

# Advanced Macroeconomic Techniques

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## **Prerequisites**

316-403 Advanced Macroeconomics

## **Contact**

Three hours of lectures and seminars per week

## **Formal subject description**

Introduction to recent developments in macroeconomics. Students will learn how to formulate and solve stochastic dynamic economic models and to apply these techniques to a number of substantive issues in consumption, asset pricing, business cycle theory, monetary economics, and labour economics. The subject will also cover dynamic models with heterogeneous households and will use these models to analyze a range of issues including income and wealth inequality.

## **Assessment**

Mid-semester examination (20%), final examination (50%) and class assignments of up to 3000 words (30%)

## **Texts**

Main text

- Ljungqvist, Lars, and Thomas J. Sargent. 2000. *Recursive macroeconomic theory*. Cambridge, MA: MIT Press

A preliminary version of the second edition of Ljungqvist and Sargent's text is available from Sargent's webpage (<<http://www.stanford.edu/~sargent/>>). Some other useful books that you might want to look at include

- Jérôme Adda and Russell Cooper. 2003. *Dynamic economics: Quantitative methods and applications*. Cambridge, MA: MIT Press

- John Cochrane. 2001. *Asset pricing*. Princeton, NJ: Princeton University Press
- Christopher Pissarides. 2000. *Equilibrium unemployment theory*. Cambridge, MA: MIT Press

### Informal subject description

This course is designed to introduce you to the methodology of modern macroeconomics. About half of the course will be concerned with basic tools and concepts of dynamic stochastic economic theory. In this part of the course, we'll study tools like difference equations, dynamic programming and Markov chains but most importantly we'll begin to write simple computer programs to help us solve and understand the properties of economic models that are often too complicated to be worked out "by hand". We'll begin to put this toolkit to work studying frictionless environments like the neoclassical growth model and the real business cycle model. In the second half of the course, we'll talk about some of the main empirical failings of frictionless models and will then turn to attempts to address some of these limitations. Along the way, we'll cover a number of important papers on asset prices, income and wealth inequality, and labour markets. We'll look at some of these papers in detail — specifically, I'll assign problem sets that involve you reproducing key points. Other papers we'll cover in less detail — I'll simply provide an overview of the issues and the main findings.

The technical background needed to participate in this course will actually be quite modest. All that will really be required is some elementary knowledge of static optimization theory (Lagrangians, etc), some matrix algebra, and some statistics (expected values, etc). For many students, the main novelty will be writing computer programs to solve models. You will be allowed to program in any language you like, but I will be encouraging you to use Matlab (and will write answers to problem sets, etc, assuming you're using Matlab) which will be available through the Department's Citrix server:

<http://hearn.ecom.unimelb.edu.au/Citrix/MetaFrameXP/default/login.asp>

I will try to make this process as painless as possible by providing bits of useful code that you can use as a starting-point. By solving models on the computer, you'll not only sharpen your economic intuition but also begin to develop an appreciation for the **quantitative** content of economic ideas. This is not a course in computational or numerical methods, however. We'll be learning about such things only to the extent that we need them in order to understand important economic ideas.

## Growth and RBC models

### Refresher on the Solow model

(2 classes). We'll start our tour of quantitative macroeconomics by quickly reviewing the Solow growth model. This will provide a forum for learning a few useful facts about difference equations, steady states and the stability properties of one-dimensional dynamic models. We'll also learn how to write simple programs in Matlab to do many of the relevant calculations.

## Ramsey-Cass-Koopmans

(4 classes). Next we'll begin our study of intertemporal decision making. We'll learn about the optimal growth model due to Ramsey, Cass, and Koopmans. We'll learn about systems of difference equations, and the stability properties of multivariate dynamic models. Most importantly, we'll begin to use dynamic programming as a methodology for understanding intertemporal decision making. We'll then turn to using Matlab to implement simple numerical methods for approximating the solutions of these dynamic programming problems.

## Stochastic growth and real business cycle models

(5 classes). We'll then turn to intertemporal decision making under uncertainty. First, we'll have to learn some background material on stochastic difference equations that will provide a way of thinking about random shocks that hit our model economies. We'll learn more about dynamic programming and practical methods for approximating the solutions of stochastic dynamic programming problems. Finally, we'll also begin to learn about the real business cycle model as a substantive application of many of the ideas we've learnt so far.

Main references:

- Ljungqvist and Sargent, chapters 1, 2, and 3
- Harald Uhlig. 1999. A toolkit for analyzing nonlinear dynamic stochastic models easily, in Ramon Marimon and Andrew Scott (eds). *Computational methods for the study of dynamic economies*. Oxford. Oxford University Press
- Robert King and Sergio Rebelo. 1999. Resuscitating real business cycles, in John Taylor and Michael Woodford (eds). *Handbook of macroeconomics* 1B. Amsterdam: Elsevier

The Matlab program files to accompany Uhlig's article (and a draft of the article itself) are available from (<http://www.wiwi.hu-berlin.de/wpol/html/toolkit.htm>). We will make extensive use of these files to make our lives easier.

## Competitive equilibrium with complete markets

(1 class). Depending on how we're doing for time, we'll then take a brief conceptual detour. Specifically, we'll learn about the general equilibrium foundations of the growth models that we've been studying. That is, we'll reinterpret our stochastic growth models as Arrow-Debreu general equilibrium models with a rich ("complete") set of asset markets. We'll use this formulation to talk about issues like risk sharing, aggregation, and the assumptions implicit behind representative agent models.

Main reference:

- Ljungqvist and Sargent, chapter 7

# Asset pricing

## Consumption-based asset pricing

(4 classes). We'll then turn to a key application of the complete markets paradigm — asset pricing. We'll learn about risk and return and the pricing of securities. Most importantly, we'll talk about the equity premium puzzle as an example of a major empirical failure of the complete markets paradigm. To deepen our understanding of these issues, we'll begin to reproduce some key articles in the literature, specifically Mehra and Prescott's original equity premium paper as well as a famous attempt by Campbell and Cochrane to solve this and other asset pricing puzzles.

Main references:

- Ljungqvist and Sargent, chapter 10
- Cochrane, chapters 1, 2, and 21

Some articles I'd like us to reproduce:

- Raghuram G. Rajan and Edward Prescott. 1985. The equity premium: A puzzle, *Journal of Monetary Economics*. 15(2): 145-162
- John Campbell and John Cochrane. 1999. By force of habit: A consumption-based explanation of aggregate stock market behavior, *Journal of Political Economy*. 107(2): 205-251

## Heterogeneity and incomplete markets

### “Bewley models”

(3 classes). Next we'll turn to departures from the complete markets paradigm. We'll study consumption/savings problems when individuals cannot fully insure themselves against idiosyncratic risk. After that, we'll reproduce a key paper by Aiyagari that studies a large cross-section of heterogeneous individuals in general equilibrium when markets are incomplete. To reproduce this paper, we'll be drawing extensively on some of the tools and Matlab programs that we've already developed. Finally, we'll talk about the use of such models to analyze income, earnings and wealth inequality.

Main reference:

- Ljungqvist and Sargent, chapters 13 and 14

An article I'd like us to reproduce:

- Rao Aiyagari. 1994. Uninsured idiosyncratic risk and aggregate savings, *Quarterly Journal of Economics*. 109(3): 659-684

Some other articles I'd like to discuss:

- Per Krusell and Anthony Smith. 1998. Income and wealth heterogeneity in the macroeconomy, *Journal of Political Economy*. 106(5): 867-896
- Ana Castañeda, Javier Díaz-Giménez, and José-Víctor Ríos-Rull. 2003. Accounting for US earnings and wealth inequality, *Journal of Political Economy*. 111(4): 818-857

## Search and matching

### Job search

(2 classes). Our next topic will be equilibrium models of labour markets and unemployment. We will begin by discussing the problem facing a single agent who is searching for a job. Models of this kind provide a standard way of thinking about frictional unemployment and labour market flows. This will also give us yet more practice with numerical dynamic programming implemented in Matlab.

Main reference:

- Ljungqvist and Sargent, chapter 5

### Equilibrium search and matching

(3 classes). We'll then turn to equilibrium models of job search and the matching process between workers and firms. We'll talk about a popular model, due to Mortensen and Pissarides, which studies a large cross-section of individuals simultaneously searching for jobs when the labour market is not frictionless. Depending on time, we'll try reproduce a recent paper by Shimer and talk about some other research of his that documents the main empirical success and failures of the Mortensen-Pissarides model.

Main references:

- Pissarides, chapters 1 and 2
- Ljungqvist and Sargent, chapter 19

An article I'd like us to reproduce:

- Robert Shimer. 2004. The consequences of rigid wages in search models, NBER working paper 10326

Some other articles I'd like to discuss:

- Dale Mortensen and Christopher Pissarides. 1994. Job creation and job destruction in the theory of unemployment, *Review of Economic Studies*. 61(3): 397-415
- Robert Shimer. 2003. The cyclical behavior of equilibrium unemployment, vacancies and wages: Evidence and theory, NBER working paper 9536

## Schedule of classes

- L1 Introduction
- L2 Solow growth model, linearizations
- L3 Ramsey growth model
- L4 Method of undetermined coefficients I
- L5 Dynamic programming I
- L6 Dynamic programming II
- L7 Stochastic difference equations
- L8 Method of undetermined coefficients II
- L9 Real business cycles I
- L10 Real business cycles II
- L11 Markov chains
- L12 Complete markets competitive equilibrium
- L13 Asset pricing I
- L14 Asset pricing II
- L15 Asset pricing III / Mehra-Prescott
- L16 Asset pricing IV / Campbell-Cochrane

### SEMESTER BREAK

- L17 Incomplete markets / Aiyagari
- L18 Stochastic dynamic programming
- L19 Simulating the Aiyagari model
- L20 Job search I
- L21 Job search II
- L22 Equilibrium Search & matching I
- L23 Equilibrium Search & matching II / Mortensen-Pissarides
- L24 Equilibrium Search & matching III / Shimer