ECON 7800: Macroeconomics

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Course Time: Wednesday, 6:30-9:20 PM

Office hours: Friday, 3:30-6:30 PM, WLB 519

1 Syllabus

1.1 Summary

This course is an introduction to macroeconomics, the study of economic aggregates. Whereas microeconomics focuses on particular entities–consumers, firms, or industries–taking the rest of the economy as given, macroeconomics focuses on general equilibrium. Of particular interest are fluctuations in consumption, investment, output, unemployment, and inflation. Macroeconomics can also be divided into theory of growth or business cycle fluctuations. We will cover some long-run issues in class, particularly related to money, but will emphasize business cycle fluctuations.

The first block of the course, composed of two lectures, contains key preliminaries: mathematical background and time series methods. The former includes a review of calculus and constrained optimization. The second encompasses autoregressive moving average (ARMA) and Markov processes. There are is also material on decomposing business cycles into cycles and trends to be read by the students.

The second block comprises two lectures on overlapping generations (OLG) models, in which individuals have finite lives and each period contains individuals from different generations. We study a simple OLG model to capture dynamic tradeoffs between consumption and investment, and then use it as a vehicle for introducing fiat money. Young individuals acquire money in order to finance consumption when old. We then examine a more advanced model to study banking issues.

The third block, consisting of three lectures, is an introduction to the business cycle theory. We start out with the standard real business cycle model; there are productivity shocks, and individuals respond by changing their choice of consumption, investment, and labor supply. We focus on calibration and simulation of the standard model. We also examine the log linear representation of the model.

In simulating business cycle models, we will discuss Euler-equation based methods, which are valid when the first order conditions are sufficient; and perturbation methods, which consider a Taylor approximation around the steady state.

The standard model captures several features of the business cycle well but misses others. We consider several extensions to the model which improve performance. These include investment-specific productivity shocks. Two more ambitious lines of extension encompass endogenous entry of firms selling differentiated goods, which affects households' ability to diversity consumption over the business cycle. These assumptions improves the performance in several dimensions.

In general, these models fit into the class called *dynamic stochastic general equilibrium models* (DSGE). The reason is that there is a focus on general equilibrium in a dynamic context subject to shocks. Agents' expectations of the future–which influence their choice today–is a key endogenous variable of the system. In solving these models, we typically assume that agents form the best forecast given available information. This assumption is called *rational expectations*.

In the fourth block, we incorporate financial frictions. In this setting, firms are restricted in their ability to invest due to collateral (limited enforcement) or there is a moral hazard problem in which firms' investment return is stochastic but unobservable to creditors without costly monitoring. In this case, the optimal contract has creditors requiring a repayment threshold and monitoring if the entrepreneur does not satisfy it. These models capture the fact that movements in asset prices–caused by shocks to productivity or other forces–have an adverse effect on investment and thereby induce a downturn.

The fifth block is a treatment of models with heterogeneous agents. For these models, the households cannot be collapsed into a *representative agent*, as is the case for the prior models. The wealth distribution depends on prices and consumption decisions, which in turn depend on the wealth distribution. The first model we examine is Aiyagari(1994). Here, households make a consumption/savings decision with idiosyncratic labor income risk and a borrowing constraint. Due to the precautionary savings motive, steady-state equilibrium features greater capital and lower interest rates than in the absence of labor income risk. This model cannot be solved analytically; we examine it numerically in a Python program. Next, we study a similar setting by Guerrieri and Lorenzoni (2017), in which households are faced with a credit crunch–a tightening of the borrowing constraint over several periods. The interest rate falls sharply on impact, overshooting the new steady state as households attempt to increase their savings. Poorer households raise labor hours and wealthier households reduce them. Since the latter are more productive on average, output actually falls due to a composition effect.

Heterogeneous-agent models are important for addressing distributional issues as well as the consequences of variation in the marginal propensity to consume. A key statistic is the presence of hand-to-mouth consumers, those who consume all their liquid resources each period. Such consumers may lack illiquid wealth ('poor hand-to-mouth') or possess liquid wealth ('rich hand-to-mouth'). In the following lecture, we study a simple model of hand-to-mouth consumers and examine empirical evidence thereof.

We wrap up the course with a search-and-matching approach to unemployment. Unemployment is both a key variable of interest and also important consideration in income risk, unemployment benefits, business cycle asymmetries, and unutilized capacity.

1.2 History and methodology

Macroeconomics–as separate from microeconomics–was only developed in the 1930's in *The General Theory of Employment, Interest, and Money* by John Maynard Keynes. This work introduced several key ideas, most notably the notion of the possibility of insufficient aggregate demand, the theory of liquidity preference and liquidity premium, and the fiscal multiplier, that is, the effect of government purchases on output. However, the theory was informal and was used to impose constraints on econometric systems of equations. Lucas (1972) pioneered theoretical dynamic systems featuring intertemporal optimization and rational expectations. Rational expectation means that agents–households and firms–optimally forecast future quantities, which influence current decisions. Kydland and Prescott (1982) developed the first significant business cycle model consisting of optimizing agents, rational expectations, and market clearing. This work initiated a long line of research of so-called dynamic stochastic general equilibrium models. Blanchard and Kiyotaki (1987) considered the role of monetary policy transmission operating through monopolistic competition and nominal rigidities. Mortensen and Pissarides (1994) seveloped a search and matching approach to unemployment. Lively literatures have developed on liquidity (Lagos and Wright 2005), heterogeneous agents (Krusell and Smith 1998, Kaplan and Violante 2010), financial frictions (Kiyotaki and Moore 1997; Bernanke Gertler and Gilchrist 1999), and unemployment (Mortensen and Pissarides 1994).

1.3 Textbook

There is no simple textbook–or set–which offers a comprehensive treatment of macroeconomics. Course lectures will draw on a number of different texts, alongside the lecture notes and papers. The aim of the lecture notes is to synthesize the material and thereby learning. The course draws on material from the following books:

Petrosky-Nadeau, Nicolas and Wasmer, Etienne. *Labor, credit, and goods markets: the macroeconomics of search and unemployment*

Ljungqvist, Lars and Sargent, Thomas. *Recursive macroeconomic theory.*

McCandless, G.T. Jr. & Wallace, N. (1992). *Introduction to Dynamic Macroeconomic Theory: An Overlapping Generations Approach.*

Hamilton, James. *Times series analysis.*

Azariadis, Costas. *Intertemporal Macroeconomics.*

McCandless, George. *The ABCs of RBCS.*

Cochrane, John. *Asset Pricing.*

The first text, often abbreviated LSP, covers many of the topics in class. However, it is very minimal in empirics and the writing style is not very friendly for students. The text by Hamilton is the standard reference on time series analysis, as is the text by Azariadis for dynamic systems. McCandless' text offers very practical guidelines on solving real business cycle models. The text by McCandless and Wallace is a nice supplement on overlapping generations models.

1.4 How to study for this course

Lectures are dense, and the course covers an ambitious amount of material. To better digest the material, I suggest the following guidelines.

- You will receive the lecture material several days prior to lecture. Review the lecture as much as possible *before* class. You will be able to follow the lecture more effectively as a result.

- Next, review the lecture a day (or at most two) after class as you work on the homework.

- Discussing and work through problems with classmates.

- If confused or need clarification, ask a question on Moodle. That way everyone can benefit.
- Do supplementary reading and use self-testing to solidify understanding.

1.5 Computation and Python

This course will make heavy use of the open-source programming language Python and will often reference the lectures and examples from QuantEcon: https://lectures.quantecon.org/py. I strongly suggest you work through the QuantEcon lectures 'Introduction to Python' through 'Data and Empirics' prior to the start of the course. These lectures will familiarize you with the basic Python objects, syntax, libraries for scientific computing (especially NumPy, Scipy, and Matplotlib), data manipulation and regression, and good coding practice.

I strongly recommend you install Python from https://www.anaconda.com/download/, which includes some of the most important libraries. A guide to setting up the Python environment is available on https://lectures.quantecon.org/py/getting_started.html. There are also instructions on updating Anaconda and installing new packages.

The installation also provides several different graphics user interfaces for using Python. Spyder is a MATLAB style IDE, and is more intuitive if you are used to Matlab. There is also a notebook interface via a Jupyter notebook. This interface is similar to that of Mathematica and integrates code, outbook, and text in executable chunks. Some of you may be familiar with VisualStudio Code. It is an editor that contains extensions for many languages, including Python.

One of most useful packages is quantecon. It supports various tools related to Markov processes, solving discrete dynamic programs, and optimization methods.

1.6 Mathematical typesetting

Researchers generally use LaTeXto typeset. Check out *The Not So Short Introduction to LaTeX*. You can install the language through Miktex. You also need a LaTeXeditor. I generally recommend TexStudio, but you can check out this article on the most popular editors.You are welcome to type up your homeworks and the referee report in TeX, and to prepare the presentation using the document class beamer. However, you are free to submit material in whichever format you feel comfortable. It is important you spend time engaging with the material rather than learning a typesetting method.

1.7 Referee report, presentation, and connection to the final exam

Doing a close reading and assessing articles critically is an important skill in economics. Accordingly, you will write a referee report of a paper and present on it at the end of class as part of a group. I will provide a list of possible papers, but you are welcome to request an article outside the list if it complements the course material well. In general, the structure of the referee report is

- Summary (includes statement of research problem, methodology, and relation to literature)
- Major revisions (what are the major areas in which the paper can be improved?)
- Minor revisions (in what minor ways can the paper be improved? This includes issues of flow, presentation, and auxiliary results).

The referee reports and presentations will cover major extensions and work related to the themes of the course that were not feasible due to time constraints. I emphasize that in order to adequately assess the paper in the context of the literature, you will need to reference several background papers and concurrent work in the referee report.

1.8 Course outline

Introductory tools: constrained optimization, time series, and dynamic systems

Week 1: Introduction and mathematical preliminaries. Supplementary material on business cycle filtering and Taylor series.

Week 2: Time series (ARMA's, Markov processes) and systems of difference equations. Suggested readings: Hamilton, Chapters 1-3; Ljungqvist and Sargent, Chapter 1; Quantecon lectures 'Tools and Techniques'

Overlapping generations and long-run trends

Week 3: Overlapping generations model I

Week 4: Overlapping generations model II

Business cycle fluctuations

Week 5: Basic real business cycle model. Suggested reading: King and Rebelo (1999), 'Resuscitating Real Business Cycles'

Week 6: Solution of RBC model and extensions

Week 7: Endogenous entry, product variety, and business cycles.

Midterm covers material around here.

Financial frictions

Week 8: Financial frictions in business cycle models.

Wealth heterogeneity and liquidity

Week 9: Introduction to heterogeneous agents: Aiyagari (1994) and Guerrieri and Lorenzoni (2017)

Week 10: A model of liquid and illiquid assets; role of rich hand-to-mouth households

Week 11: Unemployment (Mortensen-Pissarides framework)

Presentations

Week 12: Student presentations

Week 13: Student presentations

1.9 Exams and Grading Policy

The final grade for the course will be determined as follows:

Problem sets: 30%

Referee report: 10%

Presentation: 10%

Attendance/Participation: 10%

Midterm: 15%

Final Exam: 25%

The grade is comprised of problem sets, midterm, the final exam, a referee report on a paper, and attendance and participation points. Note that a full 50% of the course is not based on exams. This is designed so that you focus more on practicing the material, connecting the theory and the programming, and learning to work with others. It is important to develop skills beyond those which readily lend themselves to testing.

Homework questions involve a mix of analytical/numeric problems to be done by hand and computational problems. The latter may involve replicating results or simulating a model. Some of these will require a lot of time, so start early and work patiently.