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Commentary

The role of inter-sectoral dynamics in sustainability transitions: A comment on the transitions research agenda

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ABSTRACT

Building on the chapter "Businesses and industries in sustainability transitions" in the STRN agenda, this viewpoint calls for more attention to how economic and environmental goals can be aligned to enhance the political legitimacy of transitions. This requires, we suggest, a more integrated understanding of the relationship between industrial transformation and sustainability transitions. We provide a tentative articulation of such a perspective by recombining insights from the fields of Industrial Dynamics and Transition Studies. We point to three issues that can serve as starting points for developing such a perspective and argue why those merit more attention in transition studies. These include: (a) attention to the diversity of sectors and firms involved in, and affected by, transitions through inter-sectoral linkages, (b) how existing knowledge bases influence the direction and scope of transitions, and (c) policy challenges associated with parallel transitions in multiple sectors that constitute economy-wide processes of structural change.

1. Introduction

Sustainability transitions redistribute resources, opportunities, and power among actors and are therefore often contested and conflict-ridden (Meadowcroft, 2011; Schlaile et al., 2017). To the wider public, aligning environmental and socio-economic goals, such as jobs and value creation, is a major concern (Foxon, 2018). The legitimacy of transition policies could thus be strengthened if transitions can be combined with the creation of new economic opportunities (Vona, 2019).

A transition refers to a 'fundamental' socio-technical reconfiguration in a focal sector[1] fulfilling a societal function whereby established technologies are replaced by, or combined with, emerging niche technologies (Geels, 2002; Geels and Schot, 2007). While this conceptualization emphasizes that transitions involve multiple interlinked technologies, it portrays transitions as a single-sector phenomenon with limited attention to linkages to upstream sectors (Andersen and Markard, 2019). At the same time, many jobs

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[1] A sector is a socio-technical system consisting of actors, institutions and technologies that generates a specific set of products (e.g. chemicals, cars or electronics) or services (e.g. energy supply or transportation) (Geels, 2004). A sector may use several key technologies. A 'focal sector' is a sector in a state of transition. Sector boundaries correspond to substantial differences in the core competences (e.g. in engineering, electronics, or chemistry) needed to deliver the product or service.

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affected by transitions are often located in upstream sectors providing the components, machinery and services that underpin the functioning of focal sectors. Viewing transitions as single-sector phenomena therefore inhibits our understanding of the associated industrial transformation processes.

We therefore see a need for more systematic conceptual integration of, on the one hand, changes in jobs and economic opportunities related to upstream sectors, and, on the other, the achievement of sustainability goals in focal sectors. We propose that more attention to the role of inter-sectoral linkages in transitions is a promising way forward. This is not only important for a better conceptual understanding of transitions, but it is also an important precondition for developing policies that combine decarbonization with economic opportunities—an issue which is at the heart of notions such as 'green new deal' and 'just transitions'. We suggest that revisiting and recombining key insights from Industrial Dynamics (ID) can provide a platform for such a perspective.

2. Industrial dynamics

ID is an area of research that combines elements from Innovation Studies, Evolutionary Economics and Management Studies. It is concerned with understanding the driving forces of economic transformation, with particular attention to knowledge and innovation. Transformation processes are embedded in institutional, technological, political and geographic contexts. Of key interest is the changing sectoral composition—emergence, growth, and decline of sectors—associated with structural transformation of economies (Carlsson, 2016; Kuznets, 1971). We derive three main insights from ID to better understand the connection between sustainability transitions and industrial transformation: inter-sectoral linkages and sector characteristics; territorial knowledge bases and sector development; and territorial innovation systems and shifting techno-economic paradigms (TEP).

First, inter-sectoral linkages are vital to innovation. For example, organized via technology value chains, there is often a division of labor in innovation between sectors with some applying innovations developed in other sectors (e.g. supplier-dominated) while others also supply innovations (e.g. specialized suppliers) (Pavitt, 1984). Such inter-sectoral linkages are also important for the evolution of 'technological (innovation) systems'—that typically encompass multiple sectors (Edquist, 1997; Stankiewicz and Carlsson, 1991). Sectors linked via technological systems moreover typically differ in patterns of transformation and innovation due to differences in actors, technology and institutions (Malerba, 2005; Nelson and Winter, 1982). For example, whether sector dynamics are characterized by Schumpeterian 'creative destruction' (Mark I) or 'creative accumulation' (Mark II) can be ascribed to sectoral characteristics (Breschi and Malerba, 1997; Castellacci, 2008). The evolution of a technology value chain is therefore influenced by the degree of alignment across heterogeneous but interdependent sectors.

Second, sectors and technologies are embedded in territorial contexts with different knowledge bases mirroring economic structures (Carlsson, 2016). The knowledge bases predominantly change incrementally and are part of the selection environment for new innovations and sectors (Boschma and Frenken, 2011; Smith, 2002). Knowledge bases therefore influence the potential for new jobs and economic activity via participation in new sectors (Asheim and Isaksen, 2002; Dosi, 1988). As a consequence, economic and technological diversification is mainly related to existing knowledge bases (Hidalgo et al., 2018; Neffke et al., 2011).

Third, major innovations cluster in time and space to give rise to 'great surges' of transformation that spur entirely new sectors. Notions such as 'system innovation' and broader shifts in TEP describe this phenomenon. TEP change in particular involves multiple interlinked sectors and has pervasive ripple effects throughout the economy (Freeman and Perez, 1988; Perez, 2009). The National Innovation System concept was conceived to understand and analyze the ability of a particular country (territory) to drive forward as well as adapt to shifting TEPs through institutional and organizational innovations (Lundvall, 1992). Territorial innovation system concepts can therefore be used to devise policy mixes for how entire economies can cope with and participate in TEP change (Smith, 2000).

3. Sustainability transitions and industrial transformation

Transition studies to some extent acknowledge the insights above. Guided by our interest in inter-sectoral linkages, we, however, recombine these insights to emphasize three novel aspects of the relationship between sustainability transitions and industrial transformation.

First, each particular technology involved in a focal sector transition consists of a technology value chain which encompasses upstream sectors that produce components and subcomponents of technologies and downstream sectors that apply technology (Arthur, 2009; Stephan et al., 2017).[2] The nature and interaction of these heterogeneous sectors involved in the value chain is central for understanding the industrial dynamics of how a technology emerges, transforms or declines as part of transitions (Andersen and Markard, 2019; Malhotra et al., 2019). Transitions involve multiple, interacting technology value chains, cf. Fig. 1. Sustainability transition processes in a focal sector thus affect upstream sectors via technological reconfigurations. How actors in upstream sectors respond to those change signals can impact both the direction and pace of the transition. An inter-sectoral linkage perspective provides a nuanced view on the different sectors and firms engaged in a particular technology and can connect those changes in

[2] We distinguish between upstream and downstream sectors in relation to a particular technology value chain. The focal sector is where the technology is applied (i.e. downstream), while upstream sectors are those that produce important components and subcomponents of the technology. Note that the focal, downstream sector (in transition) is viewed as broader than upstream sectors. The main difference is that the former includes users of sector output (e.g. electricity or mobility services) while for the latter users are based in other sectors. The purpose of this differentiation is to explicate inter-sectoral linkages.

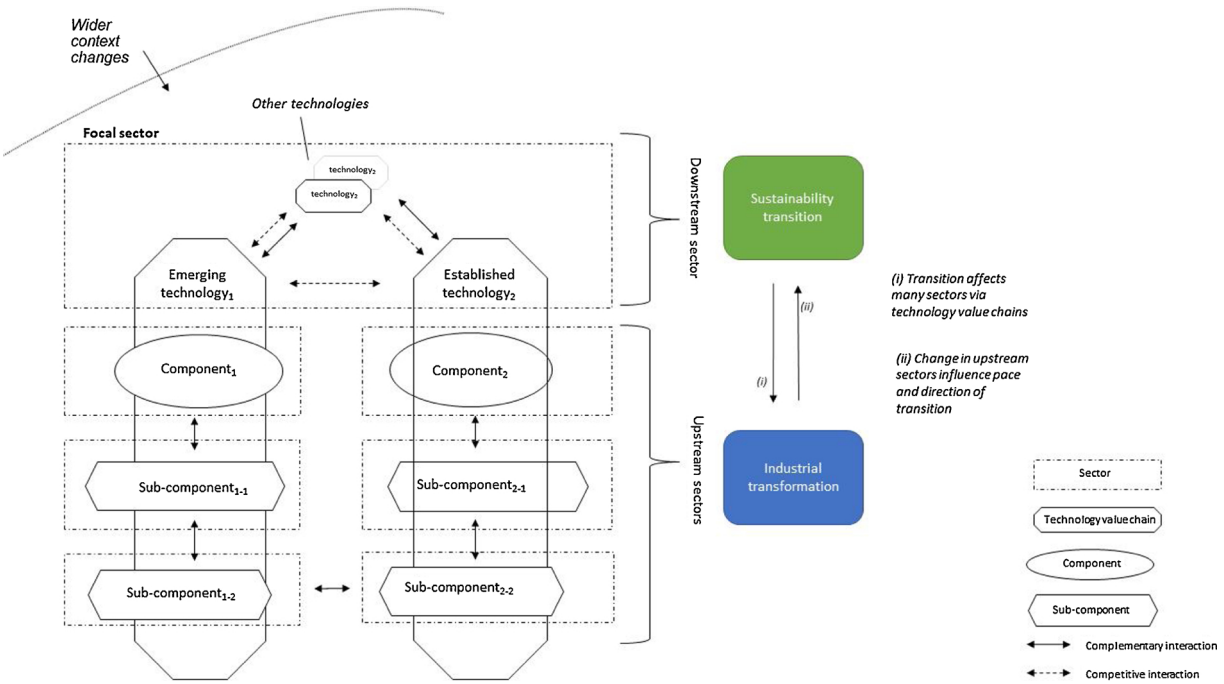

Fig. 1. Linkages between sectors and technologies in sustainability transition (based on Andersen and Markard (2019)).

upstream sectors to transition processes in a focal sector. It, for example, enables us to see how some sectors and firms (e.g. multi-technology firms) simultaneously are involved in multiple value chains including both clean-tech and fossil energy, see e.g. (Mäkitie et al., 2018). Looking upstream also helps to identify a range of mundane activities and jobs related to producing the 'nuts and bolts' of technologies that typically goes under the radar in transition studies. The latter also brings new types of actors to the fore such as labor unions and raw material providers. Industrial dynamics in upstream sectors thus warrant more attention.

Second, the ability of a particular territory to create jobs and new economic activities during a transition is conditioned by existing knowledge bases and industry structure (Boschma et al., 2017; Hansen and Coenen, 2015; MacKinnon et al., 2019). An inter-sectoral linkage perspective elicits that opportunities for participation in multiple transforming technology value chains can take place at different technology levels ranging from specially designed components over installation services to manufacturing of 'nuts and bolts'. Technology value chains and participating sectors often have inherently different characteristics (Malhotra et al., 2019). Opportunities for participation for a particular territory will therefore vary across technologies. Informed by an inter-sectoral linkage approach, policies aimed at aligning environmental and economic goals in transitions may therefore support the transition pathways most compatible with existing knowledge bases. This could take place via redeployment of existing sector and firm capabilities and resources to 'minimize' disruption and 'maximize' knowledge continuity in a particular territory with positive implications for jobs and value creation, thus increasing the political feasibility of transitions (Andersen and Gulbrandsen, under review; Mäkitie et al., 2019).

Third, sustainability challenges arguably involve parallel transitions in multiple sectors such as transport, agriculture, and electricity. As these transitions advance, they interact more and more (Geels et al., 2017; Markard, 2018). This moves the scope of the phenomenon beyond 'system innovations' in a focal sector to resemble a TEP shift (Mathews, 2013; Schot and Kanger, 2018). When we acknowledge the full range of sectors and technology value chains involved in multiple transitions as well as their 'ripple effects' in the economy, sustainability transitions grow increasingly pervasive to transcend sectoral and technology frameworks. It constitutes an economy-wide process of structural transformation with major implications for employment, value creation, and even trade patterns. As multi-sectoral transition processes also are multi-scalar, it is germane to ask whether different territorial innovation system concepts could be reinvigorated as part of addressing the intersections between territorial innovation systems, and technological and sectoral innovation systems in a more dynamic way than previously (see e.g. Bergek et al., 2008). A novel integrative perspective may be created to study and guide policymakers in coordinating multiple transitions. In this regard, an inter-sectoral linkage perspective provides a way to consider the balance and interactions between environmental (focal sector) and economic (upstream sectors) goals across the economy. This would also include aligning knowledge infrastructures (e.g. education, science, vocational training) and wider institutional arrangements (e.g. labor market and trade regulations) with the overall transition goals (see e.g. Fagerberg, 2018).

We argue that these three points are useful starting points for further work to systematically integrate the dynamics of transition processes in focal sectors driven by sustainability goals with associated open-ended, evolutionary processes of industrial transformation.

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