.

16.1.3 Economic and Political Contradictions

Sections 16.1.1 and 16.1.2 have entailed the conditions for balanced capital accumulation. But according to Marx, there are important contradictions within capitalism both in the economic and in the political spheres. In the economic sphere, these can lead to either economic stagnation or capital accumulation that is characterized by crises (16.1.3.1). In the political sphere, the contradictions lead to class conflicts and to the implausibility of radical reforms (16.1.3.2).

16.1.3.1 Stagnation or Crisis

Within the Marxian analytical framework, there are strong reasons that capital accumulation does not take place in a balanced fashion as outlined in the previous section, but instead is characterized by periodical crises. There is a detailed debate on different reasons and different views on crises within Marxian analyses.[8] Here the analysis is restricted to the major contradictions leading to crises, as argued by Sweezy (1942) and Heinrich (2005).

The central reason for crises[9] is that there is a *tendency* of the supply of consumption goods to grow faster than its demand. Due to price competition and the pursuit of profits, capitalists continuously increase production. Hence, supply increases. There are three important aspects concerning demand. First, capitalists try to decrease costs by introducing technologies that use less labour and by pushing wages down. Both strategies decrease consumption demand as total wages are reduced. Second, capitalists are inclined to use the majority of profits for reinvestments and not for consumption, due to market competition. This additionally decreases consumption demand. But a third factor increases consumption demand: As argued for the supply side, capitalists are forced to invest. This increases employment and subsequently wages and consumption demand. Overall, supply surmounts demand, though, as the effect on demand by the third aspect is of equal size as the increase in supply, but the other two aspects decrease demand. In sum, supply grows faster than demand in expansionary periods.

Sweezy (1942) offers an additional reasoning for a disparity between growth in supply and demand. The ratio between the amount of means of production and the level of production is assumed to stay constant – based on empirical observations.[10] The production of consumption goods hence increases at the same speed as the means of production accumulate. The level of consumption on the other hand increases more slowly. The reasons are that capitalists increase their consumption at a decreasing speed (Δs_1^c increases only slowly) and the spending of profits on wages increases slower than that on capital goods, due to technological change. Overall, supply therefore increases faster than demand, which implies a demand gap.[11]

According to Sweezy (1942), there are two possible reactions to the sit-

8 For a good summary see Shaikh (1978).

9 According to Heinrich (2005), the *tendency of the profit to fall* has been a major explanation for crises in traditional Marxian approaches. Heinrich, as well as Sweezy (1942) and Hein (2004) argue, however, that the tendency of the profit to fall does not necessarily lead to a fall in the profit rate and that the prime reasons for crises are to be found in other aspects of Marx's theory. This is why the tendency of the profit to fall is not covered here, despite its prominent role in Marxian discussions.

10 Note that this is the same assumption as in many Keynesian theories, in which the capital coefficient has been assumed to stay constant.

11 For mathematical proof of this, see Sweezy (1942, pp. 221 – 224).

uation that supply tends to exceed demand. Either capitalists understand that there will be insufficient demand for their products if they increase production to the extent possible. The consequence is stagnation, as capitalists invest only little. But within the framework of competitive markets – as assumed by Marx – capitalists do not have this option, as it would imply to fall behind in the race for cost reductions. The scenario of low investments and stagnation becomes more probable in economies with high market concentrations as argued in chapter 17.

The second possible outcome is that the supply increases faster for some time than consumption demand. This development can persist for some time, as investments in sector 1 initially increase consumption demand and the increase in production capacity only takes place later. At some point, the production capacity of consumption goods will outstrip consumption demand, though, which leads to a realization crisis.

In the crisis, capitalists become aware of the situation that the productive capacity of consumption goods exceeds consumption demand. The consequence is a decrease in investments (in both constant and variable capital), which decreases consumption demand even further, aggravating the crisis. The least profitable firms go bankrupt, wages decline due to rising unemployment and interest rates go down. All these aspects improve the profitability of the remaining firms, which therefore start investing again. This marks the end of the crisis and the begin of a new phase of expansion and capital accumulation (Heinrich, 2005).

16.1.3.2 Political Economy

Sweezy makes a remarkable statement on the importance of the political dimension in distinguishing Marxian from other economic schools of thought:

> The critique of Keynesian theories of liberal capitalist reform starts [...] not from their economic logic but rather from their faulty (usually implicit) assumptions about the relationship, or perhaps one should say lack of relationship, between economics and political action. The Keynesians tear the economic system out of its social context and treat it as though it were a machine to be sent to the repair shop there to be overhauled by an engineer state (Sweezy, 1942, pp. 348 – 349).

Sweezy argues that "liberal theorists" (p. 240) usually take the perspective of a "class-mediation theory" (p. 241), where the state mediates conflicting interests of different classes. The underlying assumption is that the class structure of society is given and cannot be changed. Therefore, the state can only take the role of mediating between the classes. Marxian theorists, on the other hand, regard the capitalist class structure as a historical phenomenon that can be overcome. In their view, the "primary function of the state" (p. 244) is "the protection of property [which] is fundamentally the assurance of social domination to owners over non-owners" (pp. 243 – 244). The state is first of all an instrument of the capitalist class to uphold the capitalist system and to guarantee the necessary circumstances for capitalism to persist.

When the political system is a parliamentary democracy, a tension accrues between the interests of capitalists on the one hand and the interests of the majority of people on the other. According to Sweezy (1942), this misleads many theorists to think that "the state in capitalist society is, at least potentially, an organ of society as a whole which can be made to function in the interests of society as a whole" (p. 349). On the contrary, Sweezy argues that the state always fulfils its function of protecting the existing property structure (and therefore prevents any change that would abolish exploitation). The reason is that the capitalist class would use various forms of influence and power to prevent radical change:

> In the sober world of reality, capital holds the strategic positions. Money, social prestige, the bureaucracy, and the armed forces of the state, the channels of public communication – all these are controlled by capital, and they are being and will continue to be used to the utmost to maintain the position of capital (Sweezy, 1942, pp. 351 – 352).

Within the Marxian framework, these questions of societal power need to be taken into account, when investigating the conditions for zero growth.

16.2 Conditions for Sustainable Economies Without Growth

In Marx's theory, the capitalist economic system entails various attributes that lead to continuous accumulation of capital. The two central prerequisites for capital accumulation are the ability to generate surplus value and that surplus value is reinvested instead of being consumed: "Accumulation requires the transformation of a portion of the surplus product into capital" (Marx, 1990, p. 726). Conditions for zero growth economies need to take these two issues into account.

There are two options for organizing economies without growth. The first is to centrally organize the economy by the state, which is very shortly discussed in section 16.2.1. The second option is investigated in more depth. It is argued that a combination of collective firms, diseconomies of scale, reductions in working hours and profit taxation lead to economies without growth within Marx's framework (sections 16.2.2 – 16.2.5). The discussion ends with a note on the crisis mechanism in zero growth economies and an evaluation on the political feasibility to implement such conditions within the existing power relations (section 16.2.6).

16.2.1 Prefix: Central Organization of Production

An initial way of making sure that surplus value is used for consumption instead of capital accumulation is to organize the production process by a planned economy. There is a vast amount of literature on how production can or should be organized in a planned economy by the state.[12] A planned economy can in principle bring about zero growth. The central idea is that the state would organize production in the two sectors in the manner analysed in the simple reproduction scheme. The central conditions are (again) that wages and profits are used for consumption and that the level of means of production of sector 2 is equal to the wages and profits from sector 1 ($c_2 = v_1 + s_1$). The state thus can make sure that simple and not extended reproduction takes place.

However, the organization of zero growth by a planned state economy is not pursued further in the following, mainly due to two reasons. Most importantly, switching from a market to a planned economy presents an entire shift of the economic system instead of changing selected macroeconomic conditions. The consequence is that most aspects of the macroeconomic theories applied in this work become obsolete. In other words: The planned economy is so different that it cannot be investigated by the method applied here. The second reason is that none of the authors on the four concepts on economies without growth from chapter 3 refers to a planned economy. As the work at hand is intended to provide macroeconomic foundations to those discussions, a planned economy does not seem relevant.

16.2.2 Collective Firm Ownership

A second manner to facilitate that surplus value is used for consumption instead of capital accumulation is to collectivize the ownership of firms at the firm level. In this case, the entire value product is distributed as wages ($W = v + s$):[13]

[12] See e.g., Mandel (1974b, pp. 654 – 689), Baran (1962, pp. 402 – 463) and Foster (2014, pp. 193 – 224).

[13] Note that this could also be regarded as abolishing workers' freedom in the double sense, as workers would regain the ownership over the means of production and therefore do not have to sell their labour power in order to receive the means of living.

$$\text{sector 1: } w_1 = c_1 + v_1 + s_1 = c_1 + W_1, \tag{16.14}$$

$$\text{sector 2: } w_2 = c_2 + v_2 + s_2 = c_2 + W_2. \tag{16.15}$$

Following Marx's assumption that wages are entirely spent on consumption goods, extended reproduction is not an option. The reason is that there is no surplus value to be reinvested. The condition of a stable simple reproduction is similar as above. It can be achieved by either setting the supply of means of production equal to the demand for means of production ($c_1 + W_1 = c_1 + c_2$) or by setting the supply of consumption goods equal to its demand ($c_2 + W_2 = W_1 + W_2$). Both equations can be reduced to

$$c_2 = W_1. \tag{16.16}$$

Economically speaking, the demand for production goods in the consumption goods sector needs to be equal to wages in the production goods sector.

Hence, the collectivization of firms has the potential to prevent reinvestments (above capital depreciation). Within Marx's analysis, there are two reasons that can countervail this result: price competition and the drive to accumulate wealth. The prior is discussed in the next section, while the latter is covered in section 16.2.5.

16.2.3 Competition and (Dis-) Economies of Scale

According to Sweezy (1942), the most important reason for capital accumulation within Marx's analysis is price competition. Firms are coerced to reinvest in new technologies and growing production, in order to decrease production costs and stay competitive. This usually takes the form of introducing methods of production with a higher organic composition, which decreases the labour coefficient and leaves the capital coefficient approximately constant. When all firms follow these incentives, the result is continuous positive net investments (accumulation of constant and variable capital), leading to expansion of production as outlined in the extended reproduction scheme.

The underlying assumption (which is seldom made explicit) is that there are economies of scale. Only when average production costs are lower for larger levels of production, is it necessary to expand production in order to stay competitive.[14] Macroeconomic conditions that prevent economies of scale and introduce diseconomies of scale would therefore

[14] Note that the saturation of economies of scale is put forward as one reason for secular stagnation, see section 2.3.

prevent price competition to coerce capital accumulation – while still coercing the introduction of cost-reducing technologies.

This is not the place for a detailed discussion on the reasons for economies and diseconomies of scale. But some examples, which are particularly related to the issue of sustainable economies without growth, help to illustrate the point. According to Altvater (2005), the expansion of firms' production has historically been closely related to the increasing use of fossil fuels in the production process. Hence, there is a connection between energy-intensive and large-scale production. Increasing the prices of energy (compared to labour) would therefore plausibly lead to fewer economies of scale or to diseconomies of scale. Second, according to Krugman et al. (2009) high requirements of fixed capital are a major reason for economies of scale. Therefore, methods of production with a lower (physical) capital coefficient plausibly entail less economies of scale. Third, low transportation costs are a prerequisite to produce at one location for a large geographical area (Krugman et al., 2009). Higher transportation costs – for example initiated by an internalization of environmental costs of transportation – would introduce stronger diseconomies of scale and according to BUND et al. (2008) lead to a higher share of local production.

The combination of introducing diseconomies of scale and collective ownerships circumvents incentives to expand production on the firm level and subsequently on the macroeconomic level. The underlying reasoning is as follows: Due to diseconomies of scale, each firm has no incentive to retain revenues for net investments. Firms therefore solely retain revenues for the introduction of new technologies without expanding production capacity. If all firms behave in this manner, there are no net investments by existing firms. It would be possible that new firms enter the market and thereby push net investments above zero. This would require extracting revenues from existing firms though (in order to finance the new firms). As all revenues are paid out as wages and are subsequently consumed, the financial means for additional investments are not available.

The firms nevertheless have to introduce cost-reducing technologies in order to stay competitive. Within Marx's framework, this leads to an increase in the organic composition of capital. However, a constant level of production, combined with an increasing organic composition of capital implies increasing unemployment. In the next section, possible solutions to this issue are discussed.

16.2.4 Technological Change and Working Hours Reductions

The competition between firms forces them to introduce cost-reducing technologies. Within Marx's analytical framework, these technologies are characterized by an increasing organic composition of capital. The situation is therefore as follows: There are collectively owned firms, which compete with each other and introduce technologies that use the same amount of means of production and a decreasing amount of labour per unit of production. They have no incentive to expand, due to diseconomies of scale. Therefore, they keep the level of production at a constant level.

The *amounts* of capital and consumption goods produced, stay the same over time. The *value* of both types of goods decreases, however. The reason is that labour productivity decreases the organic composition in both sectors, so that less labour is needed per unit of production. As a result, the value per unit decreases. Because the amount of units stays constant, the overall value of production in both sectors declines.

In the framework of reproduction schemes, the situation can be depicted as follows: It is assumed that production and consumption of both types of goods take place in the same period. From one period to the next, the technology changes in both sectors and is of the type described above (the number of means of production per unit of production stays constant, while the amount of labour per unit of production declines). In period t, the reproduction scheme is as before:

$$\text{sector 1: } w_1^t = c_1 + W_1, \tag{16.17}$$

$$\text{sector 2: } w_2^t = c_2 + W_2, \tag{16.18}$$

$$\text{with } c_2 = W_1. \tag{16.19}$$

In period $t+1$, technological change takes place in both sectors. This has two effects. First, the value of constant capital (c) in both sectors declines (by Δc), as the production of capital goods becomes more productive. Second, the value product (W) in both sectors decreases (by ΔW), as labour productivities in both sectors increase. The reproduction scheme in period $t+1$ is therefore

$$\text{sector 1: } w_1^{t+1} = c_1 - \Delta c_1 + W_1 - \Delta W_1, \tag{16.20}$$

$$\text{sector 2: } w_2^{t+1} = c_2 - \Delta c_2 + W_2 - \Delta W_2. \tag{16.21}$$

Setting supply and demand for capital and consumption goods equal ($c_1 - \Delta c_1 + W_1 - \Delta W_1 = c_1 - \Delta c_1 + c_2 - \Delta c_2$ and $c_2 - \Delta c_2 + W_2 - \Delta W_2 = W_1 - \Delta W_1 + W_2 - \Delta W_2$), and using the condition from above ($c_2 = W_1$) gives the condition for a stable simple reproduction with technological change:

$$\Delta c_2 + \Delta W_1. \tag{16.22}$$

Economically speaking, the decrease in the value of capital goods needed for the production of consumption goods has to be of the same size as the decrease in the value product created in the capital goods sector. Note that this is independent on the change in labour productivity in sector 2. If, for example, labour productivity would only increase in sector 1, the condition could still hold. But capital goods would become cheaper and make up a smaller share of overall production. In the following, it is assumed though that technological change leads to the same speed of increases in labour productivity in both sectors (in order to simplify the analysis).

Due to the application of the new technologies, firms experience that they have no use for all their workers anymore. There are three possible outcomes of this situation. First, the situation may put pressure on firms to expand in order to have sufficient employment and wages for its employees. When the diseconomies of scale are not strong enough, this may be a viable solution for firms. If a large number of firms pursue this strategy, the result is capital accumulation.[15] Second, the collective firms can fire part of their members. This solution is problematic as well. First, because it may be difficult to fire members of a democratically organized entity and second, because it leads to unemployment.[16] The third option is to *reduce average working hours* so that the number of employment stays constant over time. This could entail either decreasing the labour participation rate (for example by shortening the working life) or the average working hours per employee.

The third option is the only one that prevents pressure to accumulate and at the same time does not lead to unemployment. This option is therefore the condition most compatible with sustainable economies without growth and consequently used in the following lines of reasonings.

16.2.5 Appropriation of Profits by the State

In section 16.2.2 it has been argued that there is – in addition to price competition – a second possible reason for the reinvestment of surplus value: the objective to accumulate wealth. According to Marx (1990), the rate of capital accumulation depends on how much of surplus value the

[15] Note that this requires firms to not distribute all revenues as wages as assumed above, but to retain a part of revenues for investments.

[16] Nevertheless, this may be an appropriate societal strategy in case the effects of unemployment are not (as) negative as currently, in particular due to different means of income and social recognition independent from wage labour, compare e.g., Bierter and von Winterfeld (2013).

capitalist *decides* to use for consumption or capital accumulation: "Other things being equal, the ratio of these parts determines the magnitude of the accumulation. But it is the owner of the surplus-value, the capitalist, who makes this division. It is an act of his will" (Marx, 1990, p. 738). This passage is followed by an explanation by Marx why this is not the case, that is, why capitalists cannot freely choose how much they consume and how much they reinvest. The reason is price competition.

Based on the conditions for zero growth developed so far (collective firms, diseconomies of scale and reductions in working hours) the quote above regains validity, though. It is not the capitalists but the owners of the firms (the workers) who can decide what to do with the surplus value. Either they use it for consumption or for reinvestments.[17] As reinvestments in an expansion of production are limited because of diseconomies of scale, they can still try to somehow invest it profitably, e.g., in setting up an additional new firm. The important point is that the collective owners of firms can still *decide* to use part of the firms' revenues for investments despite the fact that they are not coerced to do so anymore.

This problem can be encountered by several macroeconomic conditions. One manner is to prohibit the ownership of a share of a company where a person does not work (see for example Felber (2014)). A second possibility is to tax profits to such an extent that they overall only suffice for replacement of capital depreciation – and use the taxation for consumption. This aspect can only be insufficiently be depicted within the Marxian system developed so far because the capital stock, capital depreciation and replacement investments have not been introduced. Within the reproduction schemes, it would entail that the part of surplus which firms intend to use for capital accumulation is appropriated by the state.

The extended reproduction scheme from section 16.1.2 can be used for an analysis of this situation. Wages by members of the collective firms are equal to the value of labour power and the share of surplus value used for consumption ($W = v + s^c$). Consumption out of surplus value is assumed to not change over time, as income does not either ($\Delta s_1^c = 0$). The share of surplus value appropriated by the state (s^{cs}) is equal to the share of surplus value used for capital accumulation in the extended reproduction scheme ($s^{cs} = s^{av} + s^{ac}$). The reproduction scheme is therefore (compare to equations 16.9 and 16.10):

[17] Note that this discussion is based on lifting the assumption that all wages are consumed.

$$\text{sector 1: } w_1 = c_1 + W_1 + s_1^{cs}, \tag{16.23}$$

$$\text{sector 2: } w_2 = c_2 + W_2 + s_2^{cs}. \tag{16.24}$$

The condition for stability is derived by setting production of sector 1 equal to demand for constant capital ($c_1 + W_1 + s_1^{cs} = c_1 + c_2$) or by setting production of sector 2 equal to demand for consumption goods ($c_2 + W_2 + s_2^{cs} = W_1 + s_1^{cs} + W_2 + s_2^{cs}$):

$$c_2 = W_1 + s_1^{cs}. \tag{16.25}$$

The interpretation is (again) that the demand for capital goods by sector 2 needs to be equal to the demand for consumption goods from sector 1. It is also important to keep in mind that the entire taxation by the state needs to be used to purchase consumption goods.

16.2.6 Economic and Political Contradictions in Economies Without Growth?

16.2.6.1 Economic Crises

It has been argued above that the main reason for crises in a growing economy is a drifting apart of production and consumption, according to Marx's analysis. The reason is a continuous expansion of supply due to competition on the one hand and a slacking consumption demand due to pushing wages down and low consumption out of profits on the other.

This reason for crises is less accentuated or even absent in zero growth economies. Concerning the supply side, the conditions described – collective firms, diseconomies of scale, reductions in working hours and taxation of profits – lead to constant production and no expansion. Regarding demand, surplus value is either paid as wages or appropriated by the state and thereby directed towards consumption demand. If the underlying assumptions hold (e.g., that wages are entirely used for consumption), there is no lack in demand and therefore no tendency towards a realization crisis.

16.2.6.2 Feasibility to Realize Zero Growth Within the Existing Political Economy

As argued above, in Marx's analysis the primary objective of the state is to protect the existing property structure. But in particular two of the conditions outlined would change this property structure. First, a collectivization of firms poses a reassignment of the major share of property titles. Second, the appropriation of profits which exceed the level of replacement of physical capital depreciation includes high taxation of profits or wealth. But also other conditions such as the introduction of diseconomies of scale and a strong governmental support for working hours reductions are contrary to capitalists' interests.

If the analysis of power relations in capitalist societies from section 16.1.3 is appropriate, the necessary macroeconomic conditions as outlined so far are therefore implausible to take place without changing the power relations themselves. In the following chapters, the feasibility to enforce such conditions is discussed in more detail, in particular regarding the potential role of social movements.

16.3 Results and Discussion

16.3.1 Summary of Conditions

It has been argued that the reasons for capital accumulation and economic growth within Marx's analysis can be revoked by a set of macroeconomic conditions. Four central conditions for zero growth have been developed.

1. The first condition is a collectivization of firm ownership. This would abolish the capital-labour relationship at the firm level and helps to abolish profits on the search for reinvestment opportunities.
2. The coercion to expand production due to price competition can be encountered by disestablishing economies of scale and supporting diseconomies of scale.
3. Technological change nevertheless takes place and leads to a reduction of value creation in zero growth economies. The resulting problem of unemployment can most plausibly be countered by a reduction in average working hours.
4. If people intend to invest above the level of replacement of capital depreciation, taxing profits and/or wealth can be implemented as a countermeasure.

It has further been argued that these conditions are likely to dampen the reasons for economic crises, which are inherent to the capitalist system. These conditions for economies without growth strongly oppose capital interests. Within the Marxian understanding of power relations and the role of the state, these conditions are therefore implausible to be implemented.

16.3.2 Critical Assessment

There have been many discussions and numerous contributions on criticizing Marx's theory. Covering these is outside the scope of the work at hand. Therefore, the discussion is limited to those aspects that seem crucial concerning economies without growth.

A first central criticism concerning the theory of capital accumulation stems from the Keynesian camp. Hein (2004) argues that Marx's theory implicitly assumes Say's theorem. In Marx's theory, investments are financed out of profits, which are the savings of capitalists. Savings therefore pre-date investments and are a necessary condition for capital accumulation. As shown in part III, Keynesian theorists point out that investments are financed by loans, which are made possible by the creation of money by private banks. Prior profits are therefore not necessary for investments.

The implication of this criticism concerning the conditions outlined above is that the collectivization of firms becomes unnecessary. When investments do not depend on profits but on the will of firms to invest, the collectivization of ownership is not needed to prevent investments due to profit looking for investment opportunities. Instead, diseconomies of scale should suffice to prevent firms to strive for growth. At the same time, it becomes possible that entrepreneurs open up new firms without prior savings. This could lead to increasing investments on the macroeconomic scale.[18]

A second related criticism by Hein (2004) concerns the assumption that effective demand does not pose a limiting factor for capital accumulation. In Marx's theory, capital accumulation is only limited by the level of surplus value and profits. Insufficient consumption demand does not pose a problem. This issue is taken up in the next section on monopoly capitalism, where insufficient effective demand plays the central role to explain stagnationary tendencies.

A third criticism concerns the political economy in Marx's theory. According to how Sweezy (1942) describes Marx's understanding of the power relations in capitalism and the role of the state, there is no room for radical changes without a revolution. Since Marx's publications, there have been various debates on this issue. Influential concepts have been *revolutionäre realpolitik*, associated with Rosa Luxemburg (see Haug (2009)) and *non-reformist reforms* by Andre Gorz (see Muraca (2013)). Both concepts have the idea in common that specific reforms within the existing capitalist society can improve the feasibility of further, more radical changes. Another great figure in this debate is Antonio Gramsci, who argued that it is crucial to develop new alliances between different social groups to gain the necessary power for radical change: "From the dissonant constellations in which everybody is caught, it is, in order to

[18] It should also be noted that other Keynesian theories (see in particular section 12.3) lay ground for the necessity of collective firm ownership for economies without growth. The major reason is that firms that act according to shareholder interests are more likely to expand production than collective firms.

recover agency, necessary to work out a generalization [...] of interests that respects differences. Specific interests must be newly connected and solidarity must be developed. This is what Gramsci meant" (Candeias, 2010, p. 8).

Based on the discussions on economies without growth from chapter 3, there are indications that the proposed conditions constitute changes that allow for further, more radical change. The collectivization of firm ownership would change the power relations, as firms are important social and political actors (Posse, 2015). Introducing diseconomies of scale support a higher percentage of local production, which tends to put more importance on decisions by local governments – what arguably allows for more democratic control (Paech, 2012). The reduction of working hours allows for greater democratic participation and therefore enables workers to participate more in political processes (Wittmann, 2014). It is important to note however that whether these changes are actually in accordance with theories of social transformation (for example those by Luxemburg, Gorz and Gramsci) necessitates a more thorough analysis than is possible at this point.

Chapter 17
Theory of Monopoly Capitalism

Marx's analysis rests on the assumption, "that the market system was characterized by conditions of free competition" (Foster, 2002, p. 3), that is, the economic system is marked by competitive markets where firms compete via prices. At the same time, Marx (1990) already indicates the mechanisms of concentration and centralization of capital. Concentration of capital is the increase in the size of firms due to continuous capital accumulation. Firms' sizes also grow due to centralization of capital, for example due to firm mergers. According to Baran and Sweezy (1966), it was

> [n]ot that Marx was unaware of the existence of monopoly [...] [b]ut like the classical economists before him, he treated monopolies not as essential elements of capitalism but rather as remnants of the feudal and mercantilist past which had to be abstracted from in order to attain the clearest possible view of the basic structure and tendencies of capitalism (Baran and Sweezy, 1966, p. 4).

According to Foster (2002), Marx interprets centralization and concentration as signs for the transformation towards socialism: "Marx and Engels, however, were prone to see these developments [concentration and centralization] as signs of new conditions of socialization of production that would help usher in a new mode of production – not as indications of a new stage of capitalism" (p. 4). By contrast, in the Theory of Monopoly Capitalism, monopolistic market structures replace competitive ones as the core driver of a new type of capitalism.. The change in market structure is therefore the key element that distinguishes the Theory of Monopoly Capitalism from Marx's analysis:

> We must recognize that competition, which was the predominant form of market relations in nineteenth-century Britain [the reference point for Marx's theory] has ceased to occupy that position, not only in Britain but everywhere else in the capitalist world. Today the typical economic unit in the capitalist world is not the small firm producing a negligible fraction of a homogeneous output for an anonymous market but a large-scale enterprise producing a significant share of the output of an industry [...], and able to control its prices, the volume of its production, and the types and amounts of its investments (Baran and Sweezy, 1966, p. 6).

Several authors have contributed to laying the ground for this analysis. According to Foster (2002), the first major contributions were done by Lenin (1999), Hilferding and Bottomore (1990), Veblen (2005), Steindl (1954), Sweezy (1942) and Baran (1962). These analyses culminated in the work *Monopoly Capital: An Essay on the American Economic and Social Order* (1966) by Paul Baran and Paul Sweezy. According to Lee (2009) "Monopoly Capital quickly became the book to read, discuss in study groups, and recommend to radical friends" (p. 57) and was "was translated into sixteen languages" (Barkan, 1997, p. 95) within ten years. According to Howard and King (2014), the book was the culmination of the work of its two authors, bringing together their previous theoretical work into one coherent analysis.[1]

17.1 Monopoly Capitalism

The book *Monopoly Capital* (1966) starts with three chapters in which firms and market structures in Monopoly Capitalism are investigated (17.1.1). This analysis is followed by four chapters in which possible absorptions of surplus are discussed (17.1.2).

17.1.1 Foundations of Monopoly Capitalism

The core of the Theory of Monopoly Capitalism rests upon the argument that the economy[2] is characterized by big/large/giant firms, which seek to maximize profits (17.1.1.1). Profits are maximized by a combination of monopolistic price setting and cost reductions (17.1.1.2). This leads to a tendency of increasing surplus and a lack in effective demand (17.1.1.3). Finally, more recent contributions to monopoly capitalism distinguish different types of surplus and their use (17.1.1.4).

1 Regarding the question, which aspects of the following investigation are adopted from existing work, and which are novel developments of this present study: The following representation of monopoly capitalism rests largely on this book, in particular its chapters 1-8. This analysis is extended in particular by reference to the contribution of Wolff and Resnick (2000). The theory in section 17.1 is a reproduction of the existing theory. In section 17.2 the existing theory is interpreted in order to investigate zero growth conditions.

2 Different to other theories, Baran and Sweezy point out that their theory is not intended to explain economies in general but the economy of the USA (and similar early industrialized countries in particular in Western Europe) at the time they wrote it.

17.1.1.1 Large, Manager-Controlled, Profit-Maximizing Firms

According to Baran and Sweezy (1966), "[m]onopoly capitalism is a system made up of giant corporations" (p. 52). The behaviour of big firms is the decisive factor for macroeconomic developments. This is not to say that smaller firms do not exist. But they do not have the power to shape macroeconomic developments, and "should properly be treated as a part of the environment within which Big Business operates" (p. 53).

The theory starts with an investigation of the behaviour of big firms. The first central point is that they are controlled by management, that is "the board of directors plus the chief executive officers" (p. 16). The members of management behave according to the interests of the firm they work for, as the managers' personal interests are aligned with the interests of the firm. These interests also coincide with that of large share holders (rather than small shareholders) as will be elaborated below.

Personal interests of managers are aligned with firms' interests due to two reasons. First, managers make careers within a firm depending on their contributions to the firm's success. Those managers who serve the firm better, succeed in "ascending the managerial ladder" (p. 38). Second, a manager's prestige and income depends on the status of the firm. According to Baran and Sweezy, being manager in a more successful firm increases reputation and is a major motivation for the behaviour of managers. As a consequence, managers act in accordance with the firms' interests in order to gain prestige both within the firm and within the wider manager community.

The subsequent question is what lies in the interest of the firm – or in other words what characterizes a successful firm. Baran and Sweezy refer to a study by James Earley who argues that "the major goals of modern large-scale business are high managerial incomes, good profits, a strong competitive position, and growth" (Weintraub, 1957, p. 343). Baran and Sweezy argue that a firm's status (and thereby a manager's status) depends on the firm's size, growth and strength[3] An additional goal of managers is to obtain high managerial incomes.

The major means to achieve all these goals is to generate the highest profits possible. High profits allow for investments and therefore for growth of the firm. Profits also facilitate higher managerial incomes. Additionally, profits enable firms to invest in activities that improve their competitive position. These activities are in particular related to the *sales effort*, encompassing commercials and the invention of new products (discussed in more detail below).

[3] The latter is "measured by such standards as credit rating and the price of a company's securities" (p. 39).

The argument so far has established that large firms with market power do not cease to strive for profits.[4] But Baran and Sweezy actually go a step further. They argue that the large firms are even more rational in their endeavour to maximize profits[5] than small firms, mainly due to two reasons. First, "the corporation has a longer time horizon than the individual capitalist" (p. 47), as it "is in principle immortal" (p. 48). Second, "it is a more rational calculator" (p. 47) because large firms have by far more financial means and experience than small firms to analyse which behaviour is profit-maximizing.

17.1.1.2 Monopoly Pricing, Cost Reducing and Profits

After having established that large firms are profit maximizers, the subsequent matter is how they attempt to maximize profits. It is insightful to shortly iterate the Marxian analysis of profit-maximizing by *competitive* firms. They compete mainly via the price of a certain commodity. The introduction of new technologies is central to stay price competitive. Firms have an incentive to introduce new technologies early in order to gain an extra profit. At the same time, there is an imperative to introduce the cost-reducing technology because otherwise the firm will be outcompeted by other firms (see chapter 16).

According to Baran and Sweezy (1966), this type of price competition does not exist in monopoly capitalism anymore, there is an "abandonment of price competition" (p. 67). They point out that on empirical grounds very few price reductions can be observed in monopolistic markets. The theoretical explanation is that it is in the interest of each firm to prevent price competition with the other large firms, as such a competition would be disadvantageous and risky to all of them.

The absence of price competition is connected to the ability of large firms to analyse which behaviour is profit maximizing. According to Baran and Sweezy, this goes hand in hand with a risk-averse behaviour. Assessing the potential gains and losses from an aggressive price competition with comparably strong competitors, managers most of the time come to the conclusion that it is not worth the risk. This "attitude of live-and-let-live" (p. 50) is the outcome of experience, which is why younger markets are more likely to still be characterized by price competition than older ones.

[4] Baran and Sweezy rebut existing and apparently at that time influential arguments for the insignificance of profit-seeking in large firms.

[5] In this theory the maximization of profits is different to the understanding of neoclassical theories. Because firms do not have perfect information, they maximize profits in the sense that they "search for the greatest *increase* in profits which is possible in the given situation" (Baran and Sweezy, 1966, p. 27).

Baran and Sweezy further point out that there is also a social reason for "banning price cutting as a legitimate weapon of economic warfare" (p. 58). Managers are part of a social community whose members are likely to act in a manner that benefits them as a group:

> Conscious of their power and standing in the larger national community, they naturally tend to develop a group ethic which calls for solidarity and mutual help among themselves and for presenting a common front to the outside world (1966, p. 50).

When price competition is no more a relevant strategy, the firms "have an interest in seeing that the price or prices established are such as to maximize the profits of the group as a whole" (p. 59). This is the case when the price is set as if there was a monopoly. Hence, price setting is characterized by a similar behaviour as a monopolist would do, although most markets are no actual monopolies (with only one supplier): "[T]he appropriate general price theory for an economy dominated by such corporations is the traditional monopoly price theory" (p. 59).

Baran and Sweezy claim that this monopoly-like price setting takes different forms depending on specific market structures. One form (1) is "price-leadership", where the "largest and most powerful firm in the industry" (p. 60) sets the price and the others adopt it. Again, the other firms have an incentive and a coercion to comply. The incentive is that the monopolistic price setting also helps them to maximize profits. The coercive aspect is that non-compliance leads to "price warfare [in which] the leader would be able to stand the gaff better than they could" (p. 61). If there is no clear price leader, other forms of monopolistic price setting can take place. In one form (2) "big companies take turns in initiating price changes" and in another (3) "different companies take the lead in different regional markets and to a certain extend at different times" (p. 61). There can also be (4) a mutual understanding that the price change of a firm is a proposal to change the price in the interest of all. If the other firms agree, they adjust their prices. If the other firms disagree, the initiating firm is likely to withdraw and to offer the product at the old price.

In one aspect, the price setting under monopoly capitalism differs from the traditional monopoly price theory: Price reductions are less likely to occur. The reason is that price cuts are likely to be interpreted as price competition and can therefore potentially lead to it. As all firms have an interest to prevent price competition, "everyone concerned is likely to be more circumspect about lowering than raising prices" (Baran and Sweezy, 1966, p. 62).

In sum: Prices in monopoly capitalism are set to the same level as predicted by traditional monopoly theory, with the qualification that price cutting is less likely to occur. This implies higher prices and a lower quantity of goods supplied than in competitive capitalism.

In addition to price setting and the quantity of goods sold, the other important determinant of profits is the level of production costs. Baran and Sweezy argue that firms in monopoly capitalism intend to – and are usually successful in – reducing production costs, mainly due to two reasons. First, managers pursue profit maximization. As prices are given, the central way to increase profits is to reduce costs. Hence, managers initiate any measure to reduce costs. Second, production costs decline due to "non-price competition in the producer goods industries" (p. 70). Firms who sell producer goods compete against one another and try to develop products that the producers of consumption goods are interested in buying. The producers of consumption goods are interested in such producer goods, which allow them to reduce costs. Hence, firms in the producer goods market have an incentive to invent goods that allow to reduce costs in the consumption goods sector.

17.1.1.3 Economic Surplus and Waste

The results of monopoly pricing and cost reductions are increasing profit margins and aggregate profits. "[C]ontinuously widening profit margins in turn imply aggregate profits which rise not only absolutely but as a share of national product" (p. 71 – 72). Baran and Sweezy further argue that the increasing profits are a first approximation of the tendency of economic surplus to rise: "If we provisionally equate aggregate profits with society's economic surplus, we can formulate as a law of monopoly capitalism that the surplus tends to rise both absolutely and relatively as the system develops" (p. 72).

The concept of (economic) surplus is central to the analysis of monopoly capitalism. At the same time, it is a problematic concept, because there are different definitions of it and it is difficult to measure. Before examining its tendency to rise, it is therefore necessary to discuss shortly its different meanings.

Baran and Sweezy (1966) start their analysis with the preliminary definition that the economic surplus "is the difference between what a society produces and the costs of producing it" (p. 9). In other words, the surplus is that amount of production that is freely available for the purpose the society chooses for it – while the other part of production, the costs, are necessary for sustaining the production factors (in particular consumption goods for the reproduction of workers and the replacement of capital depreciation by new capital goods).

The ambiguity of the concept lies within different definitions of (1) the production of society and (2) the costs of producing. According to

Howard and King (2014), the production of society can either be (a) the actual production taking place, (b) the potential production with regard to the given level of production factors and technology or (c) the potential production of a socialist/planned economy. Similarly, the costs can either be (a) the actual costs, (b) the "socially necessary costs" (Baran and Sweezy, 1966, p. 76) within the existing economic circumstances or (c) the "optimum consumption" (Howard and King, 2014, p. 115) in a socialist economy.

The central definition of economic surplus used by Baran and Sweezy (1966) is the difference between actual output and the socially necessary costs given the level of production factors and technology: "[W]hat we call surplus, [is] the difference between total output and the socially necessary costs of producing total output" (p. 76). Even based on this definition, it is difficult to determine the level of surplus, however, as the socially necessary costs are difficult to define and measure.

This is due to the fact that an increasing amount of surplus is "wasted" (p. 79). Waste mostly takes either the form of the sales effort or government spending, in particular on the military. Concerning the sales effort, it is difficult to separate productive from unproductive work, as they are tightly entangled in the production process. But on a purely conceptual level, waste is the difference between actual costs and socially necessary costs. Waste is therefore also the difference between surplus and profits.

17.1.1.4 Different Types of Surplus

Wolff and Resnick (2000) formalize and differentiate Baran's and Sweezy's analysis of economic surplus. They distinguish two types of surplus. First, due to class exploitation, the *surplus value* is appropriated by capitalists. This part of economic surplus is based on Marx's analysis and takes place in competitive capitalism. In monopoly capitalism, there are two additional types of economic surplus. Wolff and Resnick argue that both of these additional types are due to the market power and the ability to charge prices above competitive markets in monopoly capitalism.

The first additional type of surplus is called *non-class revenues* (NCR). It is earned by capitalists and paid by workers, when capitalists are able to charge monopoly prices. It is non-class, because it does not result out of class relations (as the surplus value does), but out of monopoly power. The second additional type is *subsumed class revenue* (SSCR). It is paid from one subgroup of a class to another. Usually this type of surplus is connected to monopolistic firms in the capital goods sector, which are able to sell the capital goods (to firms in the consumption goods sector) at monopolistic prices.

Wolff and Resnick change the equations for the two sectors (compare with equations 16.2 and 16.3) to price values.[6] P is the price of the good of the sector, Q is the quantity:

$$\text{sector 1: } P_1 * Q_1 = c_1 + v_1 + s_1 + SSCR \tag{17.1}$$

$$\text{sector 2: } P_2 * Q_2 = c_2 + v_2 + s_2 + NCR. \tag{17.2}$$

The reason why SSCR and NCR can be added to the usual components of value is that the prices lie above the prices in competitive capitalism.

Wolff and Resnick further argue that the usage of surplus can be divided into two categories. The payments that also take place under competitive capitalism are called *subsumed class payments* (SSCP), such as "expenditures on managers, capital accumulation, research and development, dividends, taxes, and so forth". Those which are unique to monopoly capitalism are expenditures that "aim to reproduce the condition of existence of those monopoly revenues, namely monopoly power in their markets [... and comprise] advertising, legal services, lobbying costs associated with securing favorable legislation, and so on" (Wolff and Resnick, 2000, section *The Simple Class Analytics of Monopoly*, para. 8). They are denoted with X. The sources and uses of surplus need to be of equal size:

$$\text{sector 1: } s_1 + SSCR = SSCP_1 + X_1 \tag{17.3}$$

$$\text{sector 2: } s_2 + NCR = SSCP_2 + X_2. \tag{17.4}$$

Wolff and Resnick (2000) argue for a connection between the sources of surplus and its uses. The surplus value is connected to the subsumed class payments and the monopolistic sources of surplus ($SSCR$ and NCR) are related to other expenditures ($X_{1,2}$) that are very similar to the concept of the sales effort by Baran and Sweezy.

17.1.2 Absorptions of Surplus and Its Tendency to Rise

To recapitulate: The structure of monopoly capitalism leads to high prices and declining costs, generating high profit margins. At the same time, Baran and Sweezy follow Keynes' argument that revenues depend on effective demand. For Marx (and later Kalecki), the consumption of capitalists and investments determine profits. Keynes argues that effective demand determines revenues and therefore also profits. The central ques-

6 Wolff and Resnick here equate the value (w) of production with the revenues ($P * Q$). Whether this is possible within a Marxian labour theory of value is related to the *transformation problem* mentioned above. A discussion of this issue lies outside the scope of this present study.

tion is therefore, whether the large profits are transformed into effective demand.

In Marx's framework, only few profits are used for capitalist's consumption. Baran and Sweezy agree with him on this point, albeit following a different reasoning (17.1.2.1). According to Marx, the remaining large part of profits is used for investments in new technologies and an expansion of production, due to price competition. Baran and Sweezy contrarily argue that this is not the case in monopoly capitalism and therefore investments are low (17.1.2.2). The result is a continuous lack in effective demand and a tendency towards stagnation (17.1.2.3). They point out two crucial manners how this tendency has been counteracted. First, the sales effort both increases production directly (the production of advertisements) and indirectly by fostering consumption (17.1.2.4). Second, government spending has stepped in to fill the lack of effective demand (17.1.2.5). Altogether, these aspects lead to the tendency of the surplus to rise (17.1.2.6). Finally, the view on political economy within monopoly capitalism is laid out (17.1.2.7).

17.1.2.1 Capitalists' Consumption

Baran and Sweezy argue that the share of capitalists' consumption out of total production declines. There are two aspects that influence capitalist's consumption: capital income and the consumption rate out of capital income. According to Baran and Sweezy, it can be shown that even if the consumption rate is equal to one, the share of capitalist's consumption out of total production has to decline in the long run, because the share of capital income declines.

The reason is connected to the analysis of managerial behaviour. Managers strive towards growth and competitiveness of their firms and profits are essential to achieve both. It is more precise to say, though, that retained profits are essential to achieve these goals, as only they can be used for expansion or non-price competition. Managers therefore have an incentive to retain a large share of profits and distribute only a small share as dividends. This interest coincides with the interest of rich shareholders, because they are likely to intend to use dividend-earnings for savings (instead of consumption) and it is more lucrative (due to the tax system) for them if the firms "do the saving for them rather than pay out dividends from which to do their own saving". "[T]his makes managers the allies of the very largest stockholders" (Baran and Sweezy, 1966, p. 35).

These interests lead to a decreasing share of dividends (in profits), implemented by the following mechanism: When profits increase, the level of dividends is adjusted only slowly, effectively decreasing the share of dividends over time. The overall result is therefore that capitalist's consumption decreases "as a proportion of surplus and even more as a proportion of total income" (p. 81). This is why, "it is clear that no solution of the problem of surplus absorption can be expected from this quarter" (p. 81).

17.1.2.2 Investments

The foregone analysis of capitalist's consumption also implies that an increasing share of revenues is available for investments (as profits increase and dividends decrease). But Baran and Sweezy argue that investments do not solve the problem of surplus absorption either. For several reasons, the structure of monopoly capitalism supports low levels of investments.

The prime reason for large investments in Marx's theory is the expansion of production that is connected to the introduction of new technologies. Monopolistic firms do not attempt to expand production significantly, because expansion does not serve their goal of profit maximization (firms would need to decrease the price in order to sell the additional products). Technological change is also unlikely to lead to high investments. The reason is that monopolistic firms are not coerced into introducing new technologies in order to stay competitive. Instead, they have an interest in using the existing capital stock longer, so that "in general there will be a slower rate of introduction of innovations than under competitive criteria" (p. 94).

Baran and Sweezy even go one step further. Not only do they argue that technological change will be slower but also that net investments do not have to be positive in order to facilitate technological change: "[W]here the amount of depreciation is very large, as in present-day monopoly capitalism, it is quite possible that business can finance from this source alone all the investment it considers profitable to make in innovations" (p. 102).

17.1.2.3 Stagnation

Based on the foregone analysis, Baran and Sweezy (1966) deduce that monopoly capitalist economies tend towards stagnation. The major reason is that the economic surplus tends to rise but it is not channelled into effective demand. The following quote summarizes their view accurately:

> Twist and turn as one will, there is no way to avoid the conclusion that monopoly capitalism is a self-contradictory system. It tends to generate ever more surplus, yet it fails to provide the consumption and investment outlets required for the absorption of a rising surplus and hence for the smooth working of the system. Since surplus which cannot be absorbed will not be produced, it follows that the *normal* state of the monopoly capitalist economy is stagnation (Baran and Sweezy, 1966, p. 108).

This is the second possible outcome of the central economic contradiction in Marxian analysis, as developed in chapter 16. Under Marx's assumption of competitive markets, an increasing supply and slacking demand leads to reoccurring crises. Under the assumption of monopolistic market structures, the result is continuous stagnation. The monopolistic firms – using their means for rational, risk-managing behaviour – restrict production to the amount of feasible sales, in order to maximize profits under the conditions of monopoly capitalism.

17.1.2.4 The Sales Effort

Baran and Sweezy point out two major strategies that are applied to solving the problem of surplus absorption within the given economic structure: the sales effort and government spending. The most obvious aspect of the sales effort is advertising. Further examples are planned obsolescence and the introduction of new but useless product features. Overall, Baran and Sweezy argue that firms' entire operations are geared towards the sales effort, putting it at the centre of firms' strategies.

The sales effort has two effects concerning the absorption of surplus. First, it increases production directly because it entails various additional work, such as the activities related to producing and spreading commercials or the invention of new (mostly useless) features of a product. This increases production and thus simultaneously generates and absorbs economic surplus. This is based on the definition that surplus is the difference between actual output and *socially necessary* costs. The production of commercials or the invention of useless but sale-enhancing product features are not regarded as socially necessary.

Second, the sales effort increases consumption and thereby also investments. The logic is that commercials etc. increase the consumption rate,[7] leading to higher demand for consumer goods, which in turn induces firms to invest in order to expand production: "[T]he economic importance of advertising lies [...] in its effect on the magnitude of aggregate effective demand and thus on the level of income and employment" (p. 124).

Baran and Sweezy spend a significant amount of time on pointing out the immense increase in the role of advertisements, referring to the development of money spent on it since the 19th century. They come to the conclusion that it has grown to be a "truly fantastic outpouring of resources" and became "an indispensable tool for a large sector of corporate business" (p. 119). Its importance is also illustrated by its increasing entanglement with the production process itself: "the sales effort which

7 Note that Baran and Sweezy implicitly deviate from Marx's assumption that workers consume their entire wage income. Only then can the overall consumption rate be increased significantly by commercials.

used to be a mere adjunct of production [...] increasingly invades factory and shop, dictating what is to be produced according to criteria laid down by the sales department" (p. 130).

In sum, the sales effort constitutes a very effective and important, and at the same time highly wasteful manner to alleviate the problem of insufficient effective demand. It adds directly to aggregate production by producing commercials and increasing the demand for consumption goods. It thereby increases the surplus, and uses part of it for wasteful purposes such as commercials and useless product features. The next section covers the second important solution to the absorption problem: government expenditures.

17.1.2.5 Civilian and Military Government Expenditures

Government spending takes a similar role as the sales effort regarding its impact on the generation and absorption of economic surplus. According to Baran and Sweezy, the effect of government spending is even significantly larger than the effect of the sales effort. Using figures from 1903 to 1961, they show that it has increased from 7.4 to 28.8 percent in the USA. Baran and Sweezy argue that contrary to traditional economic theory, government spending does not replace private spending but increases effective demand independently on whether it is financed via debt or taxation. The necessary condition is that production is below full capacity (which is usually the case in monopoly capitalism):

> [T]he vast and growing amounts of surplus absorbed by government in recent decades are not [...] deductions from what would otherwise be available to [...] private purposes. The structure of the monopoly capitalist economy is such that a continually mounting volume of surplus simply could not be absorbed through private channels; if no other outlets were available, it would not be produced at all (Baran and Sweezy, 1966, p. 147).

The underlying reasoning is as follows: When the government decides to increase expenditures, it increases effective demand by that amount. The government can finance this increase by an equal increase in taxes. This does not need to affect private spending, as overall after-tax income is the same as before. If, on the other hand, the additional spending is financed by a deficit, there is additionally a multiplier effect of the government spending on effective demand.

Government spending is in the interest of firms, because it increases effective demand and therefore sales and profits – as firms can "shift most of the associated taxes forward onto consumers or backward onto workers" (Baran and Sweezy, 1966, p. 149). The profit share stays approximately constant, so that overall profits increase. Workers also have an interest in high government spending, most importantly because it reduces unemployment. Subsequently, "there can be no doubt that it is to the interest of all classes [...] that government should steadily increase its spending and its taxing" (p. 151).

Subsequent questions are what type of government spending is pursued and whether its size is sufficient to prevent stagnation and bring the economy (close to) full capacity utilization. The two questions are closely connected, because different types of spending are related to different restrictions.

Baran and Sweezy divide government spending into non-defence purchases, transfer payments and defence (or military) purchases. Non-defence spending and transfers combined are civilian spending. Comparing 1929 with 1957, non-defence purchases rose from 7.5 to 9.2 percent, transfer payments from 1.6 to 5.9 and defence purchases from 0.7 to 10.3 percent (see Baran and Sweezy (1966, p. 152)). Based on these figures, Baran and Sweezy argue that increases in military spending have been most important for surplus absorption, while transfers have also played a smaller but still significant role and non-defence purchases were of little importance.

Baran and Sweezy continue their argument with an analysis on why these developments have taken place and at the same time, why military spending did not increase sufficiently to bring the economy to full capacity utilization. The historical account shows that the non-defence spending of the New Deal in the 1930s was not sufficient to bring the economy to full capacity, as unemployment persisted. This was only achieved by the great increases in military spending during the Second World War. After the war it was not possible to shift everything towards civilian purposes and this is also not possible to happen in general, due to the existing political economy.

The central obstacle to increases in government spending is due to the political economy of monopoly capitalism. The expansion of spending of each singular civil purpose (health, education, infrastructure etc.) above a certain level is countered by specific interest groups and lobbying. One reason can be competition between private and governmental providers of the respective purpose. Where this is not the case, parts of the "oligarchy"[8] have a strong interest to prevent government spending above a

8 Baran and Sweezy use the term *oligarchy* instead of capitalist class. While they do not define it precisely, large firms are a central component of it as "all the political activities and functions [...] can be carried out only by means of money [... and] the big corporations are the source of big money" (p. 155).

certain level. For example, expenditures on public education is limited due to the fact the existing educational system "is a central element in the constellation of privileges and prerogatives of which the moneyed oligarchy is the chief beneficiary" (p. 170). Baran and Sweezy argue that therefore "in case after case the private interests of the oligarchy stand in stark opposition to the satisfaction of social needs" (p. 173).[9] Hence, strong increases in civilian spending are prevented.

Military spending, on the other hand, does not contradict the interests of powerful social groups. On the contrary, an expansion of military spending is to their advantage. Baran and Sweezy point out four central reasons. First, a strong military was in the interest of US American capitalists, in order to win the Cold War: "[T]he need of the American oligarchy for a large and growing military machine is a logical corollary of its purpose to contain, compress, and eventually destroy the rival world socialist system" (p. 191). This is connected to the second reason. Large US American firms have an interest in keeping and expanding access to world markets under their conditions: "What they [giant multinational corporations] want is *monopolistic control* over foreign source of supply and foreign markets, enabling them to buy and sell on specially privileged terms" (p. 201). Third, military spending does not constitute competition to private firms, as there is no private demand for military services that could be crowded out. Finally, military spending fosters values and opinions in society that are in the oligarchy's class interest: "[M]ilitarization fosters all the reactionary and irrational forces in society, and inhibits or kills everything progressive and humane" (p. 209).

Due to these reasons, military spending has been expanded to a much larger extent than civilian purchases in the USA. According to Baran and Sweezy, the size of military spending has not been sufficient to achieve full capacity utilization, however (after the end of the Second World War). The reason is that military spending has become counterproductive to its own purpose, that is, to guaranteeing security: "The piling up of modern weapons of total destruction in an arms race between two evenly matched powers [...] reduces the chances that the country could survive a full-scale war" (p. 216). Baran and Sweezy argue that "this truth has now been digested and absorbed by responsible leaders of the United States oligarchy" (p. 216), which is why military spending has been limited.

9 The only exception pointed out by Baran and Sweezy are investments in the highway system, which have increased strongly over time.

17.1.2.6 The Tendency of Surplus to Rise

The theory can be summed up as follows: The change from competitive to monopolistic capitalism leads to the increase of the profit share. At the same time, the traditional channels via which profits are channelled into to effective demand – capitalist's consumption and investments – are incapable of absorbing the surplus in monopoly capitalism. The result is a continuous lack in effective demand. The sales effort and government spending partially remedy this deficiency. The two aspects are potentially sufficient to bring effective demand to the level of full capacity utilization. However, they have not done so in reality, due to reasons of political economy.

The resulting rise in surplus consists of three aspects. First, the rise of the profit share leads to increasing capitalist's (luxury) consumption, which is counted as part of surplus. Second, the sales effort is entirely surplus absorption, as it is non-necessary social labour. Third, government expenditures are counted as surplus.[10]

Hence, the increasing profit share is the *prerequisite* for the economic surplus to rise, while increases of capitalist's consumption, the sales effort and government spending are the *concrete forms* of economic surplus. A central difference to Marx's theory is that surplus is primarily used for these three forms instead of using it for investments and capital accumulation.

17.1.2.7 Political Economy

The perspective on the political economy in monopoly capitalism by Baran and Sweezy is very similar to the one developed by Marx. The state is regarded as being strongly controlled by the oligarchy (instead of the capitalist class). While workers are able to negotiate certain concessions (e.g., concerning the wage level), the interests of the giant firms are decisive. The ability of lobbyists from these giant firms to prevent rises in government spending on civilian causes are a good example.

Marx's theory and the theory on monopoly capitalism differ concerning the feasibility of revolutionizing the system. According to Foster (2014), Marx had great hopes in the revolutionary power of the working class. But Baran and Sweezy conclude that "[i]f we confine attention to the inner dynamics of advanced monopoly capitalism, it is hard to avoid the conclusion that the prospect of effective revolutionary action to overthrow the system is slim" (p. 364). The reason is that the working class is "too het-

[10] This illustrates the point that the surplus does not necessarily have to be used for irrational or unnecessary purposes, as a large part of civil government expenditures goes into rational causes.

erogeneous, too scattered and fragmented, to constitute a coherent force in society" (p. 364) and the oligarchy is effective in keeping it that way. Instead, Baran and Sweezy see more potential in revolutionary movements in peripheral countries of global capitalism.

17.2 Conditions for Sustainable Economies Without Growth

The Theory of Monopoly Capitalism is different to the theories discussed before in that it establishes a tendency towards stagnation – probably best to be interpreted as very low economic growth. One possibility is therefore to investigate how the countervailing measures to such stagnation can be prevented in order to support the forces supporting stagnation so that it leads to zero growth. This is done in prefix I (17.2.1). It is argued that this is neither feasible nor desirable when taking into account the social, environmental and economic dimensions of sustainability regarding economies without growth. Prefix II (17.2.2) briefly discusses the possibility of a planned economy.

The following sections develop conditions for sustainable economies without growth: the collectivization of giant firms (17.2.3), preventive measures to the sales effort (17.2.4), the role of diseconomies of scale (17.2.5), a redirection of technological change and/or working hours reductions (17.2.6) and the role of government spending (17.2.7). In the last part of this section, it is discussed whether such changes are feasible regarding the political economy (17.2.8).

17.2.1 Prefix I: Turning Stagnation Into Zero Growth

The main prerequisite for the tendency towards stagnation are cost reductions, because they are based on organizing the production process with continuously less labour per unit of output. The subsequent decrease in labour demand leads to decreasing wages and decreasing consumption demand. Combined with the lack of demand for investments due to reasons located in the monopolistic supply structure, overall effective demand is below full capacity, generating a continuous stagnation. As argued above, the sales effort and government spending are the primary countermeasures, which can increase effective demand.

One manner to achieve zero growth economies would therefore be to prevent such countervailing measures – possibly combined with a support of the stagnationary forces. Expenditures into the sales effort and their effectiveness on increasing consumption demand can principally be reduced. Possible measures are the prohibition of commercials, the taxation of activities into the sales effort, legislation that makes planned obsolescence difficult etc. Government spending could stop increasing or even be cut.

Additionally, the stagnationary forces in the economy could be supported, in particular by worsening the bargaining power of workers compared to capitalists, so that real wages fall and effective demand further slackens.

This scenario is unlikely to be realized in the existing political economy. The reason is that it implies political decisions that are not in the interest of any major social group. Firms and capitalists are likely to oppose, as various of the necessary measures (in particular preventing the sales effort and decreasing government spending) crucially oppose their ability to generate profits. Workers are equally likely to be unfavourable to such changes, in particular concerning the weakening of their bargaining power and cuts in government spending. As neither the majority of people nor capitalists have an interest in pushing the necessary changes for transforming the tendency towards stagnation into zero growth, it is implausible to take place.

Even more importantly, this type of economies without growth is not sustainable in social and economic respects.[11] It would imply increasing economic inequalities due to the resulting low wage share and high profit share, caused by the low bargaining power of labour. This type of zero growth economies also lead to increasing economic instability, as technological change would still continue to take place, leading to persistent unemployment. In conclusion, using the existing tendencies towards stagnation in order to further decrease economic growth is neither feasible nor desirable.

17.2.2 Prefix II: Planned Economy

Several authors have suggested that a feasible transformation towards socialism is the nationalization of big firms. According to Harvey (2011), large firms have developed the techniques of large-scale planning. These companies internally work via a control-and-command system and not via market forces. Harvey argues that these tools can be used to organize a planned macroeconomy. While Baran and Sweezy (1966) do not argue in favour of using such tools, they also put forward the notion of a revolution towards central planning. Out of the Woods (2014) additionally point out that centralized companies can be taken over by workers: "Socialism could then be understood as the workers, or in practice, the Communist Party, taking over the apparatus of centralised production and planning that capitalism had bequeathed" (paragraph 6).

Zinn (2015) makes a slightly different proposal with reference to the analysis of Joseph Schumpeter. He argues that the tendency towards cen-

[11] Environmental aspects are not part of the theoretical framework and can therefore not be examined.

tralization suspends market competition and constitutes an important step towards a centralized economy. According to Zinn, the only crucial additionally step is to nationalize the big companies.[12]

These authors all argue for the planned economy as a strategy of economic transformation. In principle, the planned economy could also be used to achieve sustainable economies without growth. This strategy is not further investigated at this point however – due to the same reasons as in chapter 16: The method applied here is not appropriate and a planned economy does not reflect the perspectives on economies without growth as discussed in chapter 3.

17.2.3 Collective Firms as Response to Investments

In the Theory of Monopoly Capitalism, the pursuit of maximum profits is the driving force for the behaviour of large companies. Managers try to maximize profits in order to have the financial means to pursue two goals: Growing the firm and obtaining financial resources for the sales effort. The pursuit of both goals contributes to economic growth: When all firms attempt to grow, investments are high. When firms spend large amounts on the sales effort, both the sales sector and demand for consumption goods are high. Both goals therefore contribute to increases in effective demand, whose lack in size is the primary limitation to economic growth in monopoly capitalism. When it comes to zero growth, it is important to examine the underlying reasons responsible for the pursuit of these goals.

As pointed out in section 17.1.1, managers strive for growth of the firm out of two major motivations. First, large and growing firms imply more prestige for managers. Second, rich shareholders have an interest that the firm uses profits in order to grow. The interests of these two groups are aligned and therefore shape the firms' decisions.

Both motivations can in principle be repealed by collectivizing firms. Collectivizing here implies as before that the firm is owned by its workers and potentially additional other stakeholders. Within the logic of most economic theories, workers' primary interest is to receive high wages.

First, based on the argument that managers' behaviour depends on the interest of their peer group, it is plausible that managers develop a different set of values and goals when their peer group are the other workers in the firm. Their prestige is likely to be less connected to the growth or size of the firm. Instead, it supposedly depends on whether the workers are contend with the managers' actions. As workers interests

[12] Original quote in German: "Verstaatlicht werden prinzipiell nur diese wirtschaftlichen Großgebilde" (p. 116).

lie within high wages and good working conditions, managers have an incentives to pursue these goals – instead of maximizing profits.

Second, in Marx's theory, the quality of work also plays an important role, so that work is less alienated.[13] High wages are in direct contrast with using a large amount of revenues for large reinvestments. In other words, there is a strong interest that a large part of profits are paid as dividends (in collectivized firms it becomes difficult to distinguish between profits and wages, as both are paid to the same group of people).

17.2.4 Collective Firms and Regulations as Responses to the Sales Effort

A major reason for profit maximization is to compete in the area of the sales effort. According to the Theory of Monopoly Capitalism, the main reason for the sales effort is the combination of high profits (which would allow for production expansion) and low effective demand. Collectivizing firm ownership contributes to avoiding both aspects. As argued above, collective ownership is likely to increase the share of revenues distributed as wages and dividends, because workers have an interest in attaining higher incomes and are poorer than the shareholders under monopoly capitalism. As a result, the funds available for the sales effort are lower. At the same time, higher income of workers implies higher demand for consumption goods. The reasons for a consistently low capacity utilization and for large expenses on the sales effort are therefore greatly diminished.

Additionally, regulatory measures regarding the sales effort can support its reduction or even abolishment. Possible regulatory policies have already been mentioned above: abolishing commercials and regulating less obvious means of the sales effort, such as planned obsolescence and the invention of useless product features. Such measures would make it more difficult and less profitable to engage in the sales effort.

17.2.5 Diseconomies of Scale?

The conditions described thus far entail a potential contradiction. When collective firms lead to higher worker incomes (and lower or even no income of capitalists), consumption demand increases due to the assumption that the consumption rate out of wages is larger than the consumption rate out of profits. The subsequent increase in effective demand could stimulate firms to expand production. This issue has already been discussed based on a similar analysis in chapter 14. The central result is

[13] According to Harvey (2010), alienation in the *Capital* (1990; 1992; 1991) implies that workers have no control over what they produce and how the production process takes place, because they have sold their labour power to the capitalist.

that other conditions have to confine investments despite the relatively high level of consumption demand.

Such an increase in production is also feasible due to technological change. The introduction of technologies allows firms to produce more goods with the same number of workers. In fact, there is even a further incentive to increase production under collective ownership. Without firm growth, a share of workers (who are also owners now) would have to be dismissed due to increasing labour productivity.

However, these aspects depict *incentives* but not *coercions* to expand production. Keeping the level of production constant does not imply to be outcompeted, as new technologies can be introduced at the level of depreciation and market power allows to have revenues well above socially necessary costs (that is, the costs associated with some minimum level of wages).

On the other hand, there are also incentives not to expand. First, expanding production requires using part of revenues for reinvestments, which signifies lower income for the workers/owners of the firm. Second, increasing production implies a larger number of workers and therefore a smaller say in the company's decisions. If quality of work is a relevant goal of workers, they may also choose to keep the firm smaller in order to have a better work atmosphere.

There are thus reasons for as well as against firms to decide to expand production. Whether expansion takes place depends on the relative weight between the reasons. Introducing diseconomies of scale, as discussed in section 16.1 would pose further incentives to avoid expansion. Measures such as progressive firm taxation or expensive transport costs favour small-scale production and hence work against expansion on the firm level.

17.2.6 Working Hours Reductions

When a firm decides not to expand production, it nevertheless has an incentive to introduce new technologies that facilitate higher labour productivity because it increases the potential wage per worker. In this situation, one option for firms is to dismiss a part of their workers, which is problematic as they are owners at the same time. The other option is to reduce average working hours while keeping wages constant. There are three reasons why the latter option is more likely to take place. First, workers have a relatively large income (compared to the situation with shareholder firms), so that increases in wages are less necessary. Second, workers have an interest in keeping their employment, and it is difficult to foresee whether they might be dismissed in the future, when dismissals become regular. Third, reductions in working hours imply more leisure time.

In case these incentives do not suffice, the state can support reductions in working time by regulation and tax incentives.

Reductions in working hours are not only a solution to the potential problem of unemployment in a monopolistic economy with zero growth. They can also depict an incentive to avoid an expansion of production. Increases in labour productivity can either be used for expanding production or reducing working hours. The larger the interest of workers to gain more leisure, the larger the additional incentive is to avoid expansion.

17.2.7 Government Spending

In contrast to Marx's theory, government spending plays a crucial role in monopoly capitalism. According to Baran and Sweezy (1966), governments have in principle the ability to increase production because output is usually below full capacity utilization. Based on the conditions developed so far, the gap between actual and potential production is smaller in zero growth economies than in monopoly capitalism: profits are smaller and effective demand is higher.

The effect of the conditions developed so far on the sales effort are unambiguously negative. The effects on investments are less clear, however. On the one hand, managers have less incentive to grow, and workers have several interests in avoiding an expansion of production. On the other hand, there is higher effective demand.

Within this unclear situation, government spending can take the role of pushing towards the level of production that is aimed for – in this case constant production. If firms invest above the level of a mere replacement of capital depreciation, the government can cut spending. In case firms invest too little, the government can expand expenditures. In principle, both civilian and military spending can achieve the goal of zero growth. But within the logic of the Theory of Monopoly Capitalism, civilian expenditures are more appropriate to support the goals of environmental sustainability (in particular spending on abatement and clean technologies) and low economic inequalities (in particular public provision of education, health services, etc.).

17.2.8 Political Economy

It is difficult to argue for final conclusions concerning the feasibility to implement the conditions outlined so far, because the Theory of Monopoly Capitalism only provides a limited analysis on the political economy. Nevertheless, some insights can be drawn here.

There are two factors that favour the feasibility of implementing the outlined conditions. First, contrary to the conditions four a continuous stagnation (in section 17.2.1), the conditions for sustainable economies without growth are in the interest of workers. They gain higher wages and more control over the conditions of work. Overall, they receive more power, as they can influence the activities of their firms. Therefore, workers have an interest to push the necessary legal changes and policies to achieve these conditions. Second, the implementation of the conditions alter the power relations and therefore make the implementations of further conditions, which go against the interests of the oligarchy, more feasible. In particular, increasing control of workers over firms implies more monetary power to influence policies favourably to the conditions described.

At the same time, there are two central limitations concerning the feasibility of such changes. First, several of the conditions described are not necessarily in the interest of workers. In particular, it is questionable whether a restriction of the sales effort is supported by them. Even if it were rational from the perspective of Baran's and Sweezy's analysis, it seems at least unclear whether it would be supported by a majority of workers. Second, and more importantly, the interests against such conditions by the oligarchy still prevail. According to the Theory of Monopoly Capitalism, the oligarchy is powerful and the working class is divided. As for the conditions for zero growth under competitive capitalism, central conditions also here contradict the interests of the most powerful societal group (in this case the oligarchy). The contradicting conditions are in particular the collectivization of ownership and limitations to the sales effort.

To conclude, the conditions for sustainable economies without growth are more likely to be implemented than those for a continuous stagnation. According to the analysis of political economy under monopoly capitalism, however, they are still unlikely to be realized.

17.3 Results and Discussion

17.3.1 Summary of Conditions

A similar set of conditions as for Marx's analysis of competitive capitalism has been developed. Five conditions play central roles in establishing sustainable economies without growth from the perspective of the Theory of Monopoly Capitalism.

1. A collectivization of firm ownership decreases the amount of profits available for investments and prevents managers from striving for investments in the name of firm growth, because it changes the social mechanisms of prestige. Collectivization also decreases the necessity and ability of firms to engage in the sales effort, because it increases the workers' income and thereby fosters consumption demand, while

at the same time decreasing the funds available for pursuing the sales effort.

2. The sales effort can further be opposed by regulations on commercials and other aspects of the sales effort.
3. It is difficult to say whether these measures are sufficient to prevent firms from investing above the level of capital depreciation. There are contradicting incentives for firms to invest and to not invest. Which incentive prevails cannot be examined on a purely theoretical basis. If the positive incentives to invest are stronger, introducing diseconomies of scale (as discussed in section 16.1) are a possible measure to discourage firms from expansion.
4. An establishment of working hours reductions (to the same extent as labour productivity increases) further prevents the necessity for firms to grow. It also depicts a possibility to prevent unemployment.
5. Government spending can balance out effective demand in case it is above or below zero growth.

These conditions countervail the central causes for economic growth in monopoly capitalism and therefore lead to economies with approximately zero growth. In order to lead to exactly zero growth, the various positive and negative determinants of economic growth discussed would need to cancel each other out exactly.[14] The conditions further lead to low economic inequalities, as workers' income increases and capitalists' income decreases.[15] The resulting economy is also likely to be stable in the manner that there is no or little unemployment, mainly due to reductions in working hours.[16] Whether the resulting economy is environmentally sustainable is not investigated because the environment plays no role in the theory.

17.3.2 Critical Assessment of the Theory of Monopoly Capitalism

As for the Marxian approach, it is outside the scope of the present work to give an elaborated analysis of the criticisms on the Theory of Monopoly

[14] As the theory is not formalized, it is not possible to illustrate the exact relationships of the opposing effects on economic growth in a formal manner.

[15] Within the theoretical framework of monopoly capitalism, capitalists' income would cease to exist, as it is only due to firms' profits. In the real economy there are also other types of capital income, however.

[16] The Theory of Monopoly Capitalism does not entail a crisis theory apart from the crisis in the form of stagnation. Therefore, other types of instabilities is not investigated.

Capitalism. Instead, those points relevant to the issue at hand are highlighted and placed within the context of the critiques of Marx's theory.

According to Howard and King (2014), a common point of criticism is that Baran and Sweezy (1966) do not develop a coherent theory of the wage level. Therefore, it is unclear why wages cannot rise and absorb part of the surplus. The argument concerning the effects of collectivization has incorporated this issue. The collectivization leads to higher workers' income (comprising wages and profits), which absorbs a large part of surplus.

Second, the assumption that large firms do not stand in price competition with other large firms has been criticized. According to Howard and King (2014), one argument is that large firms can cross-entry into other markets, which strongly increases the number of potential competitors. Another argument in the literature is that the continuous economic globalization leads to price competition on the world scale, undermining national market power. If this is true, the issue of diseconomies of scale regains significance. These help to prevent global competition and decrease the incentive of firms to expand into other sectors (provided that diseconomies are in place that discourage not only the expansion of production of a single product but the growth of firms overall).

Third, Howard and King point out that it is difficult to distinguish between unproductive and productive work. It has in particular been criticized that Baran and Sweezy (1966) declare all government spending as waste. Concerning the conditions developed above, this implies that there are limitations to a socially desirable reduction of government expenditures. As the adjustment of government spending to achieve constant production has been only of limited importance, this does not pose a significant problem. At the same time, the case that *increases* in government spending are necessary for social reasons would pose a challenge to keeping the level of production constant.

Chapter 18
Environment and Capitalism

The extent to which nature and the environment is integrated in Marx's analysis is a topic of controversial debate. According to Harriss-White (2012), earlier contributors have argued that the labour theory of value leaves little room for the importance of nature. More recently, some authors, for example Foster et al. (2010), argue that Marx had a coherent understanding of the relation between the economy and the environment. However, "the development of a Marxist ecological economics was delayed for well over a century" (Harriss-White, 2012, p. 102), and significant work has only started "since the 1990s" (p. 108).[1]

18.1 Capital Accumulation With Fossil Fuels

In Marxian ecological economics, the existing theories of capital accumulation are extended in order to incorporate environmental issues. The role of fossil fuels for the development of capitalism is highlighted. But Marxian ecological economics also develops a more general understanding of the relation between the economy and the environment (or nature). These analytical foundations are part of section 18.1.1.

Contrary to neoclassical and Keynesian theories that take environmental issues into account, Marxian ecological economists argue explicitly that common proposals for solving environmental problems cannot be successful. Both efficiency and sufficiency approaches have to fail due to systemic reasons in capitalism. These issues are discussed in section 18.1.2, concluding with the proposal for revolutionary change by most Marxian economists.

[1] Regarding the question, which aspects of the following investigation are adopted from existing work, and which are novel developments of this present study: Contrary to former chapters, the following representation is based on theoretical contributions from a variety of authors. The theory in section 18.1 is a summary of their work. In section 18.2 these approaches are applied to the question of zero growth. This includes several extensions of the existing theories. In particular, the discussions and equations in sections 18.1.2.2 and 18.1.2.3 include novel contributions by the author of this work.

18.1.1 Analytical Foundations

The concepts of *metabolism* and *ecological rift* serve as the central analytical tools to investigate the relationship between nature and humans in Marxian theories (18.1.1.1). The *treadmill of production* has been a first attempt to explain the occurrences of ecological rifts in the metabolism (18.1.1.2). The *accumulation treadmill* allows an analysis that is closer to Marx's original analysis of capitalism (18.1.1.3). The incorporation of specific features of fossil fuels finally facilitates a comprehensive analysis of the relationship between capital accumulation and the environmental effects of economic activities (18.1.1.4).

18.1.1.1 Metabolism and Ecological Rift

According to Foster (2000), the environment plays an important role throughout Marx's analysis. The soil, natural resources and nature in general are regarded as essential to human life and to economic activities. In Marx's words:

> The worker can create nothing without *nature*, without the *sensuous external world*. It is the material upon which his labour is manifested, in which it is active, from which and by means of which it produces (Marx, 2009, p. 70).[2]

When Marx attributed such importance to nature, the question arises why, according to Harriss-White (2012), "[i]t is widely supposed that Marx ignored the environment" (p. 102). A possible answer is provided by Foster et al. (2010). They argue that Marx, as most former classical political economists, saw an important difference between *wealth* and *value*. Wealth is the entire use value available to people. Not only goods bought on the market but all types of use values, such as clean air, gifts by others or wild crops count as wealth. Value on the other hand is only attributed to commodities, which are goods traded via the market. Wealth is a category existing in all societies; value, on the other hand, is a specific category of capitalism. Marx based this distinction on the work by Lauderdale (1804). According to Foster et al. (2010), the Lauderdale Paradox describes "the promotion of private riches through the destruction of public wealth" (p. 64). The concept of scarcity is central in Lauderdale's analysis. A good has to be scarce in order for it to be marketable in capitalism. There is therefore a conflict of interest: Private entrepreneurs want goods to be scarce, while an abundance of goods would contribute to (public) wealth. Foster et al. further argue that this distinction between wealth and value has been lost by later economists and that this is why many

2 This work was originally written in 1844 and first published in 1932.

believe that environment plays no important role in Marx's analysis. The reason is that nature does in fact play no central role in Marx's analysis of capitalism: "In the capitalist logic, there was no question that nature was valueless" (Foster et al., 2010, p. 64). While it is unimportant for value production and the capitalist logic, it is very important for wealth.

The central concept in Marxian analyses on the economy-environment relationship is metabolism. Foster (2000) defines it as a "complex, dynamic interchange between human beings and nature" (p. 158). The metabolism of human beings and nature encompasses all interactions between the two. While this could be rather meaningless due to the generality of the concept – it encompasses all aspects of the world – the important aspect for Marx is the analysis of the disruption of this metabolism, which is due to capitalism:

> It is not the unity of living and active humanity with the natural inorganic conditions of their metabolic exchange with nature [...] which requires explanation [...] but rather the separation between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labour and capital (Marx, 1973, p. 489).

The interaction between human beings and nature is exercized by human labour: "[I]t is an eternal natural necessity which mediates the metabolism between man and nature, and therefore human life itself" (Marx, 1990, p. 133). Therefore, it is central what characteristics the labour process has. In capitalism, labour is wage labour. Due to the dynamic of capitalism, labour and the production process take forms that are highly destructive to nature: "[C]apital creates a rupture in the 'metabolic interaction' between humans and the earth" (Foster et al., 2010, p. 77)

These ruptures are called *metabolic or ecological rifts* and constitute the central Marxian category to investigate environmental problems. According to Foster et al. (2010), Marx was "drawing on Liebig's research" (p. 123) in his analysis of metabolic rifts. Liebig, Baron von (1859) analyses the problem of "loss of soil nutrients [...] through the transfer of food and fiber from the country to the cities" (Foster et al., 2010, p. 123). Due to the increase in urbanisation (which was closely related to industrial capitalism), the nutritional cycle was disrupted.

Foster et al. (2010) argue that this concept of ecological rift can be applied to all types of contemporaneous environmental problems. Their central example is the "rift in the carbon cycle" (p. 138), but they point out that all planetary boundaries (see section 2.2.1) depict metabolic relations that either are already disrupted or are in danger of being disrupted. According to Foster et al., the reason for these rifts is to be found in the dynamics of capitalism, in particular because capitalism is "limitless in its expansion" (p. 39). The underlying reasoning is discussed in the following sections.

18.1.1.2 The Treadmill of Production

One of the earliest and most prominent Marxian analyses on the relation between the economy and the environment has been developed by Schnaiberg (1980).[3] In this work, Schnaiberg develops the *treadmill of production*, which explains the continuous expansion of the economy. His analysis entails many aspects of Marx's theory of capital, though it also misses some others (as discussed below). The important contribution regarding the issue at hand is that Schnaiberg connects his Marxian-like growth theory with a theory of technological change and includes environmental aspects.

The treadmill of production can be summarized as follows: It is assumed that the majority of people depend on wage income in order to fulfil their consumption needs. The level of private consumption depends, on the one hand, on the amount of public provision of goods (the larger the public provision the lower is private consumption) and, on the other hand, on commercials (which increase consumption). Firms strive for profits, which depend on the production level and the ability to set the price above costs. Expansion of production is the primary strategy to generate profits and at the same time leads to employment and wage income. Profits are used to introduce capital-intensive, technologies, which decreases the amount of employment per unit of production. The expansion of production necessitates increases in consumption, however. Consumption can be increased in several manners, in particular due to increases in wage levels, private debt, consumption abroad and consumption by the government.

The term *treadmill*, relates to the fact that "consumption must increase at ever faster rates to offset the substitution of capital for labor in the production process" (Schnaiberg, 1980, p. 229) in order to generate employment and profits.

Schnaiberg argues that "increasing the speed of this treadmill involves increased environmental withdrawals and additions [sources and sinks]" (p. 230). The central reason is the type of technological change that takes

3 It is debatable in how far Schnaiberg's analysis is actually a Marxian theoretical approach. Foster et al. (2010) argue that this early work by Schnaiberg was very similar to Marxian theories, while later analyses were not. They further point out that the analysis in Schnaiberg (1980) is particularly related to the Theory of Monopoly Capitalism.

place. The industry implements capital-intensive and technologies, which are at the same time energy-intensive.

Schnaiberg points out four reasons for this type of technological change. First, the energy has been cheaply available. Second, wages have risen. Third, the firms have been (technologically) able to substitute those material inputs which were unavailable by other material inputs. Fourth, the government's tax-policies contributed to high wage costs and low costs for physical capital and energy.

The decisive point is that firms use profits to introduce, capital-intensive and energy-intensive technologies. This is caused by the high price of labour and the low price of capital and energy. The effect is a decreasing labour coefficient, which requires the expansion of production in order to generate constant employment.

The solutions proposed by Schnaiberg follow directly from the analysis. The core proposal is to change the prices (and some additional incentives) of the production factors, so that it becomes attractive for firms to introduce labour-intensive and capital/energy-saving technologies.

The central shortcoming of this analysis is that the question of whether it is still possible to generate profits under such conditions is not investigated. Assuming that it is not possible, it also needs to be examined what economic and political implications follow. These questions are tackled by analysing the treadmill of capital accumulation.

18.1.1.3 The Treadmill of Capital Accumulation

The theory of the treadmill of production focusses on the interplay between production, consumption and technological change. Foster et al. (2010) argue that this is "the wrong treadmill. To understand the major thrust and inherent dangers of capitalism, it is necessary to see the problem as one of a treadmill of accumulation much more than production" (p. 201). They refer to the central relation in capitalism, $M - C - M'$ (see figure 16.1), in which money (M) is used to buy commodities (C) that are used in the production process to produce other commodities, which can be sold to a higher price (M', with $M < M'$). The central dynamic of capitalism is this process: "[C]apitalists are driven to accumulate ever more capital, and this becomes both their subjective goal and the motor force of the entire economic system" (Sweezy and Magdoff, 2004, p. 91 – 92).

Investigating the treadmill of production instead of the treadmill of capital accumulation features an important shortcoming. The treadmill of production "focused almost exclusively on *scale* and relatively little on *system* – except insofar as this is related to scale" (p. 203). Looking at the treadmill of production, it can only be deduced that the system is driven towards expansion. Foster et al. (2010) argue instead that expansion is only part of the story. It is true that the dynamics of capitalism lead to capital accumulation, which implies an expansion of scale. However, capital accumulation "has to be done in certain ways" (p. 204). And these ways tend to go along with environmental destruction: "As far as the natural environment is concerned, capitalism perceives it not as something to be cherished and enjoyed but as a means to the paramount ends of profit-making and still more capital accumulation" (Sweezy and Magdoff, 2004, p. 92).

18.1.1.4 Capital Accumulation, Fossil Fuels and Shifting Problems

The decisive point has yet to be made, however. An answer is still required for why profit maximization tends towards increasing environmental degradation. The argument that capitalism perceives the environment solely as a means to achieve capital accumulation does not automatically imply that production under capitalism leads to growing pollution. The roles of fossil fuels and shifting problems are essential here.

In Marxian analyses, commonly competition and profit maximization coerce entrepreneurs to introduce cost-reducing technologies. These technologies are depicted by an increasing use of means of production and a decreasing labour coefficient. This leads to increases in the level of production and to the continuous generation of a reserve army of workers. The generation of surplus by this introduction of new technologies is the so-called relative surplus production.

According to Altvater (2005), there is a strong connection between the increases in labour productivity since the industrial revolution and the use of *fossil fuels*. The implementation of certain technologies, such as the steam engine, the combustion engine, the electric motor, the light bulb and various others, would not have been possible without fossil fuels.

The use of fossil fuels can best be understood as a transition from an economy using solar energy by the sun towards one using stored solar energy in the form coal and oil. The use of these fossil fuels allows to increasingly replace human labour by labour from using energy.[4] due to four characteristics of fossil fuels: (1) They can be transported and their use is therefore *location-independent*. Subsequently, the location of production becomes independent on local natural conditions and can take place wherever it is most profitable. (2) Fossil fuels can be used *independent of time*, allowing for around-the-clock production. (3) Based on location and time independence, fossil fuels allow for any concentration

[4] Altvater (2005) uses the German terms "Energiesklaven" (p. 74) and "Arbeitsenergie" (p. 77).

and centralization of production processes, as they can be used at any speed (as long as they are not exhausted). (4) Fossil fuels can further be used very flexibly in small amounts, so that they can be utilized, for example, in small combustion engines.

Altvater (2005) integrates the role of fossil fuels into the core of Marx's analysis. He argues that new (physical capital-intensive and) technologies depend on increasing use of energy, in particular fossil fuels. Altvater's analysis on why energy is necessary for increasing labour productivity is similar to approaches from ecological economics (see section 2.2.3): Human labour is replaced by labour from physical energy.

Relative surplus production, the expansion of production, the continuous generation of a reserve army and the resulting ability to generate profits therefore all depend crucially on an ongoing increase in the use of fossil fuels.[5] This is why the capitalist dynamic leads to ever-increasing exploitation of fossil fuels. The use of fossil fuels is one of the major causes for transgressions of planetary boundaries (in particular, but not exclusively climate change). Therefore, their crucial importance for central capitalist dynamics is a central explanation for environmental problems.

A second, related issue is "shifting the type of rift generated" (Clark and York, 2008, p. 17). Within capitalist economies, the treatment of one environmental problem usually leads to the generation of another one.[6] Clark and York (2008) give various examples; the most important one refers to the issue of fossil fuels. Initially, wood was used in capitalist production on a massive scale. When land and thus wood became scarce, coal and later oil took its place, shifting the problem from deforestation towards climate change. Today, the scarcity of coal and oil leads to environmentally destructive manners of exploiting them – such as deep-water drilling and the exploitation of tar sands. Another effect is the production of biofuels, shifting the problem back to the scarcity of land.

According to Clark and York (2008), such shifts are "unavoidable given that capital is propelled constantly to expand" (p. 17). Capitalism always tends towards an expansion of production and as long as production is related to the use of natural resources (and in particular fossil fuels), expanding production implies increased environmental pressures.

[5] Altvater (2005) argues in fact that fossil fuels are necessary. Whether renewables can substitute fossil fuels has been discussed in section 2.2.5. The issue is further covered in section 18.2.

[6] This issue has also been one reason opposing the feasibility of green growth, as discussed in section 2.2.5.

18.1.2 Towards Solutions of the Environmental Problems

There are some contributions that develop possible solutions, or aspects of solutions to the problem of environmental degradation in capitalism. First, the second contradiction of capitalism lays the ground for the development of new social movements (18.1.2.1). Second, the reproduction schemes can be used to depict the effects of a governmentally organized abatement sector (18.1.2.2). Third, the concept of economic surplus allows us to investigate the effects of increasing prices of natural resources (18.1.2.3). Despite these approaches, Marxian ecological economists still commonly argue that a revolution is the only manner to prevent increasing environmental degradation. The inclusion of environmental aspects partly alters the perspective on revolutionary change, however (18.1.2.4).

18.1.2.1 The Second Contradiction of Capitalism

A famous contribution to Marxian ecological theory is the article *Capitalism, nature, socialism: a theoretical introduction* by James O'Connor (1988). In this article, O'Connor puts forward the idea that there is a second contradiction of capitalism – next to the well-known first contradiction.

The first contradiction is concerned with the realization problem. It has already come up as the central reason for crises in competitive capitalism and the cause for stagnationary tendencies in monopoly capitalism. Capitalists' attempt to maximize profits leads to low wages, which induce a lack in consumption demand and thereby the realization problem. As O'Connor points out that this first contradiction has also been connected to a theory of socialist transformation. It is argued that solving the crises resulting from realization problems requires increased planning (either by the state or monopolistic firms), which implies political decisions. In doing so, capitalism generates its own successive demise by placing an increasing role on planning and a decreasing role on competition.

O'Connor's (1988) major contribution is the claim that there is a second contradiction of capitalism that is related to nature. This second contradiction starts from the analysis that capitalism destroys its own "conditions of production". These are in particular labour power and the environment. These conditions are not "produced capitalistically" (p. 444). Because capitalism constantly expands, it tends to destroy both labour power and nature. This is why it is unable "to prevent itself from impairing its own conditions" (p. 445). To protect humans and nature requires political decisions, which makes political (instead of capitalistic) organization of society increasingly important. The consequences of this second contradiction is therefore similar to the consequences of first contradiction: Both lead to crises and require political/collective decisions in order to establish the necessary conditions for capitalism to continue existing.

Two additional aspects of this theory are of particular relevance for the following discussions. First, O'Connor argues that this second contradiction leads to new social movement which play a role in potential social transformations. Based on the first contradiction, the labour movement has been identified as the most important actor for social transformation. The second contradiction emphasizes the role of the feminist and the environmental movements. The former is important because it concerns the reproduction of labour power. The latter is central because it opposes the destruction of the environment.

The second aspect refers to the role of the state in solving environmental problems. Based on the second contradiction, it is necessary that the state controls firms' activities to limit the detrimental effects of production on nature: "[C]risis forcibly causes capital and state to exercise more control or planning over production conditions" (O'Connor, 1988, p. 448). A specific form of such state intervention on environmental issues is discussed in the next section.

18.1.2.2 Environmental Abatement in Competitive Capitalism

Mandel (1974a) develops a framework, where the increasing importance of an unproductive sector can oppose capital accumulation, because this unproductive sector absorbs the capital that would otherwise be available for accumulation. Mandel designs the framework in order to explain possible consequences of warfare. In the war economy, resources are used for the production of "*means of destruction*" (Mandel, 1974a, p. 332). The unproductive sector in his theory is therefore the military. The central idea is that there is an unproductive sector that produces neither means of production nor consumption goods.

Here, it is argued instead that the framework also offers insights into a potential increase in an environmental abatement sector.[7] Increased spending on environmental abatement by the government is unproductive in the sense that it produces neither means of production nor consumption goods.[8]

The extended reproduction scheme from section 16.1 is adjusted accordingly. A third sector is introduced. Sector 3 is thought of as an abatement sector, where environmental quality is produced. Additionally, it

[7] Note that the following theoretical contribution has been developed by the author of the present work.

[8] A possible objection would be that spending on warfare destroys means of production when the weapons are used. As Mandel (1974a) does not take this aspect into account, it does not alter the analysis, though.

is assumed that capitalists' consumption stays constant ($\Delta s_1^c = \Delta s_2^c = \Delta s_3^c = 0$) and that a part of the surplus in each sector is appropriated ($s_{1,2,3}^e$) by the government and redirected into sector 3. The reproduction scheme is then:

$$\text{sector 1: } w_1 = c_1 + v_1 + s_1^c + \Delta s_1^c + s_1^{av} + s_1^{ac} + s_1^e, \tag{18.1}$$

$$\text{sector 2: } w_2 = c_2 + v_2 + s_2^c + \Delta s_2^c + s_2^{av} + s_2^{ac} + s_2^e, \tag{18.2}$$

$$\text{sector 3: } w_3 = c_3 + v_3 + s_3^c + \Delta s_3^c + s_3^{av} + s_3^{ac} + s_3^e. \tag{18.3}$$

In order to have balanced extended reproduction, three conditions have to be fulfilled. First, the production of the means of production in sector 1 has to be equal to the demand for the means of production from all three sectors:

$$w_1 = c_1 + s_1^{ac} + c_2 + s_2^{ac} + c_3 + s_3^{ac}. \tag{18.4}$$

Second, the production of consumption goods has to equal the demand for consumption goods from all three sectors:

$$w_2 = v_1 + s_1^c + \Delta s_1^c + s_1^{av} + v_2 + s_2^c + \Delta s_2^c + s_2^{av} + v_3 + s_3^c + \Delta s_3^c + s_3^{av}. \tag{18.5}$$

Finally, the production of the third sector has to equal the appropriation from all three sectors by the government:

$$w_3 = s_1^e + s_2^e + s_3^e. \tag{18.6}$$

Under these conditions, the economy operates at a constant level of production with a constant level of abatement. The impact of technological change is not incorporated systematically in the reproduction schemes. Including technological change would lead to an increase of the third sector over time, both in absolute size and as share of production. It would thus require a constantly increasing appropriation of surplus value by the state.

18.1.2.3 Natural Resources in Monopoly Capitalism

Resnick (2011) uses the theoretical framework of monopoly capitalism, and in particular the theory of different types of surplus (see section 17.1.1.4), to analyse the effects of increasing prices of oil. In the following, it is argued that the analysis can in general be used for externally induced increases of costs related to natural resources.

According to Resnick, an increasing oil price implies rising monopolistic surpluses (or subsumed class revenues, $SSCR^m$) in the oil *manufacturing* industry. Resnick argues that in this situation the overall surplus is larger than the overall expenditures (compare with equations 17.3):[9]

$$\text{sector 1, manufacturing: } s_1^m + SSCR^m > SSCP_1^m + X_1^m. \tag{18.7}$$

The increasing price needs to be paid by firms in the oil *refining* industry (higher values for $SSCP_1^r$). These companies also have market power and can pass the higher price on to consumers (in particular for gasoline) and to firms that use oil as production input. They therefore generate, on top of surplus value, both types of additional surplus (NCR^r and $SSCR^r$). While these companies therefore have both higher surplus and larger costs, Resnick argues that the effect of higher surplus prevails:

$$\text{sector 1, refining: } s_1^r + SSCR^r > SSCP_1^r + X_1^r. \tag{18.8}$$

In sum, the oil-producing industry is able to charge high prices, which allows them to make large surpluses. This has negative effects on the consumption goods industry and on consumers. The consumption goods industry (sector 2) experiences high costs for constant capital, due to the high oil prices. Consumers experience a decrease in real income, as they have to pay higher prices for gasoline. Assuming that the demand for gasoline is relatively inelastic, this implies that consumers demand less other consumption goods. As a result, firms in the consumption goods sector cannot pass on the higher costs associated with expensive oil and their non-class revenues (NCR) decrease. They can attempt to balance this out by an increasing sales effort (X_2), which implies higher costs, though. The result is that their sources of surplus tend to be smaller than their uses of surplus, i.e.,:

$$\text{sector 2: } s_2 + NCR < SSCP_2 + X_2. \tag{18.9}$$

This situation implies that the firms in sector 1 generates losses. This can be prevented by paying subsumed class payments (in particular lower profits) below normal levels.

The overall results are high surplus in the oil-producing industries, low surplus in the consumption goods sector and decreasing real wages of workers. According to Resnick, this implies aggravated stagnation, as effective demand is low.

9 The equations are adjusted from Resnick (2011).

Resnick's analysis is primarily intended to investigate the existing and potential future effects of increasing oil prices. The analysis can also be used for consciously induced increases in environmental prices. For example, the increase in oil price can be due to a tax on oil (instead of decreasing supply or monopolistic price setting). The effects on the firms in the consumption goods sector and on consumers would be the same.

A decisive question is what the government would use the tax revenues for.[10] If they are used to increase the income of workers, this would spur up consumption and attenuate the problem of stagnation.

A second important question is whether the increase in the price of natural resources would lead to a change in the technologies used. As argued by Schnaiberg (1980), the low energy prices were one reason for continuous substitution of labour by energy. At the same time, according to Altvater (2005), the production of relative surplus value is only possible by using cheap (fossil) energy. Increasing energy prices would lead to a stronger bargaining position of labour and therefore squeeze profits. As will be seen in the next section, such changes require strong social movements or even revolutionary changes, according to Marxian political economy.

18.1.2.4 Political Economy

Revolutionary change is (again) the solution to the environmental problem, according to Marxian authors. Foster et al. (2010) argue: "To stop this [the ecological crash] requires nothing less than an ecological revolution aimed at bringing the social relations of production in line with the conditions of ecological sustainability" (p. 45). Sweezy and Magdoff (2004) argue similarly that "what has to be done to resolve the environmental crisis [...] is to replace capitalism with a social order based on an economy devoted not to maximizing private profit and accumulating ever more capital but rather to meeting real human needs and restoring the environment to a sustainably healthy condition" (pp. 92 – 93).

According to Foster et al. (2010), truly meaningful reforms (such as a high tax on natural resources) require a similarly strong political mobilisation as revolution does: "A movement (or movements) powerful enough to implement such changes [environmental reforms] on the necessary scale might well be powerful enough to implement a full-scale social-ecological revolution" (p. 118).

When it comes to what the resulting economic system would look like,

10 In fact, the question what the oil-producing industry uses their high profits for would also need to be investigated in order to gain a comprehensive analysis of increasing oil prices.

the ideas are equally vague as in the other Marxian theories. Foster et al. (2010) describe it as follows:

> The only real answer for humanity [...] and the earth as a whole is to alter the social relations of production, to create a system in which efficiency is no longer a curse – a higher system in which equality, human development, community, and sustainability are the explicit goals (p. 181).

While this is still overall vague, one aspect needs to be stressed, as it is a reoccurring aspect throughout the Marxian literature. The desirable *goals* need to be *explicit* in the sense that economic actors pursue those goals. This refers ultimately to Adam Smith's argument of the invisible hand in which self-interested behaviour leads to the common good. Marxian authors, on the other hand, believe that an economic system needs to explicitly set the goals it is to achieve (Foster et al., 2010).

Altvater (2005) is also of the opinion that revolutionary change is needed. He makes an insightful distinction between two types of revolutions: the political overthrow on the one hand and the transformation of the social formation on the other.[11] Altvater (2005) argues that the two processes can go hand in hand and that the capitalist system can be overcome due to external pressures (environmental limits) and internal forces (social movements). In the end, it is unavoidable to take power by these revolutionary movements, in order to realize both types of revolution.

In sum, the transformational perspectives from ecological Marxian economics are similar to previous ones, with some new attributes. As before, meaningful reforms cannot take place within the existing political economy, as they will be prevented by the ruling class. They necessitate strong social movements and in the end a political revolution. At the same time, environmental limits can foster such movements, in particular due to the second contradiction of capitalism. Strategically, it is important to align the forces of the different social movements (labour, environment, feminism) in order to gain societal power.

18.2 Conditions for Sustainable Economies Without Growth

Marxian ecological economics adds environmental aspects to Marxian political economy. It uses the same understanding of capitalism as the theories on competitive and monopoly capitalism. It therefore constitutes an expansion rather than an alternative to the other Marxian approaches. As

[11] Original quote in German: "den politischen Umsturz einerseits und [...] die Veränderung der sozialen Formation andererseits" (Altvater, 2005, p. 177).

there will be a comprehensive analysis on the conditions for sustainable economies without growth from the perspective of all Marxian theories in chapter 19, the following discussion is restricted to those issues in particular related to environmental aspects.

Contrary to neoclassical and Keynesian theorists, Marxian authors explicitly reject the idea that increases in resource efficiency or the advancement of renewable energies can solve the environmental problems (18.2.1). Based on these critiques of conventional solutions, conditions for sustainable economies without growth are developed (18.2.2).

18.2.1 Why Conventional Solutions Do not Work

In order to investigate how sustainable economies without growth can be organized according to Marxian ecological economics, it is helpful to first investigate Marxian perspectives in terms of how the necessary social-ecological transformation could take place. Marxian authors commonly see the solution to the economic, social and environmental problems in a "full-scale social-ecological revolution" (Foster, 2011, p. 118). What the revolution concretely implies varies from author to author and is often not explained in detail. The argument for a revolution is based on critiques why other proposals to solve the social-ecological problems cannot succeed, in particular concerning efficiency (18.2.1.1) and the prospects of renewable energies (18.2.1.2). There are also arguments why sufficiency of zero growth cannot work in a capitalist economy, as discussed in chapter 15.

18.2.1.1 Efficiency

The so-called *Jevons Paradox* and the newer concept of *rebound effects* play important roles in Marxian ecological economics. The Jevons Paradox builds on the analysis of Jevons (1906) that increasing efficiency in the use of coal does not decrease but rather increase use of this resource. According to Foster et al. (2010), the central argument was based on the importance of coal in two crucial aspects: Coal was the central input for the production of iron and the energy input for the steam engine. Greater efficiency in the production of iron allowed for higher production levels of iron, which was central in expanding the overall production. Increases in the efficiency of the steam engine were the second necessity to increase overall production.

Foster et al. (2010) argue that increases in efficiency are nothing new and have taken place since the beginning of capitalism. Altvater (2005) points out that efficiency gains have consistently been outstripped by the expansion of production. The argument related to the Jevons Paradox is still central in more recent discussions on rebound effects (Altvater, 2005).[12]

The basic mechanism behind the Jevons Paradox is that increases in efficiency decrease the costs of production. This increases profits, which are then available to expand production. Within the Marxian framework, these profits must be used for investments (due to market competition), so that efficiency gains *necessarily* spur up economic growth:

> Conservation in the aggregate is impossible in capitalism, however much the output/input ratio may be increased in the engineering of a given product. This is because all savings tend to spur further capital formation (provided that investment outlets are available) (Foster et al., 2010, p. 179).

18.2.1.2 Renewables

A related question is whether renewable energy can provide the necessary energy for a continuation of capital accumulation. Altvater (2005) claims that it is impossible to keep the current speed of capital accumulation based on renewables. The reason lies within the qualitative differences between fossil fuels and renewables. As pointed out above, fossil fuels are location-independent and independent of time, which implies several advantages for industrial capitalist production. In particular, production can take place in a centralized manner and transportation allows the development of global markets. Renewable energies, on the other hand, tend to be decentralized in nature, because solar energy and wind cannot be used in a centralized manner.[13] As result, the economic system compatible with the use of renewables must be set up very differently than contemporary capitalism.

Altvater (2005) comes to the conclusion that there will either be a capitalist economic system in crisis, or that a post-capitalist system based on solidarity (compatible with renewables) will come into existence. His analysis is therefore similar to the discussion on degrowth by design vs. degrowth by disaster (see chapter 3).

18.2.2 Conditions

Continuous capital accumulation is connected to increasing pressures on the environment. Two complementary approaches to tackle this problem

[12] A more detailed analysis of rebound effects is not necessary at this point, as the Marxian authors do not discuss them in detail. For a more thorough discussion, see Santarius (2015a).

[13] Whether renewables can provide the basis for continuous economic growth (and capital accumulation) is a controversial issue, as discussed in section 2.2.5.

are developed: As capital accumulation depends on the cheap availability of energy, strongly increasing energy prices imply a restriction on economic growth (18.2.2.1). Another solution is to appropriate profits and use the tax income for environmental abatement (18.2.2.2). Apart from economic growth, environmental problems are also due to externalize costs in a systemic manner. Price competition and profit maximization lead to incentives to exploit the environment, whenever it reduces costs. Two strategies to tackle this issue are diseconomies of scale and stakeholder collectives (see section 18.2.2.3).

18.2.2.1 Restricting Fossil Fuels

One of the central prerequisites in order to achieve both zero growth and environmental sustainability is to decrease the use of fossil fuels. A reduction in the use would imply a limit to labour productivity and therefore to economic growth. At the same time, the use of fossil fuels is the primary reason for climate change and is related to multiple other environmental problems, in particular because it allows for production on such a large scale (Foster et al., 2010).

Based on the logic of ecological Marxian analysis, increasing the price of natural resources and in particular energy to a certain point would lead to zero growth. The reason is that increases in labour productivity depend on substituting labour by energy (Altvater, 2005). This type of technological change can only take place when cheap energy is readily available (Schnaiberg, 1980). Increasing the price of energy above a certain level would make it unprofitable to further substitute labour by energy.

This represents both a limit to growth and to profits. When firms are unable to substitute labour by energy and they try to expand production, the demand for labour rises and so do wages. As productivity is limited, increasing wages must be done at the expense of profits.

Under conditions of competitive or monopolistic capitalism, such increases in the price of energy would experience strong resistance by capitalists. The resistance would be fierce as the ability to generate profits is challenged. This is why Foster et al. (2010) argue that such reforms (high taxes on energy) need very strong social movements. In chapter 19 it is discussed in how far the conditions from the previous section, in particular the collectivization of firm ownership, would change the situation of political economy.

18.2.2.2 Profit-Absorption

As argued in section 18.1.2.2, zero growth can in principle also be initiated by strong governmental taxation of profits. As Mandel (1974a) argues, "[w]ar economy is the typical example of contracted reproduction under capitalism" (p. 332). More generally though, contracted reproduction (economic shrinkage) takes place when "part of constant capital and labour power is used to produce commodities the use value of which does not make possible either the reconstitution of this constant capital or the reconstitution of this labour-power" (p. 332).

Zero growth implies that there is neither extended nor contracted but simple reproduction. Contrary to the simple reproduction developed above, the surplus value is extracted by the government (similar as in the war economy) and redirected towards environmental reconstruction. When exactly the amount of surplus value is extracted, sectors 1 and 2 have precisely the necessary capital left in order to keep the production constant. In this situation three conditions need to be given.

First, the means of production that are produced in one period (w_1) are equal to the means of production needed by all three sectors. Hence, the value of the means of production not used by sector 1 itself need to be equal to the demand for the means of production by the other two sectors:

$$v_1 + s_1^c + s_1^e = c_2 + c_3. \tag{18.10}$$

Second, the value of the production of consumption goods needs to be equal to the demand for consumption goods by all three sectors. Hence, the demand for consumption goods by sector 1 and 3 needs to be equal to the value of consumption goods not consumed by sector 2 itself:

$$c_2 + s_2^e = v_1 + s_1^c + v_3 + s_3^c. \tag{18.11}$$

Third, the value of production of environmental quality needs to be equal to the surplus appropriated by the government from all three sectors. As the appropriation of surplus in sector three directly goes back into that sector, the value of the demand for means of production and consumption goods from sector 3 need to equal the appropriation of surplus by the government in sectors 2 and 3:

$$c_3 + v_3 + s_3^c = s_1^e + s_2^e. \tag{18.12}$$

Under these three conditions, there would be a simple reproduction with one crucial difference to the simple reproduction developed by Marx: Part of the society's labour is used for environmental abatement.

18.2.2.3 Diseconomies of Scale and Stakeholder Collectives

The use of energy and the subsequent increases in labour productivity and the scale of production are not the only problems associated with capitalist dynamics. The second important problem is that firms have the incentive to exploit the environment whenever it reduces costs – due to competition and profit-maximization. This leads Sweezy to the conclusion that "the contemporary structure of commodity production [...] tends to maximize the overall toxicity of production [...] creating problems of ecological sustainability that far outweigh the general entropic effect" (p. 208).

An introduction of diseconomies of scale not only decreases the incentive to expand production on a firm level (as argued above) but also decreases overall competitive pressure. This is because the number of competitors involved is smaller on a local than on the global market. Such diseconomies can therefore dampen the incentive to exploit the environment, while they do not abolish them completely.[14].

A further possible strategy is to include stakeholders who are affected by a firms' actions in the firms' decisions. This, in particular, concerns local environmental issues, in which the involvement of the local authorities or population can influence the firm towards more environmentally friendly behaviour.[15]

18.3 Results and Discussion

18.3.1 Summary of Conditions

The conditions resulting from Marxian ecological economics are again partly the same and partly different to the ones from the theories discussed beforehand. Four conditions have been developed.

1. The most important theoretical addition has been the role of fossil fuels in facilitating capital accumulation. Accordingly, the use of fossil fuels has to be limited in order to prevent increases in labour productivity. It has been argued that this can be achieved by a strong tax on fossil fuels. Other measures, such as quantitative limits are also possible. The case of taxation has been chosen because it can be investigated by the available theories.
2. The second condition is that the government absorbs (e.g., via a tax) the surplus value (from both, the capital goods and the consumption goods sectors) and use it for unproductive purposes. One possible and reasonable purpose are activities that help conserving and regaining environmental quality.

   These two central conditions can be combined. The governmental tax

14 See also Liesen et al. (2014) on this issue

15 The connection between stakeholder involvement and environmental concerns is also discussed in Posse (2015).

that absorbs the surplus can be on the use of fossil fuels. From the other perspective: The revenues from the tax on fossil fuels can be used for environmental conservation. In this way, the government is prevented from using the revenues for expansionary purposes.

3. Additionally, it has been argued that the introduction of diseconomies of scale can reduce the pressure to externalize costs on the environment.
4. Finally, stakeholder involvement in firms' decision processes can help incorporating environmental issues into the direction of firms' activities.

18.3.2 Critical Assessment of the Marxian Ecological Theories

The Marxian ecological approaches have only been developed recently, and there is a limited number of authors working in this field. While the work so far is strong in its conceptual foundations, there is a lack of contributions that focus on the inclusion of environmental aspects into macroeconomic theories and models. There are also few investigations that look detailed into concrete environmental issues (such as the role of renewable energy). Connected to this general impression, there are three central issues regarding the explanatory power of these theories for sustainable economies without growth.

First, the discussion of the role of fossil fuels for the capitalist development is maybe the most insightful aspect from Marxian ecological theories. The historical importance of fossil fuels is intuitively evident and opens a new perspective on the past and future development of capitalism. At the same time, the reasoning on why renewable energies cannot replace fossil fuels is not entirely convincing and needs further examination.

Second, the incorporation of natural resources into the economic theory is still incoherent. For example, it is seldom discussed what happens to the wages and profits earned in the exploitation of natural resources – as it is not included as a sector.

Third, the theoretical inclusion of the effects of changing relative input prices is still weak. While for example Schnaiberg (1980) discusses these issues, it is not done within a coherent Marxian framework. As a consequence, it was not possible to investigate the connection between changing input prices on the one hand and the implications on wages, profits and capital accumulation on the other within a comprehensive theoretical setting.

Chapter 19
Sustainable Economies Without Growth in Marxian Theories

> No-growth capitalism is an oxymoron [...]. Capitalism's basic driving force and its whole reason for existence is the amassing of profits and wealth through the accumulation (savings and investment) process (Magdoff and Foster, 2010, p. 8).

The part on Marxian theories has covered two coherent macroeconomic frameworks: Marx's theory of capital accumulation within competitive capitalism and the Theory of Monopoly Capitalism. Additionally, the incorporation of environmental aspects in Marxian theories have been discussed. This chapter starts with a short overview of the results (19.1). Subsequently, the central conditions for sustainable economies without growth from the perspective of Marxian theories[1] are summarized in the form of two scenarios (19.2). Afterwards, the effects on environmental, distributional and stability issues are summarized (19.3), the insights are compared to the existing Marxian literature on zero growth (19.4) and finally several limitations to Marxian theories are pointed out (19.5).

As in the previous parts, a table is included that serves as summary of the Marxian theories[2] and as reference point for the discussions of this chapter.

19.1 Overview

The investigation of the Marxian theories all lead to the result that significant *systemic* changes of the economy are needed to facilitate economies without growth. The collectivization of ownership plays an important role in all theories, as it countervails the drive towards profit maximization and profit reinvestments. Other conditions played large roles in one theory, but not in others. Diseconomies of scale are particularly relevant

[1] The following discussions refer solely to the Marxian theories discussed in the preceding three chapters and not Marxian theories in general.

[2] Note that all results, conditions, limitations etc. are only based on the Marxian theories discussed in this present work, not Marxian theories in general. The term *the Marxian theories* hence also refers to those Marxian theories used in this present work and not all Marxian theories.

in competitive capitalism, as they dampen price competition (which is the major reason for the reinvestments of profits). Addressing the sales effort is particularly important in the theories of monopoly capitalism. In Marxian ecological economics, it is essential to address the issue of fossil fuels, as its use is a central prerequisite for capital accumulation. The major proposal has been to increase its price and to appropriate the gains by the government, either due to taxes or due to the nationalization of fossil fuel supply.

Apart from economic conditions, Marxian theories also refer to the political economy in competitive and monopolistic capitalism. The analyses are similar between the theories. Political decisions are strongly influenced either by capitalists or by the oligarchy. As many of the conditions for economies without growth contradict capitalists'/the oligarchy's interests, these conditions are unlikely to be implemented. The traditional actor who can assert significant changes is the labour movement. It is relatively weak, though, due to its fragmentation. Marxian authors regard an alliance between the old labour movement and new social movements (in particular the feminist and the environmental movements) as the most promising perspective to pursue radical changes.

19.2 Two Scenarios for Economies Without Growth

Two central Marxian theories have been covered. The first is based on Marx's work and depicts competitive capitalism, which is characterized by price competition. The second is the Theory of Monopoly Capitalism, in which competition takes place in form of the sales effort. The two scenarios developed in the following section refer to these two stylized types of capitalism.

In order to derive conditions for sustainable economies without growth, it is necessary to combine the analyses of competitive and monopoly capitalism with environmental aspects. This is why each scenario starts with the development of a reference framework, in which the respective type of capitalism is integrated with the role of the environment, in particular the role of energy use. Based on these reference frameworks, the respective conditions for sustainable economies without growth are deduced. After the two scenarios, the political economy of such conditions is discussed.

19.2.1 Scenario I: Competitive Capitalism With Environment

19.2.1.1 Reference Theory I: Competitive Capitalism

In Marx's theory of competitive capitalism, capital accumulation and economic growth take place as a result of a complex set of interlinked economic processes. Capital accumulation is based on the generation of

Table 19.1: Summary of the Results From Marxian Theories

(1) **Theory**	(2) **Determinants of economic growth**	(3) **Conditions for zero growth**	(4) **Environment**	(5) **Distribution**	(6) **Stability**
Marx's theory of competitive capitalism	Exploitation facilitates the generation of surplus value. Price competition coerces the reinvestment of surplus value. New technologies lead to an increasing organic composition of capital, which generates the reserve army. This makes sure that the supply of labour is sufficient for further capital accumulation.	Collective firm ownership prevents exploitation, large profits and large reinvestments. Diseconomies of scale discourage the expansion of production on a firm level, while keeping the coercion to implement new technologies with increasing organic composition of capital. Therefore, working hours reductions are needed to prevent unemployment. Appropriation of profits by the state further prevents capital accumulation.	Environmental aspects are included in the form of material use. The material use increases due to economic growth and due to increases in the organic composition of capital. In zero growth economies, the material use increases slower than in growing economies.	Distribution is an issue of class struggle over the distribution of the value product. In capitalism, workers receive solely the subsistence wage and capitalists receive the entire surplus value. Under the conditions for economies without growth, the entire value product goes to workers. Consequently, economic inequalities are lower.	Capitalism is characterized by crises, due to the realization problem. In economies without growth, this problem is alleviated, as demand is higher and investments lower. Also unemployment is less of an issue, due to working hours reductions.

The Theory of Monopoly Capitalism	Monopolistic pricing and cost reductions generate a large surplus and insufficient consumption demand. Economic growth primarily depends on whether effective demand can be increased by the sales effort and government expenditures.	Collective firm ownership prevents the disparity between large profits and low consumption demand, by increasing workers' income. It also decreases the resources and the need for the sales effort. The sales effort is further prevented by regulatory measures. Working hours reductions prevent unemployment.	Environmental impacts increase with the level of production. In particular, the great amount of waste produced by monopoly capitalism depicts a possibility of decreasing these impacts.	Workers receive wages. Shareholder receive dividends and gains in the value of their assets. Managers receive managerial income. In zero growth economies, wages increase while dividends, asset values and managerial income decrease or cease to exist. Economic inequalities hence decrease.	In monopoly capitalism, the lack of effective demand leads to stagnation and persistent unemployment. Zero growth economies prevent the lack in effective demand and unemployment by working hours reductions.
Capital accumulation and fossil fuels	The causes from competitive and monopoly capitalism are supplemented by the role of energy. The availability of cheap energy (in particular in the form of fossil fuels) is a prerequisite for technological change that increases the organic composition of capital.	A limitation of cheap energy restricts increases in labour productivity, economic growth and capital accumulation. Another possibility to generate zero growth is to appropriate surplus value for environmental abatement, and thereby prevent capital accumulation.	First, capital accumulation leads to environmental pressures due to scale effects. Most importantly, increasing use of fossil fuels leads to climate change. Second, price competition and profit maximization lead to externalization of costs to the environment when possible. Both aspects are countervailed by the conditions for economies without growth.	Monopolistic price setting redistribute surplus to energy providers. Taxes on energy or a nationalization of energy supply allows the government to appropriate that surplus and use it for redistribution.	Limiting the availability of cheap energy prevents the disparity between profits and effective demand, which countervails crises and stagnation. An end of technological change prevents continuous unemployment.

profits (absolute and relative surplus value), which is due to two central constituents of competitive capitalism: the exploitation of labour power and technological change (a). Profits are used for investments because of economic dynamics that are based on price competition and capitalists' interest to accumulate assets (b). Four prerequisites for these dynamics of competitive capitalism can be summarized (c). Finally, the macroeconomic outcomes of competitive capitalism can be deduced (d).

a Constituents: Exploitation and technological change

Marx's reasoning for continuous capital accumulation starts with the relationship between labour and capital, namely exploitation. As the means of production belong to capitalists, they are able to exploit workers. Workers only get a part of the value they create, the other part is appropriated by the capitalists. This surplus value is transformed into profits, which are available for an expansion of production.

Usually, the expansion of production would lead to a shortage of labour and a subsequent increase in the wage share and a decrease in the profit share. In Marx's theory, this is prevented by introducing new technologies with an increasing organic composition of capital and increasing labour productivity. Based on ecological contributions, these new technologies depend on an increasing use of cheap energy. Without them, the continuous generation of relative surplus value is not possible. The increasing labour productivity guarantees continuous unemployment (the reserve army) and thereby strengthens the capitalist's bargaining position for low wages and a long working day. Both aspects lead to the generation of surplus value and profits.[3]

Overall, the generation of profits is based on exploitation and facilitated by technological change and cheap energy. Profits and investments are equal to surplus value in competitive capitalism.

b Dynamics: Price competition, economies of scale and capitalists' interests

In competitive capitalism, the main reason why profits are reinvested is price competition between firms. Firms have to introduce new production technologies in order to stay competitive. Capitalists may also have an interest in accumulating assets, but they have no choice anyway.

There are two reasons why large profits are necessary for such investments: (1) Technologies are depicted by an increasing organic composition of capital, which implies an increasing share of costs dedicated to capital goods compared to workers. The introduction of new technologies therefore requires large fixed investments. Hence, large sums of retained

[3] This argument is based on the discussions in section 18.1.1.4.

earnings are necessary. (2) In the case of the existence of economies of scale, the introduction of new technologies not only implies costs for new technologies but also an expansion of production which requires additional advancements for all production inputs (capital goods, labour and material inputs). This further increases the sum of retained earnings needed.

Additionally, capitalists have an interest that profits are reinvested if they are not interested in consumption but mainly in expanding their assets. This second reason is not decisive because capitalists are coerced to reinvest profits due to price competition anyway. It is important to keep this second reason in mind, however, as it can explain reinvestment even in the absence of price competition.[4]

c Prerequisites for competitive capitalism

The basic constituents and central dynamics laid out above are dependent on certain institutions and a certain macroeconomic framework. There are four central prerequisites for the capitalist economy as described.

1. *Division between means of production and workers:* Capitalists are only able to extract exploit and generate surplus value and profits when firms are not owned by the workers who are employed in them. This goes back to workers' freedom in a double sense, as described by Marx. Only in this case do the owners of the firms – the capitalists – have the incentive and the ability to maximize profits (Marx, 1990).
2. *Cheap energy and expensive labour:* The increases in labour productivity and the generation of relative surplus value and profits depend on substituting human labour by cheap energy from fossil fuels.[5] (Altvater, 2005). Technological change substitutes labour by energy and physical capital due to the relatively low price of energy. These relative prices are due to the abundant availability of fossil fuels. Government policies have supported these relative prices, in particular the strong taxation and other types of costs associated with labour and low taxes on energy and physical capital. Without these price relations, the type of technological change and the generation of relative surplus would not take place.[6]

[4] The foregone arguments are based on the discussions in section 16.1.2.

[5] As noted before, it is a controversial issue whether increases in labour productivity and capital accumulation can only be facilitated by fossil fuels or also by renewable energies. At least some Marxian authors attribute special characteristics to fossil fuels (see section 18.1.1.4, in particular their location and time independence, in order to facilitate large-scale production with increasing labour productivity. The following discussion is concentrated on the role of *cheap energy* and leaves the question open as to whether these come from fossil or renewable energies.

[6] This argument has been put forward in section 18.1.1.2.

3. *Competition with economies of scale:* Even if firms wanted to use revenues for consumption (either by increasing wages or by capitalist consumption), they would not be able to do so in the long run. The reason is that they would be outcompeted by other firms due to price competition. To prevent this, they have to invest in new technologies. It is important to note that investments in new technologies per se do not increase production, though. Only when there are economies of scale do new technologies go hand in hand with the expansion of production. Otherwise, new technologies could replace old technologies with a constant level of output.[7]

d Outcomes

Competitive capitalism is depicted by (1) fast technological change, (2) high rates of economic growth and (3) fluctuating rates of unemployment: Firms introduce newly available technologies as quickly as possible, thereby gaining extra profits and preventing bankruptcy. Due to the economies of scale, this implies large investments. Fast technological change and large investments imply high rates of economic growth. There are ambivalent effects on employment. The type of technological change leads to decreasing labour per output, while the high rates of economic growth increase labour demand.

19.2.1.2 Conditions for Sustainable Economies Without Growth in Scenario I

Sustainable economies without growth based on the framework of competitive capitalism with cheap available energy are depicted by certain constituents that countervail the generation of large profits: collective small firms and energy-saving technological change (a). These are linked to macroeconomic dynamics based on price competition and diseconomies of scale (b). Such constituents and dynamics are based on a set of necessary conditions (c) and lead to zero growth, slow technological change and low unemployment (d).

a Constituents: Collective small firms and energy-saving techn. change

A collectivization of firm ownership in the hands of the firms' workers (and potentially other stakeholders) prevents the conflict between labour and capital. As workers own their means of production, exploitation does not take place – there are no capitalist to extract profits. As a result, there is no interest to maximize profits.[8] Instead, one interest goes into

[7] See section 16.2.3.

[8] When there is no capitalist, the category profits does not apply anymore. In the following, the term *retained earnings* is used for the revenues not used for wages in collective firms.

the other direction: the larger the retained earnings for investments or the sales effort, the lower the wage. Whether this incentive to generate low retained earnings is countervailed by opposing mechanisms depends on the macroeconomic dynamics discussed below.

In sustainable economies without growth, technological change is connected to decreasing use of energy, which leads to environmental relief and constant labour productivity at the same time. Such technological change is primarily introduced by increasing prices of energy, due to government taxation (or nationalization). The collective firms therefore have an incentive to introduce technologies that save on energy, rather than on labour. This goes hand in hand with their interest to keep the employment constant (due to the fact that it is more difficult to fire people in a collective). If increases in labour productivity are nonetheless achieved, these are transferred into working hours reductions. This type of technological change keeps the demand for labour high and therefore makes it additionally difficult to generate high profits.

Overall, the generation of large profits/retained earnings is prevented by two aspects: the collective ownership structure sets incentives to distribute the revenues as wages and the scarcity of energy prevents the increase in labour productivity, which is the central prerequisite for the generation of relative surplus value and profits.

b Dynamics: Price competition, diseconomies of scale and no capitalists

Thus far, it has been argued that collective firm ownership and high energy prices put incentives to distribute revenues as wages. The macroeconomic conditions of competitive capitalism would coerce firms into using a large part of revenues for investments, however. The main reason is price competition.

Above, it has been argued that price competition leads to large investments due to two reasons: capital-intensive production methods and economies of scale. In economies without growth the combination of high costs for energy and capital goods, plus the introduction of diseconomies of scale prevent these two reasons and therefore the necessity of retaining large sums of revenues in order to innovate: (1) Expensive energy and capital along with cheap labour initiate technological change that is depicted by a constant (or even decreasing) organic composition of capital. The lower share of capital goods leads to lower retained earnings needed for the introduction of new technologies. (2) Diseconomies of scale facilitate the introduction of technologies that do not expand the firms' levels of production. This lowers the necessary retained earnings further.

If small-scale production goes hand in hand with a lower organic composition of capital,[9] the introduction of diseconomies of scale further supports the alteration of technological change towards less use of energy and capital, and more use of labour. Diseconomies of scale also lowers the intensiveness of price competition, when there are fewer competitors in the (local) market.[10]

A second reason for using large parts of revenues for reinvestments has been argued to be a result of capitalists' interest in accumulating assets instead of consumption.[11] In worker-owned firms, income is spent in form of wages. If it is assumed that there are no savings out of wages (as commonly done), all incomes are used for consumption.[12] In this case, there are no profits available for reinvestments.

c Conditions

The conditions for this type of economy without growth can be summarized in three aspects that correspond directly to the three prerequisites for competitive capitalism laid out above:

1. *Collective ownership structures:* When firms are collectively owned, exploitation is no longer possible. Also, collective firms ensure that revenues are used for wages rather than reinvestments.
2. *Expensive energy and cheap labour:* When the supply of fossil fuels and thus of cheap energy[13] is limited, it is not possible to substitute labour by energy. Therefore, increases in labour productivity are limited and thereby growth per capita as well. Additionally, the subsequent large labour demand makes it difficult to gain a high profit rate (even if firms were not collectivized). Apart from the limited supply of fossil fuels, labour-using and energy-saving technological change can further be supported by appropriate taxation and other policies.
3. *Lower competition with diseconomies of scale:* Some diseconomies of scale (a good example is the progressive taxation of firms) primarily make it unattractive for firms to expand above a certain level – because it would make them less competitive. The primary effect of

9 This argument has prominently been put forward by Schumacher (1973).

10 This point has been developed in section 18.2.2.3.

11 See section 16.1.2.1.

12 Note that this does not imply that all people consume their entire income at a given point in time, as people can save and dissave over their lifespan. Taking consumption out of wealth into account therefore implies that aggregate consumption needs to equal aggregate income, while allowing for individual deviations.

13 Note again that a fast increasing supply of renewable energy could change this situation. This would either need to be accompanied by high prices of renewables or by working hours reductions, in order to keep the production level constant.

this type of diseconomies of scale is to lower the incentive to invest. Other diseconomies of scale (e.g., high transport costs) also make it unattractive to produce for distant markets. These also decrease the intensity of competition, as firms have an advantage in their respective geographical areas. One effect is that the pressure to externalize costs decreases.

d Outcomes

Such economies lead to (1) no economic growth with (2) slower technological change and (3) high levels of employment: The level of production is approximately constant as increases in labour productivity do not take place and net investments are approximately zero (firms tend to keep their size constant). Technological change still takes place, as firms have to introduce cost-reducing (mostly energy-saving) technologies in order to stay competitive. The speed of technological change is slower, though, as competition is weaker. Employment is high as the demand for labour is high.

19.2.2 Scenario II: Monopoly Capitalism With Environment

19.2.2.1 Reference Theory II: Monopoly Capitalism

As for competitive capitalism, two constituents are the major prerequisites for the generation of large profits (a). These are related to dynamics within monopoly capitalism that explain why profits are increasingly used for the sales effort (b). Subsequently, four central prerequisites for the functioning of monopoly capitalism are developed (c), followed by a the outcomes, which additionally to the described aspects depend on government interventions (d).

a Constituents: Monopoly surplus and technological change

In monopoly capitalism, firms are able to generate an economic surplus and high profits that are above the surplus value. The major reason is that they can charge monopolistic prices which lie above competitive prices.

The tendency of rising surplus additionally rests upon the firms' ability to reduce costs. This is primarily due to the introduction of cost-reducing technologies. These technologies substitute labour by energy and physical capital. Cost reductions and the ability to generate high profits therefore depend on the availability of cheap energy.

b Dynamics: Effective demand, sales-competition and managers' interests

There are three reasons why profits are increasingly used for the sales effort: First, in monopoly capitalism, the cost reductions go hand in hand with low wage levels, which lead to a lack in effective demand. Firms try to increase demand by the sales effort. Second, the sales effort replaces prices as the primary type of competition between firms. A third reason why profits are used for the sales effort is connected to the interests of managers and rich shareholders. Profits could also be used for capitalists' consumption or in order to increase wages. Both managers and rich shareholders have an interest in using profits for the sales effort, though, in order to increase production. As a result, a large share of profits is used for the sales effort.

Despite the sales effort, effective demand still is below full capacity utilization and the economy resides in stagnation. The government can increase effective demand and economic growth by expanding spending.

c Prerequisites for monopolistic capitalism

Monopoly capitalism also rests upon four central prerequisites that are partly similar and partly different to the prerequisites of competitive capitalism.

1. *Monopolistic market structure:* The economy is characterized by large firms that are able to engage in monopolistic price setting. This is the main condition for profits above surplus value.
2. *Cheap energy and expensive labour:* Cost reductions, the substitution of labour by energy and increases in labour productivity depend on the cheap availability of energy, which is facilitated by using easily accessible fossil fuels.[14] As in competitive capitalism, technological change is further supported by fiscal and other polices that make energy and capital goods cheap and labour expensive.
3. *Large markets:* The size of the market is decisive for the ability to expand production. The sales effort is not a manner of competition between large firms but also increases demand absolutely. This can either be due to increasing the consumption rate or due to mobilizing new consumers. The larger the potential market is, the higher the incentive is to engage in the sales effort.
4. *Convenience of the Sales Effort:* The sales effort not only depends on the will of firms to engage in it but also on their ability to do so and how convenient it is for them. For example, Baran and Sweezy (1966) argue that the expansion of the sales effort has historically depended on the ability to penetrate the media and in particular television with commercials. Whether the sales effort can be used to increase consumption demand depends on whether certain types of the sales efforts are allowed (commercials, planned obsolescence, etc.) and how costly it is for firms to engage in them.

14 As in the case of competitive capitalism, increasing availability of renewable energies could substitute fossil fuels.

d Outcomes and government intervention

Monopoly capitalism leads to (1) stagnation, (2) slow technological change and (3) a persistently high level of unemployment: Stagnation is due to the lack of effective demand. Firms only introduce new technologies slowly because they are not coerced to do so and only apply them according to considerations of profit maximization. The combination of stagnation and (albeit slow still continuing) technological change leads to high unemployment.

Government interventions can change these outcomes. When the government decides to grow expenditures strongly, it can rise effective demand to the level of full capacity utilization. In this case, the rate of economic growth would be high, technological change faster (because firms invest more) and unemployment low. At the same time it would also foster the use of natural resources and energy, with the respective impacts on the environment.

19.2.2.2 Conditions for Sustainable Economies Without Growth in Scenario II

Two constituents are crucial in preventing the generation of large profits in monopoly capitalism. Their explanation is followed by the dynamics that prevent the sales effort and lead to zero growth. This leads to four crucial conditions for sustainable economies without growth based on monopolistic market structures. Finally, the macroeconomic outcomes are described, and the role of the government is discussed.

a Constituents: Collective large firms and energy-saving techn. change

The first central condition for economies without growth is (again) the collectivization of firms. This condition serves several purposes, as will be seen in the following. Its first effect is a decrease of the retained earnings of large firms. The reason is that worker-owned firms have an incentive to use large revenues to increase wages. As in the case of competitive capitalism, it depends on the macroeconomic dynamics (below) whether this incentive prevails or is opposed by other mechanisms.

Next to monopolistic pricing, the main reason for high retained earnings is the ability to reduce costs due to new technologies that depend on the availability of cheap energy. A limitation of such energy would redirect technological change towards being energy-saving.

b Dynamics: Effective demand, local markets and collective firms

The first reason to use profits for the sales effort in monopoly capitalism – the lack in effective demand – is opposed by a collectivization of firms.

These firms are assumed to increase the share of wages and therefore decrease the lack of effective demand.[15]

The second reason for the sales effort – monopolistic competition – can be dampened by a macroeconomic framework that supports local markets and disadvantages production for the global market. This leads to fewer competitors and therefore less necessity to compete via the sales effort.

The third reason – the interest of managers and rich shareholders – is also tackled by collective-firm ownership. In such firms, managers arguably behave based on the interests of workers and the prestige they receive within the firm.[16] Rich shareholders do not exist, as all shares are held by workers.

Additionally, a fourth reason helps to prevent incentives for the sales effort: Various components of the sales effort can be made less convenient. For example, commercials, as well as planned obsolescence and the introduction of useless features can be prohibited or regulated.

c Conditions

These constituents and dynamics are based on four conditions.

1. *Monopolistic collectives:* It is still assumed that the economy is characterized by large firms, although probably smaller than current firms, as firms produce primarily for local or regional markets. They have monopolistic market power within these markets.
2. *Expensive energy and cheap labour:* The supply of fossil fuels is limited, as in scenario I. Therefore cost reductions are limited, which leads to low retained earnings. As in scenario I, policies to decrease the costs related to labour and increase the costs of energy and capital goods support a technological change that generates employment and decreases environmental costs. This type of technological change is also characterized by constant or decreasing labour productivity and therefore facilitates zero growth.
3. *Local/regional markets:* Smaller markets limit the ability to expand production and therefore make the sales effort less attractive. Revenues are rather used for wages than for the sales effort, which further decreases the lack of effective demand.

[15] Note that this constitutes a one time increase in the level of production. Afterwards, economic growth is zero due to zero net investments and redirected technological change.

[16] The major reason why managers are assumed to look for recognition by the respective firm's workers rather than other managers is that managers are democratically controlled by the workers and therefore have to engage with them and their concerns if they want to stay managers of the respective firm.

4. *Hindering the Sales Effort:* The sales effort can additionally be prevented by policies that directly address it. Examples have been given above.

d Outcomes and government intervention
Such economies are characterized by (1) an approximately constant level of production, (2) relatively slow technological change and (3) low unemployment: Production is constant as technological change does not increase labour productivity, and investments only replace the depreciation of capital equipment. Technological change is slow (as in the reference framework of monopoly capitalism) as there is no coercion to introduce new technologies. Firms still have an incentive to introduce cost-reducing technologies (in particular to save energy-related costs) and therefore implement new technologies in accordance with the cost-benefit analysis. Unemployment is low, as technology is not. Additionally, collectively-owned firms have an incentive to reduce average working hours and thereby keep employment high, even if technological change should still increase labour productivity due to the availability of renewable energy.

19.2.3 Political Economy

In Marxian theories, it is commonly argued that political decisions are primarily controlled by capitalists or the oligarchy. If this is the case, the proposed conditions are difficult to be implemented, as several of them stand in strong conflict with interests of these groups. Most importantly, the collectivization of firm ownership implies large-scale expropriations, which clearly go against capitalists'/oligarchy's interests.

Marx sees the solution in a political revolution, with the working class as the primary agent (Sweezy, 1942). Baran and Sweezy (1966) are pessimistic concerning the feasibility of revolution because the working class is too fragmented. Other authors, such as Rosa Luxemburg, Andre Gorz and Antonio Gramsci develop theoretical frameworks that allow for transformational change apart from a political revolution.[17]

Many of the conditions proposed are arguably such *revolutionäre realpolitik* or *non-reformist reforms*. Their implementation improve the viability of further changes. For example, a (partly) collectivization of ownership would change the power relations, as workers would gain more economic power. Another example is that reducing the sales effort would make people less dependent on high incomes. Also, diseconomies of scale and local markets would decrease the size and thereby the power of firms and make democratic control over firms more feasible.

Several of the conditions proposed are in the interest of workers. In par-

[17] See section 16.3.2.

ticular, the collectivization of ownership allows for higher wages, working hours reductions and save jobs. Additional advantages are an improved control over working conditions and less exposition to the sales effort.

New social movements apart from the labour movement are also concerned with various of the conditions. The environmental movement's interest in decreasing the environmental impacts of economic activities is particularly related to the condition of more expensive energy. Environmental aspects are also connected to an end of economic growth and a reduction of the sales effort.

The second movement mentioned by O'Connor (1988) is the feminist movement. Their primary relations to the conditions discussed are (arguably): the ability to influence working conditions (due to collective ownership structures) to reconcile wage labour and other types of work; the ability to work part-time due to working hours reductions; and governmental spending on civilian instead of military purposes, in particular in the care sector.[18].

These three – and potentially additional – movements therefore have different emphases regarding the conditions for sustainable economies without growth. The central prerequisite to facilitate the implementation of the proposed sets of condition are strong alliances between these movements in order to enforce such conditions with combined forces.[19]

19.3 Environment, Distribution and Stability

19.3.1 Environment

The environment has not been central to the Marxian theories discussed here, namely Marx's theory and the Theory of Monopoly Capitalism. In these theories, the environment primarily plays a role in the form of material inputs to production, which are easily available. Only recent contributions have integrated environmental aspects into Marxian analysis.

In the two scenarios, economies without growth generate significantly better environmental results than the reference frameworks of competitive and monopolistic capitalism. This is mainly due to four mechanisms. First, the level of production ceases to grow, which implies less pressure on various environmental boundaries (rifts), as compared to growing economies. Second, the use of fossil fuels is reduced. This is supported by changing the relative prices of production inputs through tax policies. Fourth, diseconomies of scale reduce price competition and therefore pressures to engage in production methods that are detrimental to the environment.

[18] Compare with Biesecker et al. (2012) and with section 18.1.2.1.

[19] Compare with the discussions in section 16.3.2.

Finally, the inclusion of stakeholders in firms' decisions increases their capacity to take local environmental impacts into account.

A possible reason for a worse environmental performance of economies without growth could be that less energy-saving technological change takes because investments are lower. This would be the case if technological change depends on investments. At the same time, technological change still takes place in the two scenarios for sustainable economies without growth, as developed above. In the case of competitive market structures with diseconomies of scale, firms still have to introduce cost-reducing technologies in order to stay competitive. In the case of monopoly capitalism, the large size of depreciation is sufficient for the introduction of new technologies, so that net investments are not necessary. Whether technological change is *slower* in zero growth than in growing economies cannot be answered within the theoretical frameworks used here.

19.3.2 Distribution

Distributive issues are seen as class issues in Marxian theories. The theories primarily explain the relative developments of different class incomes (wages and profits).

In economies without growth as described above, economic inequalities are significantly lower than under competitive and monopolistic capitalism. There are two main reasons for this. First, the distribution of *assets* is far more equal, as all workers hold shares of the companies they are employed in. Capitalists as a class is not existent anymore. Shares of firms are therefore hold relatively evenly. The theories do not cover other types of assets (e.g., real estate or financial assets). Second, incomes are distributed more equally. Workers receive income from the firms where they work. As they are workers and shareholders at the same time, it is difficult to separate wages from profits. As there are no capitalists, income inequality tends to be lower. Inequalities still exist, though, as different firms can pay different wage levels.

When the conditions described above lead to (exactly) zero growth, overall income stays constant over time. Due to the decreased income inequality, the transformation towards economies without growth would therefore imply increasing income for workers and decreasing income for capitalists (who would have to become workers as well).

Additionally, the same level of production (in terms of exchange values) is connected to a higher material standard of living (in terms of use values). The reason is that the sales effort (which is useless in terms of use values) decreases in size or is even abandoned altogether. Therefore, useful production makes up a larger share of production and the production of use values increases (only once).

At the same time, there would be a change in the relative prices of goods. Goods that rely heavily on cheap energy, e.g., gasoline, become more expensive. Goods that are labour-intensive become cheaper. Assuming some substitutability of goods, the consumer basket changes towards labour-intensive goods.

19.3.3 Stability

The major reason for instability and crises in Marxian theories is related to the first contradiction in capitalism. Capitalists maximize profits and reinvest them, thereby increasing production capacity. At the same time, it implies low wages and low consumption demand. Therefore, a disparity between production capacity and effective demand develops. This leads to reoccurring realization crises in Marx's framework and continuous stagnation in monopoly capitalism.

This contradiction is resolved under the conditions for economies without growth. Collectively owned firms within a framework of diseconomies of scale and no sales effort do not have the incentive to maximize profits but rather to maximize wages. Therefore, sufficient effective demand is created for the production capacities at hand.

The second contradiction of capitalism relates to supply side constraints of production due to environmental limits. Economic activity exploits or destroys its own environmental foundations and thereby decreases production capacity. The conditions of economies without growth slows down the destruction of the environment and thereby alleviates the second contradiction. The extent to which the conditions are sufficient to prevent the second contradiction (entirely) cannot be examined on the purely theoretical grounds used in the investigation at hand.

Finally, unemployment is a source of instability both in competitive and monopolistic capitalism. The major reason is the continuous replacement of human labour by energy, which is connected to the incentive for capitalists to reduce labour costs. Both mechanisms are prevented by the conditions developed for economies without growth. Expensive energy and the relative low costs related to labour lead to high labour-demand. Additionally, collective firms are likely to pursue policies which target the sustainment of employment, e.g., by reducing working hours.

19.4 Insights in the Light of Existing Literature

In the introduction to the part on Marxian theories, it was pointed out that, according to Magdoff and Foster (2011), the central feature of zero growth is that all revenues are used for consumptive purposes (after allowing for replacing the depreciation of capital equipment). The unanimous position of the existing literature, however, is that this is not possible within capitalist structures. Price competition *coerces* capitalists to reinvest and produces an *incentive* to use profits for the sales effort. Therefore, overall "[n]o-growth capitalism is an oxymoron" (Magdoff and Foster, 2010, p. 8), as stated in the introductory quote to this chapter.

The conditions for sustainable economies without growth developed above are a concrete proposal under what conditions Magdoff's and Foster's central feature of zero growth can be realized. The necessary set of conditions differs (slightly) depending on whether competitive or monopolistic market structures are taken as point of departure.

At first glance, this seems to imply a contradiction between the existing literature and the results found here. While authors have previously argued that zero growth is not possible, here conditions for it are developed. This does not necessarily have to be a contradiction, though. The reason is that authors such as Altvater (2005), Harvey (2010) and Magdoff and Foster (2011) have argued that zero growth is impossible *within capitalism*. The sustainable economies without growth described above are arguably not capitalist economies, in particular as the collectivization of firm ownership contradicts a crucial feature of capitalism – private ownership of the means of production. They have more similarities with *market socialism* which "is an economic system that combines social ownership with market allocation" (Gregory and Stuart, 2013, p. 186).

Regarding the political economy, the same actors have been identified as potential drivers of economic change, as is the case in other recent Marxian contributions: the labour, environmental and feminist movements. The conditions developed above depict an agenda for these movements that may facilitate to bring about new or stronger alliances between them. The reason is that several conditions lie in the interest of more than one movement. For example, collective firm ownership leads to higher wages (a typical goal of the labour movement) and facilitates more flexible working conditions (important from feminist perspectives). Another example is increasing the costs related to energy, relative to the costs related to labour. This is advocated by environmental movements in order to decrease the use of fossil fuels. It is also in the interest of the labour movement, as it increases the demand for labour and thereby leads to higher wages and lower unemployment. A third example is to use large revenues not for the sales effort but instead for working hours reductions. This decreases wasteful production (environmental perspective) and reduces the workload (labour perspective).

19.5 Limitations to Insights From Marxian Theories

The Marxian theories are less formalized than the Keynesian and in particular than the neoclassical theories investigated in this present study. This brings about the disadvantage of being imprecise or open to interpretation at various points. For example, central concepts in the Theory of Monopoly Capitalism are interpreted differently among the authors, such as economic surplus and waste.

At the same time, Marxian analyses allow (maybe due to not being formalized) us to incorporate a larger number of factors into the analysis. Four aspects deserve highlighting. First, the coercion to invest due to price competition contributes an important aspect to understanding the reasons for growth and subsequently necessary conditions for zero growth. This plays no role in neoclassical theories and is not investigated comprehensively by Keynesian theories. Second, the Theory of Monopoly Capitalism is the most detailed theory covered in this work on the importance of big firms. It entails an apparently realistic formulation of central drivers for the behaviour of big firms. Neoclassical (the endogenous growth theories) and Keynesian (in particular Kalecki's theory) are less sophisticated regarding this aspect. Third, Marxian theories make a qualitative difference between fossil and renewable energy. While it is a controversial issue whether the use of renewable energy can facilitate for continuous capital accumulation, the qualitative difference seems to be important to take into account. Finally, the political economy only plays an important role in Marxian theories. It is therefore the only theoretical framework used in this work that allows a discussion on not only *which* macroeconomic conditions are necessary for sustainable economies without growth but also on *whether and how* they can be implemented.

On the other hand, there are several limitations to the insights from Marxian theories. The first concerns the relation between savings and investments. The Marxian theories often argue that profits are reinvested. This implicitly assumes that there are savings (profits) which pre-date investments. This issue has been criticized by Keynesian authors, based on the actual functioning of the monetary system and money creation (see in particular chapter 12). A second issue relates to the role of fossil fuels. Marxian authors argue that the type of capital accumulation as experienced in the past depends on fossil fuels. Due to the particular characteristics of fossil and renewable energies, a substitution of the former by the latter has to be accompanied by a transformation of the economic system (see section 18.1.1). Whether and why this is the case requires further investigation. For example, the argument that renewable energies are not compatible with a centralized mode of production seems controversial. A third limitation of the Marxian theories covered here is their (lack of) incorporation of feminist perspectives. While some authors have touched on the issue (see section 18.1.2.1), it still needs further investigation.[20]

[20] Note that there are various Marxian authors working on this topic, see for example Haidinger and Knittler (2013). However, it was not possible to include them in the analysis of this present study.

Part V

Synthesis of Results

Chapter 20

Summary of Results to This Point

This investigation started with the premises that organizing economies without growth *is in principle possible*, can help to reduce environmental pressures and can be compatible with high social welfare and economic stability. The question throughout this work has therefore been *how* to achieve such economies. In other words: Which macroeconomic conditions lead to sustainable economies without growth?

In part I, the existing literature on economies without growth was summarized with reference to four different existing concepts: *steady state economies*, *degrowth*, *Postwachstum* and *prosperity/managing without growth*. These existing concepts offer a diverse set of proposals for macroeconomic conditions.

Parts II – IV were dedicated to investigating which macroeconomic conditions can be derived from an examination of three major economic schools of thought: neoclassical, Keynesian and Marxian. For each school, several single theories have been examined, each theory suggesting a specific set of conditions for zero growth economies. The central conditions have been summarized for each school of thought at the end of the respective part. Each summary additionally entailed the development of several scenarios of how to achieve sustainable economies without growth (see chapters 9, 14 and 19 for the summaries of conditions and scenarios).

In the following last part of this investigation, the results from the different schools of economic thought are compared and synthesized.[1] Such a synthesis necessarily leads to the loss of the theoretical coherence that a single theory entails. At the same time, it allows us to integrate a larger number and to develop a wider scope of conditions than is possible based on any one school of thought, let alone any one single theory.

The part is structured as follows. First, this chapter summarizes the results up to this point structured along the four parts of the investiga-

[1] Note again that these results are based on the theories covered in this work alone and do not necessarily apply to all existing theories from the three schools of economic thought.

tion.[2] Second, the results from the three schools of thought are compared regarding three central aspects on conditions for zero growth (chapter 21). Third, seven areas of conditions from the different schools are synthesized (chapter 22). This synthesis integrates not only the conditions from the three schools (neoclassical, Keynesian and Marxian) but also relates them to the state of research from the four existing concepts in the literature (steady state, degrowth, Postwachstum and prosperity/managing without growth). Fourth, these syntheses culminate in the development of a model of sustainable economies without growth. It integrates the major conditions from the three schools of economic thought. Fifth, the results of this present study are compared to the state of research (chapter 24). The study concludes with a short summary and an indication of potential avenues for future research (chapter 23).

20.1 Foundations

Significant economic growth per capita is a recent phenomenon, historically speaking. It started with the industrial revolution and growth rates varied strongly between different phases in early industrialized countries. In recent decades, growth rates per capita have successively fallen.[3]

The recent decline in growth rates has led to a new debate on secular stagnation. The explanations for low growth rates concern the supply and the demand side. On the supply side, it is argued that the amounts and productivities of production factors do not grow as fast as they used to. In particular, technological change does not increase labour productivity in the same manner it did several decades ago. On the demand side, the most important explanations are a satisfaction of consumption and increasing income inequality.[4]

Another strand of literature puts into question the desirability of economic growth. This debate, and the resulting proposals for alternative economic concepts, refer to the labels *steady state*, *degrowth*, *Postwachstum* and *prosperity or managing without growth*. These concepts argue that it is more feasible to achieve environmental sustainability, low economic inequalities and economic stability by organizing economies without growth (than with growth). The concepts entail a broad range of proposals for macroeconomic conditions for sustainable economies without growth. They also entail three central strategies to reconcile zero growth economies with environmental sustainability and full employment: reduc-

[2] This summary is based on the results from all four prior parts (I – IV). It in particular refers to the results from chapters 2, 9, 14 and 19.

[3] This issue is discussed in more detail in section 2.1.

[4] Compare to the discussion on secular stagnation in section 2.3.

tions in average working hours, a redirection of technological change and sectoral change from dirty to clean products.[5]

20.2 Neoclassical Theories

In neoclassical theories,[6] the major macroeconomic variables of interest (economic growth, capital accumulation, employment, the relation between the economy and the environment) are primarily determined by two aspects: the supply of production factors (capital, labour and natural resources) and the direction and speed of technological change. To a large extent, the neoclassical theories covered in part II are different explanations for the developments of these two aspects.

The general condition for zero growth in the neoclassical theories is that the sum of the developments of the supplies of production factors and the developments of their productivities (which are due technological change) equal each other out, so that aggregate supply stays constant over time. The supplies and productivities of the factors are determined as follows: (1) Capital accumulation is mainly influenced by savings behaviour (which is defined by households' preferences) and the marginal productivity of capital (which is due to the state of technology). (2) Labour supply is the result of household preferences and the level of wages (which is also mainly due to the state of technology). (3) The supply of natural resources is either determined by profit maximization of the owners of such resources or (in other theories) controlled by the government. (4) The direction of technological change is the result of incentives (in particular the prices of production inputs, but also tax incentives and subsidies). The speed of technological change is determined by the amounts of resources put into the development of new technologies and/or human capital.

Based on this view, three scenarios have been developed. In the first scenario, labour-augmenting technological change and reductions in average working hours lead to zero growth and constant employment. The second scenario additionally includes natural resources. The combination of labour-augmenting technological change, constant labour supply and decreasing availability of natural resources leads to zero growth, constant employment and decreasing use of natural resources. In the third scenario, technological change is redirected towards resource augmentation. This

[5] This strand of literature is discussed in detail in chapter 3. The three scenarios can be found in chapter 4.

[6] The following summary is based on the discussions in part II and in particular on the results in chapter 9.

redirected technological change and constant labour supply lead to zero growth, constant employment and decreasing use of natural resources.[7]

20.3 Keynesian Theories

In Keynesian theories,[8] economic developments are examined from the perspective of an interplay between aggregate demand and aggregate supply. Aggregate supply changes due to investments and technological change. Aggregate demand consists of investments, private consumption and government spending. Aggregate supply and aggregate demand are mutually dependent. The primary connection between the two is the combined mechanism of investments and technological change (which are closely linked). On the one hand, investments and technological change have a clear positive effect on aggregate supply as both increase production capacity. On the other hand, their effect on aggregate demand is ambivalent. Investments increase income and consumption demand. At the same time, technological change decreases the labour coefficient, employment, and therefore also consumption demand. The level of investments and technological change primarily depends on the level of aggregate demand. In sum then, investments and technological change depend on aggregate demand while at the same time, they have a strong influence on both aggregate supply and aggregate demand. Due to the effect of technological change, the resulting effective demand tends to be below the level of full employment. In this case, increases in government spending can raise aggregate demand and thereby prevent unemployment.

The central condition for zero growth is that both aggregate demand and aggregate supply stay constant over time. This necessitates investments to stay constant and at the level of capital depreciation (in order to keep aggregate supply constant). With constant investments, consumption and government spending also need to stay constant in order to keep aggregate demand at a steady level. When technological change leads to a decrease in the labour coefficient, average working hours have to decrease at the speed of technological change in order to prevent unemployment and keep income and consumption at constant levels. Two aspects can dampen the decrease in the labour coefficient due to technological change. First, a redirection of technological change leads to decreases of the resource coefficient rather than the labour coefficient. Second, sectoral change shifts demand from dirty products with low labour coefficients to

[7] These scenarios are explained in detail in section 9.2.

[8] The following summary is based on the discussions in part III and in particular on the results in chapter 14.

clean products with higher labour coefficients. Both aspects decrease the necessary level of working hours reductions to keep employment constant.

The four scenarios developed in the Keynesian part build upon these aspects. In the first, technological change with a decreasing labour coefficient is combined with reductions in average working hours. The outcomes are zero growth and constant employment. In the second scenario, changes in relative input prices lead to a redirection of technological change. The result is zero growth, constant employment (with constant average working hours) and decreasing use of natural resources. The third scenario starts with a sectoral change of consumption and government spending from dirty to clean products (caused by altered decisions of consumers and the government). The results are the same as for the second scenario: zero growth, constant employment and decreasing use of natural resources. The fourth scenario entails both a redirection of technological change and a sectoral change. The former does not change the labour coefficient and the latter increases it. The outcomes are therefore zero growth, increasing employment and decreasing use of natural resources.[9]

20.4 Marxian Theories

Marxian theories[10] concentrate on the explanation of capital accumulation. Firms use money capital to acquire the means of production, including labour power. Because capitalists exploit workers, they are able to generate surplus value and profits. In competitive markets, price competition coerces firms to reinvest profits, which leads to the introduction of new technologies and to capital accumulation. This requires the availability of cheap energy, as it is needed for increases in labour productivity. In monopolistic markets, profits are used for the sales effort in order to increase effective demand and to compete with rival firms. Government spending can further foster effective demand and bring the economy closer to full capacity utilization and economic growth.

The central condition for zero growth economies is to prevent capital accumulation. Five aspects are crucial. First, a collectivization of the ownership structure avoids exploitation and the generation of large profits. This prevents the necessary funds for reinvestments and capital accumulation. Second, diseconomies of scale prevent firms from having to expand production in order to stay competitive. Third, increasing the price of energy decreases its use and thereby prevents rises in labour productivity and helps to decrease economies of scale. Fourth, collective firms and a

9 These scenarios are explained in detail in section 14.2.

10 The following summary is based on the discussions in part IV and in particular on the results in chapter 19.

regulation of the sales effort decrease firms' engagement in the sales effort. This helps to prevent increases in effective demand. Fourth, government spending stays constant, which also helps to keep effective demand constant. The combination of these conditions leads to zero growth.

Two scenarios have been developed based on the Marxian theories. These two scenarios are based on two different assumptions concerning the constitution of capitalism. The first is based on competitive capitalism, while the latter is situated within monopolistic capitalism. A part of the conditions resulting from these different capitalisms are the same. In particular, the collectivization of firm ownership and the increase in the price of energy is central in both scenarios. Other parts of the conditions differ. Diseconomies of scale are the central additional condition in competitive capitalism to prevent capital accumulation. In monopoly capitalism, it is the prevention of the sales effort and an end of growth in government spending.[11]

A unique feature of Marxian theories is the inclusion of political power relations in the analysis. Either the capitalist class or the oligarchy is dominant in influencing political decisions. As several of the conditions for zero growth contradict their interests, the conditions are difficult to implement. The most promising perspective is that social (in particular labour, environmental and feminist) movements gain power and align forces to demand such conditions.

[11] These scenarios are explained in detail in section 19.2.

Chapter 21
Comparison of General Results

It is a challenge to compare and integrate the results from the investigation of overall 29 different theories from three different economic paradigms. In this chapter, the results from the three schools of thought are compared regarding three different aspects: whether zero growth is possible; the preanalytic views on the functioning of the economy, economic growth and zero growth; and the scenarios developed for each school. These three aspects concern results on a more general level. The concrete conditions for sustainable economies without growth are compared and synthesized in the subsequent chapters 22 and 23.[1]

21.1 Is Zero Growth Possible?

The central question of this work is not *whether* but *how* zero growth economies can be initiated. This presupposes that it is possible in principle. However, the investigation has also brought insights into the perspective of the three schools on *whether* it is possible.

The neoclassical theories see no fundamental problem with the establishment of zero growth economies. This is in line with the (limited) existing literature on the issue. For zero growth, the developments of the supplies and productivities of production factors have to be appropriate. As all markets clear, as unemployment cannot take place, as no monetary system is included and as accumulation of capital plays no role, there is also no problem related to zero growth.[2]

Keynesian theories also allow for zero growth. The major problematic issue is that zero growth leads to increasing unemployment under the common assumption of increases in labour productivity. Several solutions to this problem have been proposed (in particular, reduced working hours, redirected technological change and sectoral change).[3] A second issue is whether the monetary system is compatible with zero growth. Most prominently, Binswanger has argued that it is not. This work has put forward that Binswanger's growth imperative can be prevented by certain

[1] The following comparison is based on the investigations in parts (II – IV). In particular, it refers to the results in chapters 9, 14 and 19.

[2] Compare to the results from neoclassical theories in chapter 9.

[3] Compare to the results from Keynesian theories in chapter 14.

conditions – in particular by preventing continuous accumulation of assets in the banking sector.[4] Similar results have been found by previous research.[5]

Marxian approaches entail the strongest opposition to the feasibility of zero growth economies. There is an apparent contradiction between the results from the existing literature and the results from the present work. The state of research suggests that zero growth is impossible in capitalism. The major reason is that competition and profit maximization always lead to capital accumulation. Additionally, the power relations of capitalism prevent the radical changes that are necessary for zero growth.[6] The present work, on the contrary, has led to the development of conditions that facilitate zero growth. These conditions imply radical changes of important economic institutions – such as the ownership of firms and major determining factors of market dynamics (such as relative prices of production factors and diseconomies of scale). The apparent contradiction is resolved by taking into account that sustainable economies without growth would probably not be categorized as capitalist economies by Marxian authors. In particular, the collectivization of the means of production suspends of central capitalist institutions and dynamics. Hence, zero growth is possible from a Marxian perspective, but the result is a non-capitalist economic system.[7]

21.2 Three Perspectives Leading to Very Different Contributions

The three schools of economic thought have very different preanalytic visions (or perspectives) on the mechanisms and dynamics of economies. As a result, the schools also contribute different aspects to an understanding of sustainable economies without growth.

The neoclassical view focuses on the *supply of production factors and on the role of technological change*. Accordingly, its major contribution has been to indicate different potential developments of production factors and technological change in line with sustainable economies without growth. These are reflected in the three scenarios in the neoclassical part.[8] The neoclassical view also entails concrete explanations for the development of the supply of production factors. Several of them have been

[4] See section 12.3 for the discussion on Binswanger's theory.

[5] See chapter 10 for a discussion of the previous Keynesian research on this issue.

[6] The existing Marxian literature on this issue is summarized in chapter 15.

[7] Compare to the results from neoclassical theories in chapter 19.

[8] The scenarios can be found in section 9.2.

criticized on various grounds though.[9] This is why not all of them are included in the development of a model on sustainable economies without growth in chapter 23.

The Keynesian views combine considerations concerning *aggregate demand and supply*, with a focus on the former. Investments and technological change play particularly important roles, as they are the major connections between aggregate demand and supply. There are three major contributions from Keynesian theories regarding zero growth economies. First, they deliver the conditions for effective demand – the intersection between aggregate demand and supply – to stay constant over time. Second, Keynesian approaches reveal important conditions for investments to equal capital depreciation. Third, Keynesian theories are the only ones covered in this present study, that allow to investigate the conditions on savings and the monetary system in zero growth economies.

The key issue in facilitating zero growth in Marxian approaches is how capital accumulation can be brought to an end. Marxian views focus on the *economy as a system* and the *political economy*. The systemic approach provides insights concerning fundamental institutions of the economy. In particular, a collectivization of firm ownership and an introduction of diseconomies of scale depict radical institutional changes that are necessary to prevent further capital accumulation. The inclusion of power relations in the analyses facilitates a discussion not only on which conditions are necessary but also how these conditions can be implemented.

These contributions from the three schools of economic thought are to a large degree complementary, as they facilitate an understanding of sustainable economies without growth regarding different aspects of the economy. Chapter 22 discusses in more detail regarding which issues the schools of thought are complementary and how they contradict each other.

21.3 Scenarios From the Three Schools of Economic Thought

Different scenarios for sustainable economies without growth have been developed based on existing concepts for economies without growth and for each of the three schools of economic thought.[10] The scenarios represent different *sets of conditions* that lead to zero growth. In other words:

[9] The plausibility of single explanations are discussed and compared to those of the other schools of economic thought in chapter 22. A summary of the criticisms can be found in section 9.5. For more details, see also sections 6.4.2, 7.5.2 and 8.6.2.

[10] See chapters 4, 9, 14 and 19.

The scenarios indicate different paths of economic development that fulfil the criteria of sustainable economies without growth.

Table 21.1 gives an overview of the scenarios. One central finding is that the three scenarios from the existing literature have also been developed based on neoclassical and Keynesian theories. Those scenarios that are very similar to one another have been labelled with the same capital letter. The scenarios labelled (A) entail technological change that increases labour productivity[11] and reductions in average working hours. (B) marks scenarios in which the technological change is redirected so that it does not increase labour productivity but rather resource productivity. (C) are those scenarios in which a sectoral shift from dirty to clean products facilitates a reconciliation between zero growth and constant employment.

The other scenarios from the neoclassical and Keynesian theories cannot be placed exactly under one of these three labels. They are quite similar nevertheless. The second neoclassical scenario is depicted by an augmentation of labour, while the labour coefficient stays constant (due to the decrease in overall production as natural resource use declines). The outcomes are therefore very similar to the results of scenarios (A). The fourth Keynesian scenario is simply a combination of scenarios (B) and (C).

The Marxian scenarios are organized along different lines and therefore focus on other aspects. Different sets of conditions have been developed based on different assumptions concerning the constitution of the economy (competitive vs. monopoly capitalism). The Marxian scenarios are consequently difficult to compare to the other scenarios. This does not necessarily imply that the Marxian scenarios stand in conflict with the other scenarios but is rather the result of the choice of how to organize the scenarios in the part on Marxian theories.

In general, different scenarios are often complementary and compatible. This is true for different scenarios from one school of economic thought as

[11] Note that the different theories use different terms for types of technological change. In neoclassical theories, technological change that increases the productivity of a factor is usually called labour-*augmenting* or resource-*augmenting*. The idea is that the technological change *augments* the productivity of the factor. In Keynesian theories, technological change has commonly been discussed regarding how the labour or resource *coefficients* develop. For example, increasing labour productivity implies a decreasing labour coefficient. In Marxian theories, technological change implies that the *organic composition of capital* is altered. For example, increases in the organic composition are accompanied by increasing labour productivity.

Table 21.1: Scenarios From the Three Schools of Economic Thought

	1st Scenario	2nd Scenario	3rd Scenario	4th Scenario
Existing concepts	Increasing labour productivity and reductions in average working hours. (A)	Redirected technological change. (B)	Sectoral change. (C)	
Neoclassical theories	Increasing labour productivity and reductions in average working hours. (A)	Increasing labour productivity and reductions in natural resource use.	Redirected technological change and reductions in natural resource use. (B)	
Keynesian theories	Increasing labour productivity and reductions in average working hours. (A)	Redirected technological change due to changes in input prices. (B)	Sectoral change due to shifts in demand. (C)	Redirected technological change and sectoral change.
Marxian theories	Competitive capitalism: collective firms, changes in input prices and diseconomies of scale.	Monopoly capitalism: collective firms, changes in input prices and no sales effort.		

well as for scenarios from different schools. The reason is that the scenarios often represent a focus on a specific mechanism.

The three mechanisms of the three neoclassical scenarios can be combined. The resulting economic development would be characterized by reductions in average working hours, reductions in natural resource use and technological change that is both labour-augmenting and resource-augmenting technological change. The underlying cause would be a partly redirection of technological change. Similarly, the different Keynesian scenarios can be combined. The result is an economy with reductions in average working hours, a (partly) redirection of technological change and sectoral change. The same is also true for the Marxian scenarios. If it is assumed that the real economy is a mixture between competitive and monopolistic markets, a combination of the conditions from the two scenarios supports zero growth[12].

A combination of the scenarios from different schools of thought is developed in chapter 23. Before this is possible, it is necessary to discuss in how far single macroeconomic conditions from the different schools of thought are complementary or contradicting.

[12] This integrated perspective has been discussed in section 20.4.

Chapter 22
Synthesis of Macroeconomic Conditions

The previous chapter has mainly *compared* the results from the three schools of economic thought. This current chapter starts to *synthesize* the results. The approach is to integrate the different results by use of a specific pluralist method, which is shortly explained in section 22.1. The method is applied to the seven areas of macroeconomic conditions already known from the discussion on the existing concepts for economies without growth (in chapter 3):[1] (1) environmental regulation, (2) investments and capital depreciation, (3) business types, (4) consumption and government spending, (5) employment, (6) distribution and (7) monetary system and savings (sections 22.2 – 22.8).

Most of the conditions from the different schools prove to be of complementary rather than conflicting nature. Only few conditions are clearly contradictory. These are discussed in more detail, in order to either find ways to integrate them or to argue which of them can be dismissed. Many of the conditions are similar to the macroeconomic conditions in the four concepts from the existing literature in chapter 3.

At the end of each section, the central conditions within the respective area are highlighted. These serve as the building stones for the model of sustainable economies without growth in chapter 23.[2]

22.1 Method to Compare and Synthesize

A specific pluralist method is used in the following investigation. It has been developed by Dobusch and Kapeller (2012) and provides an applicable method that concretely points out how a certain object of enquiry (in this case sustainable economies without growth) can be investigated by using a plural set of theories. Dobusch and Kapeller (2012) develop what they call "interested pluralism [... which represents] a striving for constructive interaction between different theoretical traditions in order

1 Note that two areas are extended to incorporate a wider set of relevant conditions: The area *consumption* is now *consumption and government spending* and *monetary system* is now *monetary system and savings*.

2 The following synthesis is based on contents from parts (I – IV). In particular, it refers to the conditions developed in chapters 3, 9, 14 and 19.

to come up with an improved and expanded set of relevant explanatory statements" (p. 1043).

The major argument underlying interested pluralism is as follows: Theoretical statements from different economic schools of thought concerning a specific object of enquiry are by the great majority complementary or capable of being integrated, rather than being contradictory or even mutually exclusive. In their words:

> [W]e argue that this engagement [between different schools of economic thought] would be most productively realized at the level of theoretical statements, dealing with distinct empirical phenomena. [...] This would allow pluralist practices to be interpreted as complementary research strategies, whose orientation depends on the relationships between different theoretical statements stemming from distinct schools of economic thought (Dobusch and Kapeller, 2012, p. 1050).

Dobusch and Kapeller (2012) argue that theoretical statements from different schools of thought can have six different relationships: Statements can be *identical*, *convergent*, *compatible*, *neutral*, *divergent* or *contradictory*. These different relations between theoretical statements relate to four different pluralist strategies to deal with them (for an overview see table 22.1):[3]

Table 22.1: Relations Between Theoretical Statements and Pluralist Strategies

Relations between theoretical statements		Pluralist research strategies		
(1) ⇒⇐	Identical	} (a)Integration (rows 1–3)		
(2) ↗↖	Convergent			
(3) ⇈	Compatible		} (b) Division of labour (rows 3–4)	
(4) OO	Neutral			} (c)Diversification (rows 4–6)
(5) ↖↗	Divergent	} (d) Test of conflicting hypothesis (rows 5–6)		
(6) ⇐⇒	Contradictory			

Adapted from Dobusch and Kapeller (2012, p. 1050).

1. *Integration:* When statements are identical, convergent or compatible, it is possible to integrate them. Integration presupposes that the statements are on a similar subject so that they can be integrated into a more meaningful explanation of that subject. One example of

[3] For a more detailed explanation of the theoretical statements and the pluralist strategies see Dobusch and Kapeller (2012, pp. 1050 – 1053).

integration is the incorporation of the Marxian argument that investments are due to competition between firms, into a Keynesian theory of macroeconomic investments.[4]

2. *Division of labour:* When statements are compatible or neutral, they can coexist as they do not contradict each other, but can also not be integrated. An example are the issues of the monetary system (see section 12.3) and technological developments in zero growth economies (an important issue throughout this work). Both issues concern economies without growth but cannot be integrated as they regard different aspects of the economy..
3. *Diversification:* When statements are neutral or divergent, a "recombination of statements taken from different theoretical contexts" (p. 1052) can lead to a more differentiated perspective on the subject for "(apparently) incompatible" (p. 1052) statements from different theories. An example brought forward by Dobusch and Kapeller (2012), which concerns the topic at hand, are the contradicting views on economic growth from ecological and Keynesian economics.[5] This apparent contradiction is resolved or at least differentiated by showing how constant employment is derived despite the absence of economic growth.[6]
4. *Test of conflicting hypotheses:* When statements are divergent or contradictory, it is not possible to combine them fruitfully in one analysis. In this case, Dobusch and Kapeller (2012) argue for empirical tests to settle the issue. An example in this work is the explanation of increases in labour productivity. While neoclassical theories argue that pure technological progress is the reason, ecological economists point out that increases in energy (useful work) inputs are necessary.[7]

Dobusch and Kapeller (2012) argue that this type of examination requires a detailed comparison between different theories and considerable patience and pragmatism:

> The conception of a pluralist paradigm, as outlined in this paper, is surely demanding, and requires, above all, pluralist economists who

[4] This incorporation has been done by Kalecki et al. (1987) and is pursued in chapter 23.

[5] While ecological economics regard an end of economic growth as necessary for environmental sustainability (see section 2.2.3), Keynesian economists argue that growth is necessary for full employment (see part III).

[6] This argument has been made in chapter 14 and is incorporated into the synthesis of chapter 23.

[7] Compare to the debate in section 2.2 between environmental (neoclassical) economics and ecological economics.

> are content — and sufficiently flexible — to work in a pluralist tradition. They need to be able to carefully compare different economic approaches and recognize their similarities and complementaries, while retaining a patiently pragmatic stance on potential contradictions, without ignoring them (p. 1053).

This is attempted in the course of the following investigation.

22.2 Environmental Regulation

The first of the seven areas is environmental regulation. It sets important parameters for the macroeconomic framework, in particular concerning the costs of input factors. This central role concerning input prices has also been highlighted in existing concepts for economies without growth (see section 3.6.1). There, various concrete proposals for environmental policies have been put forward. The contribution of this present study has been to set such environmental regulation into relation with macroeconomic theories and with other conditions for zero growth.

22.2.1 Neoclassical Conditions

In the neoclassical theories, environmental aspects are usually included as a third production factor – as natural resources.[8] An important feature of neoclassical theories is that substitution between production factors is possible. It depends on the relative prices of the factors and the elasticity of substitution, which is technologically determined (by the production function). The substitutability can therefore change due to technological change.[9]

The central condition for zero growth (regarding environmental regulation) is limiting the availability of resources. This leads to a substitution of natural resources by physical capital and/or labour. Given a constant supply of labour and a certain state of technology, production per capita is lower for a lower supply of natural resources. A certain speed of technological change (either labour-augmenting or resource-augmenting) combined with a reduction of natural resource supply leads to constant production.[10]

The type of technological change that takes place depends on the relative prices of the production factors. Increasing the price of natural resources steers technological change towards being less labour-augmenting

[8] Another common way of including environmental aspects is pollution. The types of models are very similar, see chapter 8.

[9] Compare in particular to chapter 8.

[10] See the results from neoclassical theories in chapter 9.

and more resource-augmenting. This process can further be supported by subsidies into research on resource-augmenting innovations.[11]

In sum: Changes in relative input prices, limits on natural resources and subsidies on resource-augmenting innovations support the application of technologies with a lower resource coefficient.

22.2.2 Keynesian Conditions

In the Keynesian theories, the environment has also most commonly been integrated as a natural resource (or materials). Contrary to the neoclassical approaches, a substitution between production factors for a given state of technology is very limited or impossible. Changes in relative input prices therefore primarily have an influence on the direction of technological change.[12]

Additionally, the type of consumption by households and governments plays an important role. They can *decide* whether to consume dirty or clean goods and thereby change the overall labour and resource coefficients.[13]

To summarize: Changes in relative input prices and limits on natural resources support the development of technologies with a lower resource coefficient. Additionally, consumption decisions by households and the government lead to sectoral change.

22.2.3 Marxian Conditions

In the Marxian theories discussed, the availability of cheap fossil fuels is regarded as a central prerequisite for increases in labour productivity, profit generation and capital accumulation. A central condition for economies without growth and environmental sustainability is therefore to limit the supply of fossil fuels. In Marxian thought, as in the other schools, this can be done via absolute limits and/or increases in prices, e.g., due to environmental taxation.[14]

A further issue in Marxian theories is the prevention of economies of scale and the introduction of diseconomies of scale (see section 22.3).

[11] The determinants of the direction of technological change have been most intensively been discussed in the theories on directed technological change, see sections 7.4 and 8.5.

[12] Different types of technologies in Keynesian theories play central role in Robinson's approach, see section 11.7.

[13] This issue has been discussed based on Harris' theoretical contributions, see section 13.2.

[14] These issues have been discussed in chapter 18 on ecological Marxian theories.

Environmental regulations overlap with the measures for diseconomies of scale – e.g., increases in transport due to increasing prices of fossil fuels.[15]

In sum: Changes in relative input prices and limits on natural resources are also important in Marxian theories to redirect technological change. Additionally, environmental regulation can contribute to support diseconomies of scale in order to avoid economic expansion.

22.2.4 Comparison and Synthesis

Central conditions resulting from the three schools of thought are *identical*. All three argue for limits to and/or increasing prices of natural resources and emissions. Other conditions are *compatible*. In particular, the changes in prices support the sectoral change and the sectoral change – induced by changes in the behaviour of households and the government – make changes in prices less detrimental to social welfare. The introduction of diseconomies of scale and changes in relative input prices are also *compatible*, as they overlap in the concrete policies suggested. Also, small-scale production is arguably depicted by technologies with higher labour and lower resource coefficients. Finally, diseconomies of scale and sectoral change are arguably *compatible*, as local production tends to produce more labour-intensive goods.

Regarding environmental regulation, an *integration* of the conditions is therefore applicable. The four conditions of (1) **changing relative input prices**, (2) **limiting the availability of natural resources and fossil fuels**, (3) **shifting demand from dirty to clean goods** and (4) **introducing diseconomies of scale** are complementary in nature and support the goals associated with them. These are (1) **a redirection of technological change**, (2) **sectoral change** and (3) **fewer incentives for firms for large investments to extend production**.

22.3 Investments and Capital Depreciation

The level of investments and the speed of capital accumulation are central determinants of economic growth. Existing concepts on economies without growth (see section 3.6.2) also emphasize their importance. They put forward a combination of investments in clean sectors and disinvestments (faster capital depreciation) in dirty sectors. This present investigation has focused on the overall level of investments in zero growth economies instead.[16]

[15] See chapter 16 on Marx's theory.

[16] Future research could improve the integration of disinvestments into the analysis of macroeconomic theories (see also chapter 25).

22.3.1 Neoclassical Conditions

Investments and capital accumulation play a comparatively passive role in neoclassical theories and in the zero growth scenarios developed based on them. The reason lies in the decreasing marginal productivity of physical capital. Without an increase in the supply of another production factor or technological change, capital accumulation comes to an automatic end. As long as this point is not reached, savings are the central determinant of the level of investments. The higher the willingness of households to save, the lower the interest rate is and the larger investments are. The willingness is determined by individuals' time preferences for consumption.[17]

Regarding the conditions for zero growth, the level of production can thus only be changed by savings behaviour and investments. Whether the economy continuously grows depends on other factors – in particular technological change.[18]

22.3.2 Keynesian Conditions

Investments are the central determinant of economic growth in Keynesian theories. There seems to be a contradiction between this statement and the analysis that investments also come to an end in Keynesian theories when no technological change takes place (due to the decreasing marginal efficiency of capital) and when there is no increase in aggregate demand. The central difference to neoclassical theories, however, is that investments are also the primary cause for these two factors. Investments trigger technological change and increase income and thereby consumption demand. Investments are thus at the centre of the dynamics of the economy.

The crucial condition for zero growth is that investments are equal to capital depreciation.[19] In Keynesian theories, the determinants of investments are very different than in neoclassical theories. Savings only play a minor role. Instead, it is central that (actual and expected) aggregate demand has to stay constant. There is therefore a mutual dependence between two important conditions for zero growth: Investments need to stay constant in order to have constant aggregate demand and aggregate demand has to stay constant in order for investments not to increase. Further determinants of investments are the costs of capital goods, the

[17] These issues have been discussed in detail in the fundamental neoclassical theories in chapter 6.

[18] Compare to the results from the neoclassical theories in chapter 9.

[19] This is the case when technological change keeps the capital coefficient constant. Otherwise, investments need to slightly deviate from the level of capital depreciation, as discussed in chapter 14.

existing types of business entities, the level of competition and the level of the existing capital stock. These factors need to be in a constellation that leads to investments at the level of capital stock in zero growth economies.[20]

22.3.3 Marxian Conditions

The determinants of investments differ significantly between the two central Marxian approaches discussed in this present study. In Marx's theory, the level of investments is equivalent to the size of surplus value, as firms are coerced into reinvesting due to price competition.[21] In the Theory of Monopoly Capitalism, investments are relatively low and depend on effective demand.[22]

The conditions for zero growth relate to both arguments. First, the ability to extract surplus value can be prevented by collectivizing firms. Second, the coercion of reinvestments beyond the replacement of existing production capacities can be tackled by introducing diseconomies of scale. Third, an increase in effective demand can be prevented, in particular by limiting firms' strategies to increase consumption demand, such as commercials. The collectivization of firms also prevents such strategies as collective firms have fewer financial resources (retained earnings) available for such purposes. Fourth, retained earnings above the level that is necessary to replace capital depreciation can be taxed/appropriated by the state in order to discourage positive net investments.[23]

22.3.4 Comparison and Synthesis

The three schools of thought have very different views on investments. The determinants differ significantly, however. Not only are the determinants different, the theories even contradict each other on central issues. In the following, it is argued that this contradiction can at least partly be resolved when it is differentiated between different *dimensions* (or understandings) of investments and savings.

The neoclassical theories can be interpreted in a *real* or a *monetary* dimension. For example, Solow's model[24] can be interpreted as a theory relating to real terms: A certain given fraction (due to the savings rate) of production is used for the production of capital goods rather than con-

[20] See in particular the fundamental keynesian theories in chapter 11.

[21] This point is based on Marx's theory, see chapter 16.

[22] This is based on the Theory of Monopoly Capitalism in chapter 17.

[23] See the detailed discussion on the results from Marxian theories in chapter 19.

[24] See section 6.2.

sumption goods. But the mechanisms of more recent theories suggest an interpretation in the monetary dimension. For example, they entail that the decisions of individuals between consumption and savings influence investments. This has to take place on a monetary, rather than real dimension, as it is necessary to introduce the mechanism of the interest rate. Higher savings increase the supply of money, which decreases the interest rate and fosters investments.[25]

Keynesian approaches analyse investments primarily using a *monetary* dimension. Firms take out a loan in order to invest. This generates higher employment and household income in monetary terms. Households save part of their income, in the sense that they put it in a bank account. In this manner, monetary investments generate monetary savings. This also includes a real dimension: Larger investments lead to the production of additional capital goods and, via the increase of income, also to additional demand for and production of consumption goods.

The Marxian theories discussed here even entail three different dimensions. First, Marx's theory is on the dimension of *labour values*. A certain part of the value produced is extracted as surplus values and used for purposes of capital accumulation rather than consumption. A second manner to interpret his theory is that it regards a *real* dimension: A part of labour is attributed to the production of goods (machines and consumption goods to feed additional workers) which facilitate additional production in the next period instead of producing consumption goods (for workers and capitalists) for this period.[26] Third, the Theory of Monopoly Capitalism can rather be interpreted as relating to the *monetary* dimension: Here, large firms make large (monetary) profits, which they aim to reinvest.[27]

This differentiation between dimensions allows to indicate in which way the theories contradict each other, and where they are similar or complementary. In the *real* dimension, the Keynesian and Marxian theories are identical. Investments imply that additional capital and consumption goods are produced. In neoclassical theories, investments only refer to additional capital goods. The general idea is still the same, though. The *labour value* dimension is only used by Marxian approaches. Therefore, an integration is not possible.

The *monetary* dimension is probably most controversial and most important. There is a clear *contradiction* between the neoclassical and the Keynesian approach. In neoclassical theories, savings are a central prerequisite for investments. In Keynesian theories, on the contrary, investments

[25] These microfoundations have been introduced in section 6.3.

[26] These first two dimensions are based on Marx's theory in chapter 16.

[27] See chapter 17 for the Theory of Monopoly Capitalism.

generate its appropriate savings. It could be attempted to integrate the two approaches by arguing that the influence of savings on investments is one among many aspects which influence investments. This is not possible, though, as it would contradict central aspects of neoclassical theories and would lead to the dismantlement of other essential neoclassical mechanisms.[28]

In the following, the neoclassical approach is dismissed and the Keynesian perspective is adopted. The reason is that the Keynesian understanding of the monetary system seems to be significantly more in line with the functioning of the real world monetary system than the neoclassical theories.[29]

There is also a difference between the Keynesian and the Marxian approach concerning the monetary dimension. In the Keynesian approach, investments are financed by loans. In the Marxian, they are financed by profits. These two potential finances of investments do not contradict each other, though. Firms can use both sources of finance. Also, it appears that the inclusion of the other type of investment into the theory does not constitute a fundamental problem to either of the theories. In fact, Keynesian authors such as Kalecki and Binswanger include finance out of profits. Likewise, the ability to finance investments out of loans does not contradict the drive to maximize profits, exploitation or other central mechanisms in Marxian theories.

To summarize: In the real dimension, the differences are small and therefore *compatible*. In the dimension of the labour value theory, only Marx's theory can contribute – hence a *division of labour* can be pursued. In the monetary dimension, the neoclassical approach has been discarded (due to a *test of conflicting hypothesis*) while the Keynesian and Marxian approaches are *compatible*.

As a result, the concrete conditions are primarily combinations between the Keynesian and Marxian theories. The **constant levels of consumption demand by households and the government** play *identical* roles in Keynesian and Marxian theories. The issue of **collective firm own-**

[28] The interest mechanism brings savings and investments into equilibrium in neoclassical theories. Assuming that it is only one among many other determinants of investments and savings repeals the reason for a general equilibrium, which is a central feature of neoclassical theories.

[29] This is therefore a case of *contradiction*, in which Dobusch and Kapeller (2012) propose a test of hypothesis. As an empirical test is outside the scope of the present work (and also difficult to conduct in general, as both approaches argue for a correlation between savings and investments, only the causal direction differs), here the decision is made based on what is theoretically more convincing.

ership is *convergent*, as there are different ways of reasoning why it is necessary in the different theories which do not contradict each other. Multiple additional conditions to keep investments at the level of capital depreciation (**diseconomies of scale, regulating the sales effort, policies to increase the costs of capital goods and investments, taxation and appropriation of profits**) are each only emphasized by one of the schools but are *compatible*, as they work towards the same goal and do not contradict the other theory. The central effect of all these aspects is that **gross investments are equal to capital depreciation** (which is shared by all three schools of economic thought).

22.4 Business Types

The major connection between business types and the dynamics of (zero) growth is whether revenues are used for wages, investments or the sales effort. The relation between business types and investment behaviour is also included in existing concepts on economies without growth (see section 3.6.3). The issue of the sales effort has (to the best of my knowledge) not been related to business types thus far and is therefore a new contribution of this present study. It should also be mentioned that a central issue discussed in the existing literature has not been part of the present work: the role of prosumers, commons and other manners to organize production and consumption.[30]

22.4.1 Neoclassical Conditions

In many neoclassical theories, there is only one type of firm. Firms are small so that they are price takers. They are privately owned and profit maximizers. Due to perfect competition, firms' revenues are entirely used for the compensation of physical capital and labour according to their marginal productivities.[31]

In some theories (in particular the endogenous growth theories), certain sectors are monopolistic. Typically, these sectors are the ones that generate innovations. The reason is that monopolistic profits are necessary to generate investments in research and development.[32]

The role of different business types has not been discussed concerning neoclassical theories. The underlying reason is that the neoclassical

30 See section 3.6.3. These issues are difficult to integrate into the traditional paradigms of economic thought. Future research could integrate such issues into macroeconomic theories (see chapter 25).

31 See the Basic Macroeconomic Model in section 6.1.

32 Monopolistic attributes are discussed in endogenous growth theories in chapter 7.

theories themselves do not attribute much attention to this issue. Subsequently, the investigation of the neoclassical theories does not contribute to the issue which business types are necessary for sustainable economies without growth.

22.4.2 Keynesian Conditions

Similarly, there are only few Keynesian theories that put an emphasis on business types. One exception is Kalecki,[33] who introduces the notion that firms have market power and can subsequently charge a price above unit costs. The degree of monopolistic power is the major determinant of the profit share. For Kalecki, the business type thus mainly refers to distributional issues. A second exception is the work of Binswanger.[34] He connects certain business types with certain investment behaviour, which influences economic growth. The common business type is the shareholder-owned firm. Such firms have a strong incentive to reinvest profits rather than distribute them as dividends. This is the major cause for investments and economic growth in Binswanger's theory.

A central condition for zero growth economies is therefore to prevent such incentives for businesses/firms to use a large share of revenues for investments. One possibility is to change the businesses towards worker-owned entities. Collective ownership leads to altered incentive structures within the firms. Instead of using revenues for investments, collective firms have a higher incentive to increase wages, improve working conditions and reduce average working hours. Overall, they therefore lead to a lower level of investments and thus, economic growth.[35]

22.4.3 Marxian Conditions

The constitution of firms plays a central role in Marxian theories. In Marx's theory, private ownership of means of production is necessary for exploitation, the generation of surplus value and hence for investments and economic growth.[36] In the Theory of Monopoly Capitalism, the interests of managers and shareholders determine firms' activities. Managers want the firm to grow for personal prestige. Rich shareholders have an interest in firms increasing the value of their shares (rather than paying large dividends). These interests lead to profit maximization and the increasing

33 See section 11.5.

34 See section 12.3.

35 Compare to the results from the Keynesian theories in chapter 14.

36 Compare to the discussion of Marx's theory in chapter 16.

role of the sales effort, which is aimed at increasing effective demand and thus economic growth.[37]

A central condition for zero growth within Marxian theories are therefore business types that do not facilitate exploitation and do not generate large retained earnings. It has been argued that collective firms (where either workers or a wider set of stakeholders decide democratically) support zero growth. In particular, revenues are used to increase wages rather than positive net investments or the sales effort.[38]

22.4.4 Comparison and Synthesis

There are two different understandings of firms' constitutions across the three schools of thought: a competitive and a monopolistic one. In neoclassical and in Marx's theory, firms are small and have to act according to market forces. They have no market power and therefore do not possess agency in the sense that somebody in the firm can take decisions and thereby change macroeconomic outcomes. The central condition resulting from Marx's perspective is that collective ownership structures are necessary to prevent exploitation and capital accumulation (this has to be combined with diseconomies of scale in order to be a sufficient condition for zero net investments).[39]

In Keynesian theories and the Theory of Monopoly Capitalism on the contrary, firms are large and have market power. They possess a certain degree of agency over the prices they charge and whether they use revenues for wages, dividends, investments or the sales effort. At the same time, they are far from being entirely free in these decisions as they still have to compete among market shares.

A first reason for the condition of collective firm ownership is (almost) *identical* between the Keynesian and the Marxian perspective: In shareholder-owned firms, the shareholders have an interest in reinvestments in order to increase the value of their shares.[40] Worker-owned firms on the contrary have a primary interest in increasing wages. This first reason is *compatible* with the second reason brought forward by the Theory of Monopoly Capitalism: In the existing economic system, managers use profits for investments and the sales effort in order to gain prestige. When managers have to respond to the employees (who are at the same time

[37] Compare to the discussion on monopoly capitalism in chapter 17.

[38] Compare to the results from the Marxian theories in chapter 19.

[39] In neoclassical theories a collectivization of firm ownership would make no difference as firms make no profits above capital compensation in the first place.

[40] While Binswanger (2006a) argues for this case in general, Baran and Sweezy (1966) only regard it as in the interest of rich shareholders.

owners) of firms, they follow other goals – such as working conditions and high wages. The two reasons are compatible as both make **collective firm ownership** necessary to prevent economic growth.

22.5 Consumption and Government Spending

The central role of consumption and government spending is to stay constant in size and shift towards clean products in zero growth economies. These results are also part of the state of research on the issue (see section 3.6.4). The issue of advertising is also important both in the existing literature and in this present work. One issue emphasized by the state of research has not been discussed here: the role of structural obstacles and social dynamics concerning consumption.[41]

22.5.1 Neoclassical Conditions

Neoclassical theories of consumption are related to the supply of labour and savings. First, households supply labour in order to receive income that they can use for consumption. A high preference for consumption therefore increases the labour supply. Second, households save money in order to receive interest rates and be able to consume more in the future.[42] Government spending plays no important role in the neoclassical theories covered in this work.

The central condition for zero growth regarding consumption is that the preferences connected to it facilitate a labour supply in accordance with a constant level of production. In the case of labour-augmenting technological change with increasing labour productivity,[43] households need to have a strong preference to use increases in hourly wages for additional leisure rather than more consumption – so that average working hours decrease. In case of technological change with constant labour productivity,[44] preferences have to generate constant consumption and labour supply, as there are no changes in wages.

22.5.2 Keynesian Conditions

In Keynesian theories, consumption is primarily a central component of aggregate demand. The consumption level thereby influences the level of production at a given point in time and also influences investment decisions and economic growth. The central determinants of consumption

[41] This also depicts a possible field of future research, see chapter 25.

[42] These issues are discussed in most detail in the Basic Macroeconomic Model in section 6.1.

[43] As developed in scenario I in chapter 9.

[44] Developed in scenario III in chapter 9.

are the level of income and the propensity to consume. The latter depends on the level of income inequality and on preferences/attitudes.[45]

Government spending is important in Keynesian theories. It is also a central component of aggregate demand and therefore plays a similar role as consumption. In some theories, it is argued that increasing government spending is necessary to bring effective demand at the level of full employment. The reason is that technological change decreases employment and income, so that additional demand is needed.[46]

Regarding zero growth economies, the sum[47] of consumption and government spending needs to stay constant so that firms have no incentive to expand capacities. This implies that increases in labour productivity are accompanied by decreases in average working hours to keep income and consumption constant. In this way, expanding government spending is also not necessary in order to achieve full employment. In Keynesian theories, average working hours are rather the result of a societal bargaining process (in particular between workers and firm owners) than individual choices (as is the case in neoclassical theories). Therefore, strong labour unions and legislative support by the government are necessary to facilitate appropriate reductions in working hours.[48]

A further condition for sustainable economies without growth is the shift of private consumption and government spending from dirty to clean goods. This not only decreases the amount of resources needed for production but also increases the level of employment, so that reductions in average working hours are less important or rendered unnecessary (see scenario III in chapter 14).

22.5.3 Marxian Conditions

In Marxian theories, the level of consumption has an ambivalent relation to the speed of economic growth. In competitive capitalism, high consumption requires high wages, which implies lower profits and lower investments. Here, high consumption therefore goes hand in hand with low (or even no) economic growth. Low wages and consumption allow for large investments. These run into realization problems, though, due to the lack of consumption demand – crises are the result. In monopoly

45 These issues are in particular emphasized by Keynes, see section 11.1.

46 See the theories by Keynes (11.1) and Davidson (12.1).

47 To keep things simple, the possibility of a shifting relation between consumption and government spending is not discussed here.

48 This argument has been elaborated in more detail in scenario I in chapter 14.

capitalism on the contrary, there is a chronic lack in effective demand, so that any increase in consumption leads to more production.[49]

A unique feature of Marxian theories is the role of the sales effort. In monopoly capitalism, large parts of firms' revenues are used for the sales effort which is aimed at increasing consumption demand. Additionally, increases in government spending help to increase effective demand.[50]

Regarding zero growth, consumption also needs to stay constant over time in Marxian theories. As consumption is mainly out of wage income, this requires constant wages. Constant private consumption also requires a reduction or abolishment of the sales effort. Additionally, the government needs to keep spending constant. Due to the political economy of monopoly capitalism, both aspects (a reduction of the sales effort and constant government spending) require a fundamental change of the constitution of firms. Monopolistic firms generate large profits, which are used for the sales effort or to lobby for higher government spending. A collectivization of firm ownership would lead to higher wages and lower profits, which would help to prevent the sales effort and lobbying.[51]

22.5.4 Comparison and Synthesis

The theoretical understandings of the role of consumption and government spending regarding economic growth are very different. While consumption is solely the motivation for labour supply in neoclassical theories, it is an integral part of effective demand in Keynesian and Marxian theories. And while government spending is not part of the neoclassical theories covered here, it is of crucial importance for effective demand in the other two schools of thought.

The result is that the central conditions are similar between the theories while the underlying causes differ significantly. All theories come to the result that the level of consumption is approximately constant in zero growth economies. In neoclassical theories, this is due to **preferences for leisure**, while in the other two it is mainly due to **a constant level of income** and in particular **a constant level of wage income**. A **reduction in the sales effort** is necessary for constant consumption from the perspective of Marxian theories. A **collectivization of firms** facilitates this. Additionally, Keynesian theories emphasize a **shift of consumption from dirty to clean goods**. As these conditions are either *identical*, *convergent* or *neutral*, they can be *integrated*. That is, the

[49] See Marx's theory in chapter 16.

[50] Compare to the Theory of Monopoly Capitalism in chapter 17.

[51] These results are based on the discussion in chapter 19.

introduction of these conditions all help to facilitate a **constant level of consumption**.

In all theories, reductions in average working hours play a central role. In neoclassical theories these are again due to **preferences for leisure**, while they are due to **societal negotiation processes and incentives** in the other two theories. These two conditions are *compatible* and can be combined to achieve **reductions in average working hours**.

Keynesian and Marxian approaches put an *identical* importance on constant government spending while it plays no role in neoclassical theories. Moreover, the Keynesian theories emphasize the role of a **shift of government spending from dirty to clean goods**. Based on Marxian political economy, a **collectivization of firms** helps to make such governmental decisions possible. Additionally, strong **social movements** can help to enforce it. These conditions are also *compatible* and help to generate a **constant level of government spending**.

22.6 Employment

In the state of research on employment in economies without growth (section 3.6.5), three strategies to prevent unemployment have been indicated: reductions in average working hours, redirected technological change and sectoral change. These strategies also play the central roles in the conditions found in this present study. The investigation of macroeconomic theories on the issue has additionally covered the underlying economic mechanisms for these three strategies.

22.6.1 Neoclassical Conditions

In neoclassical theories, employment is mainly a matter of labour supply. As there can be no unemployment, the labour supply determines the amount of employment. It depends primarily on preferences and on the hourly wage.[52]

The relation between zero growth and employment depends primarily on the type of technological change. When technological change increases labour productivity, preferences need to be of such type that individuals opt for reductions in working hours rather than higher income. When tech-

[52] This argument is based on the discussion regarding the Basic Macroeconomic Model in section 6.1. There, it is pointed out that households are willing to work more for higher wages. This has been criticized as one can also argue for lower labour supply for higher wages. Due to this ambivalent relation, the issue is not included here.

nological change does not change labour productivity, the labour supply must stay stable.[53]

22.6.2 Keynesian Conditions

In Keynesian theories, the level of employment is determined by effective demand and the labour coefficient. Effective demand determines the level of production. The labour coefficient defines how many hours of labour are necessary for that level of production.[54]

In zero growth economies the level of production stays constant. The amount of employment therefore depends on the direction of technological change and on changes of average working hours. To achieve a constant level of employment, average working hours have to change to the same extent as the labour coefficient changes.[55]

A further issue is sectoral change. When clean sectors have a larger labour coefficient than dirty sectors, a sectoral change increases employment and therefore decreases the necessary speed of reductions in average working hours to keep employment constant.[56]

22.6.3 Marxian Conditions

In Marxian theories, capitalist economic growth has ambivalent effects on the level of employment. On the one hand, an expansion of production requires more workers. On the other hand, the introduction of new technologies increases the organic composition of capital and therefore decreases the labour coefficient. The result is a constant generation of a reserve army of workers, that is, constant unemployment.[57]

Two central conditions support constant employment in zero growth economies in Marxian perspective. First, labour productivity increases more slowly (or stays constant) because energy is made more expensive. This tends to decrease unemployment.[58] Second, collective firms have been argued to reduce working hours instead of firing staff, i.e., members of the collective.[59]

[53] See the results from the neoclassical theories in chapter 9.

[54] See the fundamental keynesian theories in chapter 11.

[55] This argument has been developed in detail in chapter 14.

[56] The issue of sectoral change has been discussed based on Harris' theory in section 13.2.

[57] This argument is based on Marx's theory in chapter 16.

[58] This relation has been argued for in chapter 18 on ecological Marxian theories.

[59] Compare to chapter 19.

22.6.4 Comparison and Synthesis

Again, the theoretical understandings of the connection between the level of production and employment differ significantly between the theories. At the same time, the resulting conditions do not contradict one another.

First, a **redirection of technological change** leads to fewer increases in labour productivity and subsequently to more employment. The underlying conditions have been discussed above (section 22.2). Such a redirection is compatible with all three schools of thought.

Second, a **sectoral change** also slows down increases in average labour productivity. The conditions for sectoral change have been discussed in sections 22.2 and 22.5. Neither does it contradict any line of thought of the three theories.

Third, reductions in average working hours at the speed of increases in labour productivity are necessary to keep the employment level constant. The underlying conditions differ between the theories. In neoclassical theories, it is a **preference for leisure**. In Keynesian thought, the main reason put forward are **societal negotiation processes**. Based on Marxian theories, **collective firms** can support such changes. These conditions are *compatible* and all help to facilitate **reductions in average working hours**.

22.7 Distribution

The present work comes to similar conclusions concerning distribution as the existing concepts for economies without growth (see section 3.6.6). Low economic inequalities are regarded both as an explicit objective to achieve high social welfare[60] as well as a condition for zero growth economies on various grounds.

22.7.1 Neoclassical Conditions

The issue of distribution plays a comparatively small role in the neoclassical theories discussed in this work. Alterations in macroeconomic conditions change the functional income distribution. As a representative household is assumed throughout the theories covered in this present study, this has no impact on the individual income distribution, though. Also, no conditions for zero growth economies with regard to economic inequalities have been deduced from the neoclassical theories.[61]

[60] The relation between economic inequalities and social welfare has been covered in section 2.1.3.

[61] See also the summary on neoclassical results in chapter 9.

22.7.2 Keynesian Conditions

Keynesian theories entail two important views on the distribution of income. The first relates to the functional income distribution and divides the society into workers and capitalists. Here, the decisions of capitalists determine the functional income distribution. The more capitalists invest and consume, the higher are the profits.[62] The second view is based on the personal income distribution. Here, the consumption decisions of households are important. The more unequal the income distribution, the lower is the overall consumption rate. As consumption is an important component of aggregate demand, lower consumption leads to fewer investments and reduced economic growth.[63]

The central condition regarding distribution in zero growth economies is to obtain low income inequality in order to facilitate low investments. This condition can be viewed from the perspective of investments and from the perspective of savings. First, zero growth economies are depicted by low investments (at the level of capital depreciation). This leads to low profits (as the level of investments is an important determinant of it) and thus low income inequality. Second, low investments in zero growth economies require low savings (as savings need to be equal to investments). This presupposes a relatively equal distribution of income.[64] Additionally, the government needs to redistribute in such a manner that no single group of economic actors continuously accumulates assets (because this implies economic instability in a zero growth environment, as another group of actors would have to accumulate debt). This also helps to decrease economic inequalities (this issue is also discussed in section 22.8).[65]

There is an apparent contradiction regarding low income inequality in zero growth economies. As argued in the second view above, low inequality is often seen to foster consumption demand and therefore investments. If this is true, other conditions are necessary to prevent large investments.[66]

[62] This argument is made in the theories of Kalecki (section 11.5), Robinson (section 11.7) and Kaldor (section 11.6).

[63] This perspective is particularly present in Keynes' (11.1) and Davidson's (12.1) theories.

[64] For the development of these conditions see Kalecki's (section 11.5) Kaldor's (section 11.6) theories.

[65] This condition is based on the theory of Godley and Lavoie in section 12.4.

[66] See the results from Keynesian theories in chapter 14 for a more elaborated discussion of this issue.

22.7.3 Marxian Conditions

In Marxian theories, the distribution of income and assets is organized along the division between capitalists and workers. Workers solely earn wages. As wages are at subsistence level, workers' income level primarily depends on the socially determined level of the subsistence wage. As workers use the entire wage income for consumption, they do not accumulate assets. Capitalists (or the oligarchy in the Theory of Monopoly Capitalism) own the means of production and earn profits. Due to competition, a large share of profits is used for investments and the sales effort. Hence, capitalists' consumption is limited as well.[67]

Income inequality in zero growth economies is also low from the perspective of Marxian theories. The major reason is the collectivization of firms. It repeals the division between capitalists and workers. Thereby, the income distribution becomes more equal. Additionally, retained revenues above the level of a firms' replacement of capital depreciation are taxed or entirely appropriated by the state. Assuming that the state uses them in a progressive manner, this additionally reduces economic inequalities.[68]

22.7.4 Comparison and Synthesis

Both the Keynesian and the Marxian theories[69] lead to conditions for zero growth that also generate comparatively **low levels of economic inequalities** as compared to the status quo. The conditions leading to this result are **low investments**, **collective firm ownership** and **redistribution** in case of continuous accumulation of assets of one group of actors. These conditions are *compatible*, as they do not contradict each other and work towards the same end.[70]

22.8 Monetary System and Savings

The monetary system has not been examined in detail in this present study. The reason is that the work has focussed on prominent, comprehensive macroeconomic theories. These often do not entail any inclusion of monetary aspects or use very simple ones. Only the Keynesian theories covered here entail monetary aspects to such a degree that related

67 See Marx's theory in chapter 16.

68 These conditions have been developed in detail in chapter 19.

69 It is focussed on the conditions from Keynesian and Marxian theories as distribution plays no important role in the neoclassical theories.

70 Note that an important contradiction regarding the distribution of income exists within the Keynesian theories. The contradiction between a high wage share on the one hand and low investments on the other has been mentioned above. For a detailed discussion, see section 14.1.4.

issues have been able to investigate. This is why the following summary is restricted to the findings from Keynesian theories.

Several issues regarding the monetary system have not been investigated here but play central roles in existing discussions on economies without growth (see section 3.6.7). These are in particular the role of fractional/full reserve banking and complementary currencies. This is partly due to the reason mentioned above – the theories covered here are not appropriate to investigate those issues. Another reason is that there is already a comparatively large scientific literature on these subjects.

22.8.1 Keynesian Conditions

The theories covered in the Keynesian part deliver the most insightful analyses concerning the monetary system and savings in zero growth economies. The monetary system is based on endogenous money creation by private banks. It is restricted primarily by the refinancing rate set by the central bank. Firms demand loans from private banks in order to invest. This leads to the generation of additional income and subsequently to savings of the same size as investments.

The central condition for zero growth economies concerning the monetary system is that **no single actor accumulates assets**, because this implies the accumulation of debts by another actor. This would lead to economic instabilities, in particular to an economic downward spiral as argued by Binswanger. Several conditions can facilitate this. First, **the collectivization of firms** leads to lower inequalities between households and therefore to a lower likeliness of some households to accumulate assets, while others accumulate debts. Second, this can be supported by **redistribution**. Taxation of profits and high incomes can additionally enable the government to have a balanced budget so that it does not accumulate debt. Third, firms can repay the loans if all income is used (on average) for consumption. Fourth, the introduction of **public instead of private banks** and/or a **regulation of banks** can prevent banks from accumulating assets.

Chapter 23
A Model of Sustainable Economies Without Growth

This chapter entails a model that synthesizes major conditions from the previous investigation. It is impossible to include all relevant conditions for sustainable economies without growth from all the theories examined. The following model is therefore restricted to what has been argued to be the central conditions. These are those conditions marked **bold** in the previous chapter.

The resulting synthesis is a combination of aspects from all three schools of thought. At the centre stands the argument that both aggregate demand and aggregate supply have to stay constant in zero growth economies. As argued above, the scenarios are regarded as focuses on single strategies for zero growth. These strategies are combined in order to achieve a detailed set of conditions for sustainable economies without growth.

The resulting model entails a relatively large number of factors, and hence a large number of conditions. This goes along with the fact that not all conditions are formally included in the model. In order to achieve a high degree of clarity and at the same time to facilitate the integration of such a large number of conditions, a combination between a formal, a graphic and a textual approach has been chosen.

In the following, first the intuition of the model is explained (23.1). Afterwards the model is developed in two steps. Step one entails the basic conditions for zero growth (23.2), step two elaborates on the detailed conditions (23.3). The chapter finishes with a summary of the model's outcomes (23.4).[1]

23.1 Intuition and Summary

The economy is characterized by collectively owned firms. The collective ownership prevents the generation of large retained earnings that would drive capital accumulation and the sales effort. Instead, increases in rev-

[1] The following model is based on contents from parts (II – IV), in particular the conditions from chapters 9, 14 and 19. It integrates the insights from the previous two chapters (21 and 22).

enues and labour productivity are used to provide high (albeit not increasing) wages for the members of the collectives, to improve working conditions and to decrease average working hours.

Firms sell their products on markets that are embedded in a significantly different macroeconomic framework than in growing economies. Four features of this framework shape the economy. First, the government introduces strong environmental policies such as strict limits on the exploitation of natural resources and strong environmental taxes. At the same time, the government reduces the costs of labour besides wages, i.e., non-wage labour costs. The effect is a strong change in the relative prices of production factors. Energy, natural resources and physical capital become more expensive while labour gets cheaper. Second, policies that prevent economies of scale and introduce diseconomies of scale are implemented: increasing transport costs, local infrastructures, regulations to treat small firms preferentially, etc. Third, the sales effort is regulated, including measures concerning commercials, planned obsolescence and new features. Fourth, reductions in average working hours are supported by governmental policies, e.g., incentives and regulations.

On the supply side, the resulting economy is characterized by constant production, gross investments at the level of capital depreciation, a redirection of technological change and reductions in average working hours. Firms have no incentive to invest above capital depreciation due to diseconomies of scale. They introduce resource-saving technologies. Increases in labour productivity are very limited due to the high costs associated with the use of natural resources and energy. If there are gains in labour productivity they are used for reductions in working hours because of the respective governmental policies, because collectively owned firms avoid worker dismissals and because people prefer increasing leisure rather than increasing income.

On the demand side, the levels of private consumption and government spending stay constant and they shift from dirty towards clean products. Private consumption is constant because income stays constant (due to low increases in labour productivity and reductions in working hours) and because the sales effort has been largely repealed. Government consumption is constant as expansion is not needed to generate employment. Both types of consumption shift away from dirty towards clean products because clean products are relatively cheaper due to the changes in relative prices of production factors and because households and governments decide to shift consumption based on political attitudes.

Regarding monetary aspects, the economy is characterized by zero savings and no continuous accumulation of assets by any single group of economic actors. Zero savings result from zero net investments. The condition of no accumulation of assets by any one group is necessary for economic stability as accumulation of assets by one group implies the accumulation of debt by another. It is achieved by low economic inequalities, redistribution by the state and a regulation of the banking system.

The first outcome of these conditions is zero growth, because both aggregate supply and aggregate demand stay constant over time. Second, environmental pollution decreases because production stops growing, because technological change is redirected towards emission reductions and due to sectoral change from dirty products (with high emission and low labour coefficients) towards clean products (with low emission and high labour coefficients). Third, wealth inequality is low, as the ownership of firms is distributed among the population. Income inequality is also low as wages are the only type of income. Income inequality still exists because wages differ between firms. Fourth, the economy is stable in the sense that employment is constant (as increases in labour productivity are limited and absorbed by reductions in working hours) and there is no instability stemming from the monetary system.

23.2 Step I: Basic Conditions

The development of the model begins with some central conditions. These are depicted in figure 23.1. The argument starts with the objective that the economy is characterized by an economic growth rate (g) of zero (labelled as (c1) in the figure):

$$g = 0. \tag{23.1}$$

23.2.1 Aggregate Supply

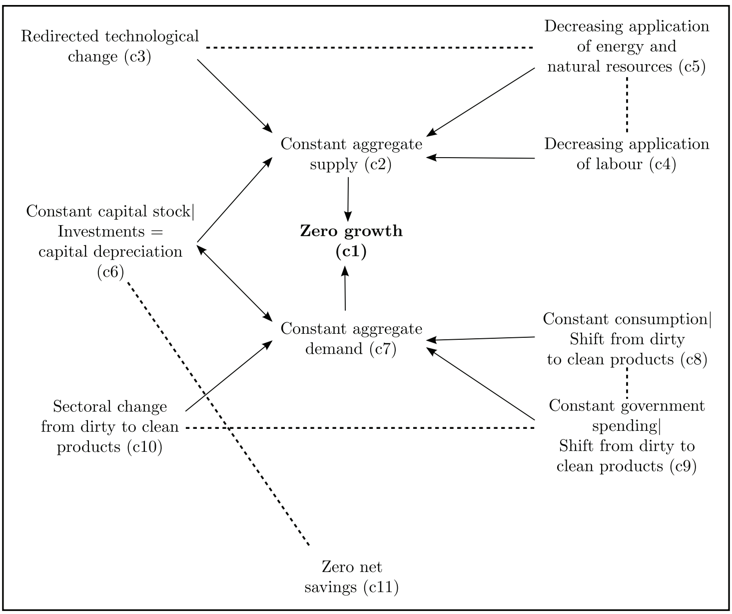
This implies that aggregate supply is constant over time (c2). Supply entails the three production factors labour (L), natural resources (R) and capital (K). Technological change is both labour-augmenting (T_t) and resource-augmenting (Γ_t). The production function is:

$$Y_S = F(T_t L, \Gamma_t R, K). \tag{23.2}$$

Technological change is redirected (c3), so that it is a combination between the technological change in scenarios II and III in the neoclassical part. It increases both the productivity of labour and resources. The productivity of labour changes at the rate (g_T). The productivity of resources changes at the rate (g_Γ). A condition for stable aggregate supply is that the increase in labour and resource productivities are countervailed by appropriate decreases in the supplies of labour (g_{LS}) and natural resources (g_R) respectively:[2]

$$-g_{LS} = g_T \quad \text{and} \quad -g_R = g_\Gamma. \tag{23.3}$$

Figure 23.1: Basic Conditions for Sustainable Economies Without Growth



Explanation: Arrows depict causal relationships in the sense that one condition influences the other. Dotted lines refer to relationships in which the conditions are closely linked and interdependent: c3, c4 and c5 combined constitute a different path of technological development; c8, c9 and c10 combined constitute the shift from dirty to clean products; c6 and c11 imply that zero net savings require zero net investments and the other way around.

2 Other constellations of developments of the productivities and supplies can also lead to zero growth but are not discussed here to keep the analysis simple. Such constellations would imply changes in the functional income distribution.

This means that the supply of labour decreases (c4) and the use of natural resources declines (c5). The level of physical capital stays constant over time (c6):[3]

$$g_K = 0. \tag{23.4}$$

Overall, this implies that growth of aggregate supply (g_{YS}) is zero:

$$g_{YS} = 0. \tag{23.5}$$

23.2.2 Aggregate Demand

Aggregate demand also has to stay constant in order to facilitate zero growth (c7). Aggregate demand has three components in a closed economy: Investments (I), consumption (C) and government spending (G):

$$Y_D = I + C + G. \tag{23.6}$$

Under the assumption that capital depreciation is constant over time, the condition of a constant capital stock suggests that investments are also constant[4] and at the level of capital depreciation (δK):

$$I = \delta K. \tag{23.7}$$

The assumption of constant aggregate demand therefore implies that the sum of private consumption and government spending stays constant:

$$\Delta C + \Delta G = 0. \tag{23.8}$$

[3] Within a neoclassical logic, the reason is that the marginal productivity of capital does not change, as the effective levels of supplies of the other production factors do not change. Within Keynesian and Marxian logics, other factors determine the accumulation of physical capital. These are discussed in more detail below. Nevertheless, it is important to note that here it is assumed that the capital coefficient stays constant over time, despite a redirection of technological change. This assumption takes a middle ground between the positions from environmental and ecological economics (see section 2.2). Environmental economists commonly argue that natural resources can be substituted by an increasing stock of physical capital. Ecological economists on the other hand point out that the two are complements so that the capital stock has to decline in order to decrease the use of natural resources. The assumption of a constant capital stock is therefore a compromise between the two.

[4] Note that this is compatible with a high level of capital depreciation, e.g., when dirty production sides are dismantled over time.

For the sake of simplicity, in the following it is assumed that the relation between private consumption and government spending stays the same. This implies that private consumption (c8) and government spending (c9) each stay constant over time.

Additionally, the type of products demanded by households and the government changes (this is also included in c8 and c9). Demand shifts from dirty towards clean products. Both, the levels of private consumption and absolute government spending, stay constant over time. Therefore, the increases in demand for clean products (ΔC_C, ΔG_C) has to be equal to the decreases in demand for dirty products (ΔC_D, ΔG_D):

$$\Delta C_C = -\Delta C_D, \text{with } \Delta C_C > 0, \quad (23.9)$$

$$\Delta G_C = -\Delta G_D, \text{with } \Delta G_C > 0. \quad (23.10)$$

The two aspects combined depict the sectoral change (c10). Note that the effect of this sectoral change on the labour and resource coefficients are already included in the equations above on the redirection of technological change. The redirection of technological change therefore entail two components: the application of resource-saving technologies and the shift towards clean products.

23.2.3 Savings

In zero growth economies, gross savings are equal to gross investments:

$$S = I. \quad (23.11)$$

This implies that net savings are zero (c11), as investments are equal to capital depreciation.

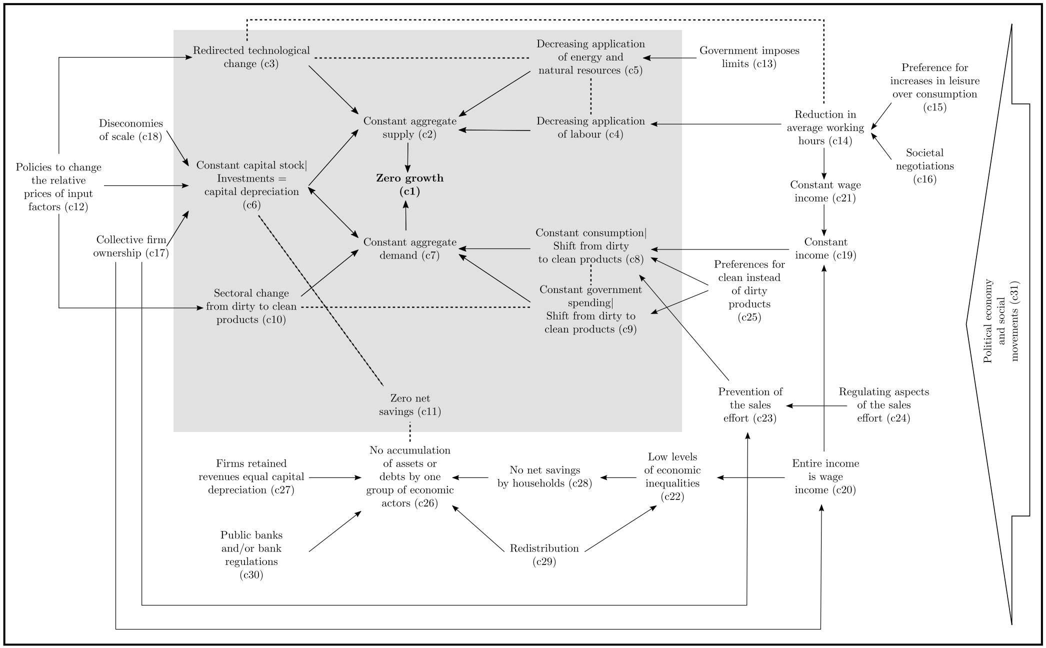
23.3 Step II: Detailed Conditions

The above conditions regarding aggregate demand and aggregate supply are central to zero growth economies. At the same time, they solely *describe* characteristics of a zero growth economy. They do not *explain* why these changes take place. Such causal explanations are provided by the following conditions. Figure 23.2 illustrates the relations between the various conditions. Note that most, but not all connections described in the text are included in the figure.

23.3.1 Redirected Technological Change

The redirection of technological change is connected to three aspects. Maybe most importantly, policies are implemented to change the relative

Figure 23.2: Detailed Conditions for Sustainable Economies Without Growth



Explanation: Again, arrows depict causal relationships and dotted lines relationships of close interdependence. Three dotted lines are explained in figure 23.2. The fourth, c3 and c14 is that the increases in labour productivity need to be accompanied by a reduction in average working hours at the same speed. The large arrow at the right symbolizes the influence of the political economy on the implementation of most of the conditions.

prices of production factors (c12). The prices of natural resources, energy and physical capital increase relative to the price of labour. This can be achieved by a variety of measures: environmental taxes, cap and trade systems, taxation on the production or the sale of physical capital, profit appropriation or profit taxation, etc.

Second, a reduction of the supply of energy and natural resources (c5) puts an additional incentive to redirect technological change. In essence, the effect is also an increase in prices. Finally, sectoral change (c10) is part of a redirection of technological change, as it changes the average input coefficients.

23.3.2 Decreasing Application of Energy and Natural Resources

The application of energy and natural resources is reduced due to lower supply and lower demand. A reduced supply can either be due to natural reasons (resources run out), be implemented by the owners of such resources (due to considerations of profit maximization) or be implemented by the government. Regarding the fact that issues relating to environmental sinks are far more pressing than those relating to sources (see section 2.2.1), the former two causes are unlikely. Therefore imposition of limits on the extraction of natural resources by the government is of primary relevance (c13). The demand for energy and natural resources declines due to two factors. First, the redirection of technological change (c3) leads to a decreasing resource coefficient. Second, economies with a zero growth rate (c1) imply lower demand for natural resources (ceteris paribus) as compared to growing economies.

23.3.3 Decreasing Application of Labour

Decreases in the application of labour follow a similar logic as for energy and natural resources. On the one hand, redirected technological change (c3) and zero growth (c1) imply a decreasing demand for labour.[5] On the other hand, reductions in working hours (c14) lead to a decreasing labour supply. The reductions in working hours are due to two factors. First, preferences towards increases in leisure rather than consumption (c15) support individuals to demand shorter working hours.[6] Second, average working hours are the outcome of societal negotiations (c16).[7] Here, the

[5] The conditions for redirected technological change have been laid out above.

[6] The conditions for changes in preferences have not been discussed in this present study. The reason is that the macroeconomic theories applied here do not explain it. This is an area for future research.

[7] It has also not been possible to discuss the functioning of such societal negotiations in detail based on the theories applied in this present work.

collectivization of firm ownership (c17) plays a central role as it strengthens the interests of workers. Additionally, collective firms have an interest in reducing working hours rather than dismissing workers (who are owners at the same time).

23.3.4 Investments

Three conditions are central in influencing whether investments are equal to capital depreciation (c6). First, the level of investments stands in a mutually dependent, positive relation to aggregate demand. On the one hand, real and expected aggregate demand have to be constant (c7) to incentivize firms not to expand production. On the other hand, investments have to stay constant in order to generate constant aggregate demand. The second and third conditions are a collectivization of firm ownership (c17) and the introduction of diseconomies of scale (c18). The combination of these two conditions prevents the coercion of firms to expand production. The collectivization leads to a higher wage share and therefore fewer retained earnings to be reinvested. Diseconomies of scale dismantle the coercion of expanding production in order to stay price competitive. Diseconomies of scale can be supported by a variety of economic policies, such as increases in transport costs, support of local rather than global infrastructures, progressive taxation of firm revenues, limitation of firm size, etc. The issue of diseconomies of scale therefore overlaps with the fourth condition regarding investments, i.e., policies to change the relative prices of production factors (c12). These support diseconomies of scale for example by increasing transport costs and by supporting labour-intensive production that often takes place on a smaller scale. Additionally, increasing the price of physical capital enacts an incentive to keep investments low.

23.3.5 Consumption

While the level of consumption stays constant, its composition changes towards clean products (c8). The level of consumption depends on the level of income and the consumption rate.

The level of income (c19) stays constant due to a combination of factors. First, the collectivization of firm ownership increases the wage share and decreases the profit share. If all firms are collectivized, the entire income is wage income (c20). The reduction in average working hours at the speed of increases in labour productivity leads to constant wage income (c21). The result is that the level of income stays constant.

Two conditions influence the consumption rate. First, the fact that the entire income is earned via wages implies a low level of income inequality (c22). This goes hand in hand with a higher consumption rate.

Once firms are collectivized, there is no reason why income inequality and subsequently the level of consumption should *change* over time, however. Second, the sales effort is an important cause for increasing consumption in growing economies. Hence, the prevention of the sales effort (c23) is a central condition for constant consumption. The collectivization of firm ownership (c17) helps to prevent the sales effort, as fewer retained revenues are available to pursue it. The sales effort can further be prevented by regulative measures on commercials, planned obsolescence, new product features, etc. (c24).

The composition of consumption shifts due to two factors. First, a change in preferences towards clean instead of dirty products (c25) supports such a shift. A possible reason is an increasing consciousness on the environmental impacts of dirty consumption.[8] Second, a change in the relative prices of input factors (c12) also changes the relative prices between dirty and clean products and therefore lead to a substitution of dirty by clean products.

23.3.6 Government Spending

The level of government spending stays constant and its composition shifts towards clean products (c9). Both are primarily political decisions and are therefore due to the political economy (see below). Some conditions facilitate such decisions, however. First, reductions in working hours (c14) make it unnecessary to increase government spending in order to generate employment. Second, changes in the preferences of people (c25) as well as different price relations (c12) make it easier to shift spending towards clean products.

23.3.7 Savings

Savings are generated by and therefore equal to gross investments. As gross investments are equal to capital depreciation, gross savings are of equivalent size. This implies that net savings are zero (c11). A central condition for zero growth economies maintaining stability is that no single group of actors continuously accumulates assets or debts (c26). These two conditions are closely linked. Net savings imply that, on average, the assets of all actors have to stay constant. From the other perspective, if no economic actor accumulates assets there are also zero net savings.

Subsequent conditions relate to single groups of actors. Firms need to retain revenues at the level of capital depreciation (c27) in order to nei-

8 This would also depict a change in preferences. Why preferences change in such a manner has not been possible to investigate in this work, as already mentioned above.

ther accumulate assets nor debts. Households overall do not save (c28). This implies that individuals are able to save and dissave over their life span. At the same time, economic stability requires that no large number of households goes bankrupt and therefore also that no group of households continuously accumulates assets. This is facilitated by low levels of economic inequalities (c22). The reasons for low inequalities are that households solely receive wage income (c20) and can further be supported through redistribution by the state (c29).

If private banks tend to accumulate assets[9] their replacement by public banks or a regulation of their activities is necessary (c30). If one of these or another group of economic actors does accumulate assets or debts, the government needs to redistribute incomes and/or wealth (c29) in order to guarantee economic stability.

23.3.8 Political Economy

The political economy of these conditions has only been discussed sporadically throughout this work. Only the Marxian theories entailed an analysis of political economy and their understanding of it has also only been of secondary nature to this investigation.

At the same time, governmental activities play a major role in the conditions and are strongly dependent on the political economy. The conditions entail various important governmental policies: the tax system is strongly reformed towards environmental taxation; strict limits are imposed on natural resources; firms are transformed from private to collective ownership; income is redistributed; the sales effort is regulated; reductions in working hours are supported; banks are regulated; and government spending is restricted and geared towards clean products.

Many of these policies stand in conflict with interests of strong social groups. In particular, they contrast the interests of the capitalist class (in Marx's terms) or the oligarchy (in the terms of the Theory of Monopoly Capitalism). These groups would loose major parts of economic wealth and income and the ability to accumulate capital. The forces of the existing political economy therefore prevent these conditions from being enforced. Strong social movements and alliances between different (in particular the labour, environmental and feminist) movements are the most plausible manner to implement these conditions anyhow.[10]

9 This argument is the major reason for the growth imperative as developed by Binswanger, see section 12.3.

10 For a more detailed discussion, see part IV.

23.4 Outcomes Concerning Sustainability

The previous section has discussed the conditions for zero growth (research question 1) in detail. The model also takes into account the other three research questions regarding the environment, economic inequalities and economic stability. In the following, the impacts of the model's macroeconomic conditions on these three aspects are summarized.

23.4.1 Environment

The model predicts a decreasing level of environmental degradation (use of natural resources and level of pollution) over time. Three aspects lead to this outcome. First, the constant level of production alleviates environmental impacts compared to growing economies. Second, the redirection of technological change implies the application of technologies with lower resource coefficients. Third, the sectoral change shifts production towards sectors with lower environmental impact.

Additionally, it should be noted that the introduction of diseconomies of scale lessens the pressure on firms to externalize costs where possible. Because competition is argued to be less fierce on local (than on global) markets, firms gain leeway to decide to produce environmentally friendly (a necessary but no sufficient condition).[11]

A possible mechanism that impedes the environmental outcomes of the model is a close connection between the level of investments and the introduction of new technologies with lower resource coefficients (see section 8.3). Note, however, that most theories investigated in this work, which include environmental aspects, do not regard large investments as necessary for environmental technological change.

23.4.2 Economic Inequalities

The model's conditions lead to low economic inequalities – both regarding wealth and income. This has four reasons. Most important is the collectivization of firm ownership. A consequent execution of this condition for all firms reduces the two types of economic inequalities significantly. Within the model (and within most models covered) firm ownership is the only existing type of ownership. Hence, the collectivization of firm ownership leads to collective ownership overall.[12]

Second, the redirection of technological change increases the demand for labour and decreases the demand for capital and natural resources.

[11] For more details on this argument see chapter 18.

[12] It was not possible to discuss issues of other types of ownership within this framework (important issues are for example all financial assets and housing).

This leads to higher wages and lower capital incomes. This type of technological change is also likely to increase demand for low-skilled labour rather than high-skilled labour (compare to section 7.4). A disproportionately large increase of wages for low-skilled labour further decreases income inequality.

Third, redistributive measures may be necessary in order to guarantee stability – in case one group of actors accumulates assets. Per definition this further decreases inequalities. Fourth, reductions in working hours have the potential to decrease inequalities. The prerequisite would be that those individuals with high hourly wages decrease working hours above average. The issue of working hours reductions therefore also represents a connection to the discussion of feminist economics. As men work more on average (in wage labour, not including reproductive labour), a reduction in average working hours, conducted primarily by men, would contribute to a more equal distribution of both types of labour and of income between the genders.

23.4.3 Economic Stability

Throughout this present study, two types of economic (in)stabilities have been discussed: unemployment and instabilities stemming from monetary aspects. Regarding the first, the model represents three major strategies to cope with potential unemployment in zero growth economies. (1) Redirected technological change and (2) sectoral change work towards higher labour coefficients. Whether the labour coefficient still decreases, stays constant or increases depends on the exact circumstances. As the size of the population has been assumed to stay constant throughout this study, a constant labour coefficient would imply no change in unemployment. In case the coefficient decreases, (3) reductions in working hours can guarantee the same amount of employment (in number of jobs). It has also been argued that reductions in working hours are more likely under the conditions lined out in this model – due to several reasons: The reduction in the sales effort facilitates a shift of preferences towards leisure rather than consumption; the collectivization of firms strengthens the bargaining position of workers in societal negotiations; and collective firms are less likely to fire people and instead distribute the remaining work among members.

Monetary economic instabilities refer to possible dynamics that can lead to a downward spiral. Most importantly, it is argued that an insufficient demand for consumer goods can prevent firms from earning sufficient revenues to stay in business. In the model above, demand suffices for firms to pay their costs (wages and interests). At the same time, the model does not entail a discussion on what happens in case of an (exogenous) temporary shrinkage of demand for consumer goods. As argued in chapter 14, some mechanisms suggest that this may lead to a downward spiral. Other mechanisms suggest balancing effects, however, so that the economy fluctuations around a constant level of production.[13]

[13] Future research could investigate the factors that determine which mechanisms might prevail, see chapter 25.

Chapter 24
Embedding the Results in the State of Research

The state of research as discussed in part I includes two different types of approaches towards economies without growth. The first set of theories[1] argue that economic growth rates automatically decline over time, and they aim to explain this secular stagnation. The second set of theories[2] starts from the conviction that economies should be organized without growth due to environmental, social and other reasons. These theories subsequently develop necessary macroeconomic conditions that would lead to sustainable economies without growth.

In the following, the results of this present study are first compared to the state of research on general grounds. Second, the focus shifts to the concrete sets of conditions developed.

24.1 General Comparison

The results of the present study are largely compatible to results from existing literature. The relations are discussed with reference to the different strands of literature in part I:

1. Historically speaking, economic growth is a recent phenomenon. Furthermore, the speed of economic growth in early industrialized countries has differed between historical phases and have recently declined. From this perspective, the conditions for sustainable economies without growth can be regarded as a new historical phase.[3]
2. It has been argued that environmental and ecological economics take different stands regarding the question of whether a sufficient decoupling is feasible. The conditions developed in this present work do not depend on the outcome of this debate. Instead, it has been argued that an end to economic growth can help to achieve environmental sustainability and does not contradict social welfare.[4]
3. The classical economists predicted that the stationary state is in-

[1] These are covered in section 2.3.
[2] They are discussed in more detail in chapter 3.
[3] Compare to section 2.1.
[4] Compare to section 2.2.

evitable. While this point has not been discussed in this present work, the conditions resemble many of the features of a stationary state as envisioned by them. The conditions are particularly similar to Mill's vision of a stationary state.[5]

4. The debate on secular stagnation puts forward various arguments to explain the low growth rates – both regarding the supply and the demand side. The conditions developed in this work resemble almost all of the mechanisms discussed there. The central difference is that the conditions of this study aim at desirable outcomes in economies without growth, while secular stagnation leads to various environmental, social and economic problems.[6]
5. The existing literature on consciously generated economies without growth comprises four concepts: *steady state economies*, *degrowth*, *Postwachstum* and *prosperity/managing without growth*. These discussions have led to the development of a diverse set of macroeconomic conditions.[7] The extent to which these conditions are equal to the ones developed in this study is discussed below.
6. At the same time, these analyses are seldom placed within a comprehensive macroeconomic framework.[8] One major contribution by this present study is therefore that the (previously known) conditions have been embedded into macroeconomic frameworks. This has facilitated an investigation of under what circumstances such conditions actually lead to zero growth and how they relate to each other.
7. The limited number of previous investigations within neoclassical[9] and Keynesian[10] frameworks suggest that zero growth is possible under certain conditions. This result has been reaffirmed by the present investigation. The Marxian literature on the contrary argues that zero growth is not possible within capitalism.[11] This present study nevertheless develops conditions for zero growth within Marxian theories – however, these economies are not necessarily capitalistic anymore.
8. An entirely new contribution of this present work has been the development of different scenarios for sustainable economies without growth. Initially, these have been developed to summarize the state of

[5] Compare to section 2.3.1.
[6] Compare to sections 2.3.2 and 2.3.3.
[7] Compare to section 3.6.
[8] Compare to chapter 3.
[9] Compare to chapter 5.
[10] Compare to chapter 10.
[11] Compare to chapter 15.

research.[12] Similar scenarios have been developed based on the three schools of economic thought. The scenarios include three insightful strategies to reconcile zero growth with constant employment: reductions in average working hours, redirected technological change and sectoral change.

9. The analysis of conditions within macroeconomic theories has finally allowed us to integrate the different conditions in a coherent framework. The result is a model that synthesizes the central conditions for sustainable economies without growth.[13]

24.2 Comparison of Conditions

A major finding is that the conditions from the existing concepts and the conditions generated by this present study largely overlap. The analysis of seven areas of conditions[14] has shown that in each area the existing conditions are similar to the one found in this work. These are (among others): increasing prices of natural resources and energy; a redirection of technological change; collective business types; restricted private consumption; reductions in average working hours; low economic inequalities;[15] and altered consumer behaviour.

At the same time, several conditions developed in this study have not been part of the existing literature or play a substantially different role.

1. The existing literature focuses on the shift of investments from dirty towards clean sectors. This present study has instead investigated in detail which conditions are necessary to keep overall investments at the level of capital depreciation. This has been argued to be one of the most important conditions for zero growth. It requires, in particular, collective firms, diseconomies of scale and constant (actual and expected) aggregate demand.
2. Diseconomies of scale play almost no role in the existing literature. In this study[16] it has been shown, however, that diseconomies of scale are an important condition for economies without growth.[17]
3. The issue of the sales effort plays a role in existing concepts as well as

[12] Compare to chapter 4.

[13] Compare to chapter 23.

[14] See chapter 22.

[15] These are not only an explicit goal but also a prerequisite for stable economies without both in the existing literature and this present study.

[16] See in particular the discussions in the Marxian part IV.

[17] The reason is that, as long as price competition plays a role, the existence of economies of scale coerces firms to expand, which leads to positive net investments and economic growth on the macroeconomic level.

in the present study. Its interpretation is substantially different however. In the existing literature, commercials, planned obsolescence and new product features appear as reasons for growth in private consumption. The resulting proposals refer to regulations of such processes and different behaviour of consumers.[18] The analysis of the Theory of Monopoly Capitalism on the contrary emphasizes the firms' interests in the sales effort. This analysis suggests that regulations and changes in consumer behaviour do not suffice. Instead, the constitution of firms has to be altered, in order to prevent large expenses on the sales effort (from privately towards collectively (worker) owned business types).[19]

4. The role of government spending is little discussed in the existing literature. The investigation of the present study suggests that zero growth economies require an end of increases in government spending and a shift from dirty towards clean sectors.[20][21]
5. Also the issue of savings is a comparatively vacant issue in existing discussions. The present work has found the impactful condition that aggregate net savings have to be zero in zero growth economies. This implies that the accumulation of assets by one actor always implies the accumulation of debt by another. When the latter is to be prevented, continuous accumulation of assets is therefore not possible for any group of actors. This aspect also implies a new role for redistribution: Not only is it desirable for social welfare but also necessary for economic stability.

[18] Compare to section 3.6.4.

[19] This is discussed in detail in chapter 17.

[20] This condition has been developed both on Keynesian (see in particular sections 11.1 and 12.1) and Marxian (see chapter 17) theories.

[21] It has not been possible to discuss based on the theories applied in this present work, whether and how constant government expenditures are compatible with social welfare systems and other governmental responsibilities.

Chapter 25
Summary and Future Research

25.1 Summary

This study has investigated conditions for sustainable economies without growth, i.e., economies that are characterized by zero growth, environmental sustainability, low economic inequalities and economic stability. The central motivations for organizing economies without growth are that economic growth is environmentally unsustainable and does not contribute to high social welfare in early industrialized countries. As a result, a significant amount of literature on concepts for economies without growth has developed, referring to the terms *steady state economies*, *degrowth*, *Postwachstum* and *prosperity/managing without growth*. This literature has generated a diverse set of conditions for sustainable economies without growth.[1]

However, there is a research gap regarding analyses of such conditions from macroeconomic perspectives.[2] Several contributions investigate specific issues of zero growth economies or conduct their research by using specific models.[3] Still missing are investigations that make use of well-established, comprehensive macroeconomic theories. Accordingly, the theme of this book is to provide a substantiated macroeconomic analysis for conditions of sustainable economies without growth. A plural set of macroeconomic theories is applied in order to facilitate a comprehensive understanding. Overall 29 single theories from the neoclassical, Keynesian and Marxian schools of economic thought are applied to the question, which macroeconomic conditions lead to sustainable economies without growth.

The analysis of neoclassical theories entails fundamental neoclassical theories (e.g., the Solow Model), endogenous growth theories and theories that include environmental aspects. All theories allow for stable zero growth under certain conditions. The central result from neoclassical the-

[1] The results from the four concepts have been summarized in more detail in chapter 4.

[2] The macroeconomic foundations of the four concepts have been examined in sections 3.1.3, 3.2.3, 3.3.3 and 3.4.3, respectively.

[3] The literature on zero growth economies within neoclassical, Keynesian and Marxian theories have been summarized in the introductions to each part, i.e., chapters 5, 10 and 15.

ories is that aggregate supply has to stay constant over time. Therefore, any change of either a level of supply or of a productivity of one production factor (i.e., labour, capital and natural resources) needs to be balanced out by a proportional and opposite change of a level of supply or of a productivity of another production factor. Additionally, three scenarios are developed based on the neoclassical theories. They lead to zero growth by combining (1) labour-augmenting technological change and reductions in average working hours, (2) labour-augmenting technological change and decreasing supply of natural resources and (3) resource-augmenting technological change and decreasing use of natural resources.[4]

Keynesian theories comprise fundamental contributions (e.g., by Keynes and Kalecki), monetary theories and theories that include environmental aspects. Again, all theories are compatible with conditions for stable economies without growth, albeit some theorists argue to the contrary. In Keynesian theories, the central condition is that both aggregate supply and aggregate demand must stay constant over time. Subsequently, the level of investments has to equal capital depreciation. This requires constant demand from households and the government, so that firms have no incentive to expand production. When technological change increases labour productivity, reductions in average working hours need to take place in order to keep wages, incomes and private consumption constant. Net savings equal net investments and are therefore zero as well. In order to prevent instabilities, groups of economic actors (firms, households, banks and the government) need to have balanced accounts. Four scenarios are developed for the Keynesian theories. They all lead to zero growth and no unemployment due to (1) increasing labour productivity and reductions in working hours, (2) a redirection of technological change based on altered relative input prices, (3) sectoral change from dirty towards clean products and (4) a combination of redirected technological change and sectoral change.[5]

Three types of Marxian theories have been examined: Marx's theory, the Theory of Monopoly Capitalism and theories that include environmental aspects. Marxian authors themselves argue that zero growth is

[4] The results from the neoclassical theories are summarized in chapter 9. The results for the subsets of neoclassical theories have also been summarized at the end of the respective chapters, that is, in section 6.4 for fundamental, in 7.5 for endogenous and in 8.6 for environmental neoclassical theories.

[5] The results from the Keynesian theories are summarized in more detail in chapter 14. The results for the subsets of Keynesian theories have also been summarized at the end of the respective chapters, that is, in section 11.8 for fundamental, in 12.5 for monetary and in 13.4 for environmental Keynesian theories.

incompatible with capitalism. On the contrary, this present study develops conditions for zero growth economies for all three types of theories. However, these economies would then no longer be capitalistic necessarily. The central conditions in Marxian theories are that firms are collectivized, diseconomies of scale replace economies of scale, the sales effort is prevented and the availability of cheap energy (based on fossil fuels) is limited. Marxian theories additionally entail an analysis of the political economy, i.e., the power relations in society. These contradict the implementation of the necessary conditions for sustainable economies without growth. Two scenarios are developed for the Marxian approaches, which emphasize partially different conditions: (1) In competitive capitalism, the diseconomies of scale are central to prevent the coercion to invest due to price competition. (2) In monopoly capitalism, the prevention of the sales effort is essential as the sales effort is the major reason for increasing effective demand.[6] Both scenarios emphasise the conditions of collective firm ownership and limiting the supply of cheap energy.

After having analysed the conditions for each school of economic thought,[7] these conditions have been compared and integrated.[8] This has been done for seven areas: (1) environmental regulation, (2) investments and capital depreciation, (3) business types, (4) consumption and government spending, (5) employment, (6) distribution and (7) monetary system and savings. As most conditions are complementary rather than contradicting, they have been integrated into a unified set of conditions.[9]

The synthesis has culminated in the development of a novel model of sustainable economies without growth. It entails the major conditions from the investigation. In this model, aggregate supply and aggregate demand stay constant over time. On the supply side, the supply of natural resources, energy and labour decrease – including a reduction in average working hours. Technological change is redirected so that it primarily decreases the resource coefficient. On the demand side, investments, private consumption and government spending stay constant. Net investments are zero. This is achieved by a collectivisation of firm ownership, diseconomies of scale and the expectation that aggregate demand stays constant. Pri-

[6] The results from the Marxian theories are summarized in more detail in chapter 19. The results for the subsets of Marxian theories have also been summarized at the end of the respective chapters, that is, in section 16.3 for Marx's theory, in 17.3 for the Theory of Monopoly Capitalism and in 18.3 for ecological Marxian theories.

[7] A more detailed summary of the results from the three schools of thought can be found in chapter 20.

[8] See chapter 21.

[9] See chapter 22.

vate consumption does not increase because income stays constant (increases in labour productivity are used for reductions in average working hours rather than higher wages). Government spending stays constant due to political decisions. Additionally, the type of demand changes from dirty towards clean products so that a sectoral change takes place. Finally, net savings equal net investments and are therefore zero. In order to guarantee economic stability, income is redistributed so that no group of economic actors continuously accumulates assets or debts. Whether such conditions can be implemented depends on the willingness of the actors involved and on social power relations. While strong social actors have interests to oppose these conditions, alliances between social movements may facilitate them.[10]

25.2 Future Research

In the beginning of this present work, it has been pointed out that there is a research gap regarding theoretical investigations on sustainable economies without growth based on comprehensive macroeconomic theories. This study has aimed at filling this gap by using theories from three major schools of economic thought. Regarding the complexity of sustainable economies without growth, there are still plenty of research fields to be seized. During the course of this present work, three important areas have repeatedly come up. These three areas seem important in order to understand the subject, while it has not been possible to discuss them in the present study. To the best of my knowledge,very little other research regarding these aspects exists.

1. The present study has been limited to investigating conditions for closed economies.[11] As many of the early industrialized countries are highly integrated in global markets, this constitutes a serious limitation to the insights gained here. Accordingly, future research can investigate conditions for sustainable economies without growth for *open economies.*
2. This study has only touched upon the issue of the *political economy* of economies without growth. This issue seems of vital importance, as it is important to know under what circumstances conditions for sustainable economies without growth can be realized. The preliminary results found in this study indicate that the social power relations oppose such changes. Future research can utilize the existing literature

[10] The model is laid out in detail in chapter 23.
[11] This assumption has been motivated in chapter 1.

on strategies to realize (radical) social change.[12] to improve the understanding of potential paths towards sustainable economies without growth.

3. The focus of the present work on the three schools of economic thought has excluded those parts of production that take place *outside of markets*, such as reproductive work and commons.[13] Future research can integrate these issues into macroeconomic conditions for zero growth and thereby extend the analyses by crucial aspects of the economy.

Some additional fields for future research have come up throughout this present work:

- *Measurement of GDP:* The measurement of GDP is quite complex.[14] The macroeconomic theories covered here do not take this complexity into account: Usually, it is assumed that one final good is produced.[15] Future research can improve the understanding of these issues, for example by applying theories that have more differentiated understandings of economic growth.
- *The financial system:* The theories discussed here only have a limited analysis of the financial system. Future research can hence improve an understanding of which conditions concerning the financial system are necessary for sustainable economies without growth.
- *Banks:* It has been argued that banks need to be regulated so that they do not continuously accumulate assets.[16] Future research can thus investigate how such banks can be regulated and organized in zero growth economies.
- *Disinvestments:* While disinvestments play an important role in existing concepts for economies without growth, they have not been discussed in detail here. Future research can elaborate on what this means for firms and for the functioning of the macroeconomy.
- *Determinants of individual behaviour:* The preference for reduced working hours and for the consumption of clean rather than dirty products cannot be explained based on the macroeconomic theories

[12] See section 16.3.2 for a short, preliminary discussion on some of them.

[13] This has been argued for each school of economic thought, see sections 9.5, 14.5 and 19.5.

[14] It incorporates issues as inventions of new products, alterations of products and changing consumer baskets, see section 2.1.1.

[15] This also concerns the relation between economic growth and environmental aspects, as different types of economic growth have different effects on the environment. See section 2.2.

[16] See in particular the discussion on Binswanger's theory in section 12.3.

covered here. As these are central conditions, future research can elaborate on this issue.

- *Population:* The role of population growth has been entirely excluded from this study. Future research can therefore investigate, how the conditions would change for growing or shrinking populations.

This study and future research can help to develop an understanding of how economies without growth can be organized in sustainable ways. Research can provide analytical frameworks and indicate possible paths towards sustainable economies without growth. However, it is up to society as a whole to decide whether and how such economies are to be realized. It is upon civil and political organizations, in particular, to discuss these issues and facilitate the necessary changes.

Appendix A
Kalecki's Investment Multiplier and Savings Due to Investments

In this appendix, it is explained why in Kalecki's general model of the economy, additional investments financed by credit creation generate an amount of savings that is equal to the additional investments. Additionally, the investment multiplier is derived. The calculations in the appendix are done by the author of this work. Kalecki develops the investment multiplier in a slightly different manner, yet comes to the same conclusion. (Hein, 2004, chapter 8) comes to the same conclusion and develops the same multiplier; however, he uses a different derivation.

In section 11.5 it has been argued that the economy consists of the three sectors producing goods for (1) investments, (2) consumption of capitalists and (3) consumption of workers. Each of the sectors have given wage (w_1, w_2, w_3) and a profit shares (p_1, p_2, p_3), with $p_1 = 1 - w_1; p_2 = 1 - w_2; p_3 = 1 - w_3$. For simplicity, it is assumed that they are equal in all sectors: $w = w_1 = w_2 = w_3; p = p_1 = p_2 = p_3$. This allows a combination of sectors 2 and 3 into one sector, which is called the overall consumption sector (OC) with the wage and profit shares w, p and $p = 1 - w$.

Income of the investment sector is divided into wages and profits with

$$I = W_1 + \Pi_1. \tag{A.1}$$

Wages and profits of sector 1 are defined by the amount of investments and the wage and profit shares:

$$W_1 = wI \quad \text{and} \quad \Pi_1 = pI = (1 - w)I. \tag{A.2}$$

The same holds for the overall consumption sector. Income is divided into wages and profits

$$OC = W_2, 3 + \Pi_2, 3, \tag{A.3}$$

Wages and profits are defined by the size of the overall consumption sector and the respective shares:

$$W_2, 3 = wOC \quad \text{and} \quad \Pi_1 = pOC = (1-w)OC. \tag{A.4}$$

Investments directly increase production by increasing sector 1:

$$\Delta Y = \Delta I. \tag{A.5}$$

The direct effect on savings is equal to the savings out of profits

$$\Delta S = (1-q)(1-w)\Delta I. \tag{A.6}$$

The share of original savings is defined as

$$f = (1-q)(1-w). \tag{A.7}$$

The original savings are therefore given by

$$\Delta S = f\Delta I. \tag{A.8}$$

The change in wages and profits in sector 1 are determined according to

$$\Delta W = w\Delta I \quad \text{and} \quad \Delta\Pi = (1-w)\Delta I. \tag{A.9}$$

As the additional wages are entirely spent on consumption goods and a fraction (q) of additional profits are spent on consumption, the original additional amount spent on consumption due to the additional investments are given by

$$\Delta OC^1 = w\Delta I + q(1-w)\Delta I = (w + q(1-w))\Delta I. \tag{A.10}$$

The share of original income spent in sector 1 is defined as

$$g = (w + q(1-w)). \tag{A.11}$$

The additional production is hence

$$\Delta OC^1 = g\Delta I. \tag{A.12}$$

Note that $f + g = 1$ (as $(1-q)(1-w) + (w + q(1-w)) = 1$). This makes intuitive sense as f is the share of δI that is directly saved and g is the share that is spent on consumption. This relation is used below. The resulting savings are equal to the savings out of profits that are made due to the additional production.

$$(1-q)(1-w)(w + q(1-w))\Delta I = fg\Delta I. \tag{A.13}$$

The second additional production is equal to the additional wages generated due to the first additional production ($wg\Delta I$) and the share of the additional profits from the first additional production that is consumed ($q(1-w)g\Delta I$)). This amounts to

$$\Delta OC^2 = wg\Delta I + q(1-w)g\Delta I) = g^2\Delta I. \tag{A.14}$$

This again results into savings that are equal to the share of savings out of the profits that are made due to the second additional production:

$$\Delta S^2 = fg^2\Delta I : \tag{A.15}$$

This argument can be done for $n = \infty$ periods. The sum of production is therefore

$$\Delta Y = \Delta I + g\Delta I + g^2\Delta I + g^3\Delta I + ... = \frac{1}{1-g}\Delta I = \frac{1}{1-(w+q(1-w))}\Delta I. \tag{A.16}$$

This is the *investment multiplier*. It is positively correlated to the wage share (w) and the consumption rate out of profits (q).

The argument for additional savings can also be done for $n = \infty$ periods. The resulting amount of savings is

$$\begin{aligned} \Delta S = f\Delta I + fg\Delta I + fg^2\Delta I + fg^3\Delta I + ... &= f\frac{1}{1-g}\Delta I \\ &= f\frac{1}{1-(1-f)}\Delta I = \Delta I. \end{aligned} \tag{A.17}$$

Overall savings are therefore equal to the original change in investments.

Appendix B
Kalecki's Investment Multiplier

Production is defined by the sum of investments, consumption of capitalists and consumption of workers:[1]

$$Y = I + C_K + C_W. \tag{B.1}$$

Income consists of profits and wages:

$$Y = \Pi + W. \tag{B.2}$$

Workers do not save, therefore $W = C_W$ and therefore

$$\Pi = I + C_K. \tag{B.3}$$

Consumption of capitalists is assumed to be a function entailing a constant (changing over time) and a fraction of profits:

$$C_K = A + q\Pi. \tag{B.4}$$

Combining equations B.3 and B.4 yields

$$\Pi = I + A + q\Pi, \tag{B.5}$$

or

$$\Pi = \frac{I + A}{1 - q}. \tag{B.6}$$

A change in investments thus leads to a change in profits according to the following equation:

$$\Delta\Pi = \frac{\Delta I}{1 - q}. \tag{B.7}$$

Additionally, it is known that profits are equal to the profit share ($p = 1 - w$) times production

$$\Pi = (1 - w)Y, \tag{B.8}$$

[1] This appendix reflects to a large degree the reasoning in (Kalecki et al., 1987) chapter 10.

and a change in income leads to proportionate change in profits:

$$\Delta\Pi = (1 - w)\Delta Y, \tag{B.9}$$

and

$$\Delta Y = \frac{\Delta\Pi}{1 - w}. \tag{B.10}$$

Combining equations B.7 and B.10 yields the investment multiplier

$$\Delta Y = \frac{\Delta I}{(1 - w)(1 - q)}. \tag{B.11}$$

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Acknowledgements

Challenging economic growth is still uncommon. This is particularly the case in the economics profession. While the popularity of concepts such as *post-growth*, *degrowth* or *prosperity without growth* have experienced a rise in popularity over the past years, these debates have barely entered economic discourses.

Various civil organizations have (re-)started discussions on the pros and cons of future economic growth. NGOs, churches, trade unions and other actors in civil society engage in a lively debate in many European countries. At the same time, other organizations have a hard time warming up to the idea of an end to economic growth.

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Steffen Lange is an economist, primarily researching how economies can be transformed to be socially just and environmentally sustainable. He has studied economics and other social sciences in Maastricht/Netherlands, Santiago de Chile, Göttingen/Germany and Hamburg/Germany. Currently, he is a post-doc researcher at the Institute for Ecological Economy Research in Berlin/Germany, where he investigates the social and environmental effects of digitalization and conditions for post-growth economies. Parallel to his academic work, he engages in social movements and civil society organizations, to foster a social and ecological transformation.

The book series „Wirtschaftswissenschaftliche Nachhaltigkeitsforschung“ (Sustainability Research in Economics and Management Studies) is an outlet for excellent sustainability-related research in both disciplinary fields. Contributions focus on pressing ecological problems as well as social and economic sustainability concerns. They combine disciplinary approaches with genuinely transdisciplinary sustainability research.

"This is one of the most important pieces of research to come out in ecological macroeconomics in the last 20 years, alongside Peter Victor's 'Managing Without Growth', and Tim Jackson's 'Prosperity Without Growth'. It is the first and only attempt to systematically work out the conditions for zero growth under different economic models."
Giorgos Kallis, Research Professor of Ecological Economics,
Autonomous University of Barcelona

"Steffen Lange has provided an amazing piece of work. The book has good chances of becoming a standard work for ecological economists in due course."
Arne Heise, Professor of Macroeconomics, University of Hamburg

How can we organize our economies without growth? 'Macroeconomics Without Growth' provides a comprehensive understanding of how non-growing economies can be sustainable. With this book, Steffen Lange brings new momentum into the debate on post-growth, degrowth and steady state economies. The book delves deep into economic theory to understand how an economy can operate without growth. By applying a highly diverse set of theories – from Neoclassical, Keynesian and Marxian traditions – the book is able to cover a wide range of macroeconomic aspects: Is zero growth possible in a capitalist economic system? What happens to aggregate demand and aggregate supply when economies stop growing? And what role do firms, markets and technological change play in post-growth economies?

Steffen Lange conclusively shows that sustainable economies without growth are feasible from a macroeconomic perspective. However, small changes will not suffice. Rather, key economic institutions and dynamics need to be rearranged: the prices of labour and natural resources, the structures of companies, the framework of markets – just to name a few. 'Macroeconomics Without Growth' is the first economics book to investigate nongrowing economies in a comprehensive manner. It is a must read both for economists who want to use economics for a sustainable future, and for environmentalists who want to understand the economic principles of sustainable transformations.

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