Quantitative Macroeconomics
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Office Hours: TBD

This is designed as a 6 week course. 5 ECTS.

Description:

The aim of this course is to learn the tools and algorithms to undertake research in quantitative economics. This course is divided in four chapters. Chapter 1 introduces the topic of quantitative economics. Chapter 2 presents the relevant numerical methods that help us solve modern macro models. Chapter 3 and 4 presents applications of these methods i.e. solve heterogeneous agent models in stationary and non-stationary environments, with or without aggregate shocks. Finally chapter 5 presents some discussion topics in quantitative macro.
This course is computationally intensive, thus previous programming knowledge is a requirement. You can choose your favorite programming language (Fortran, C, Julia, Python, Matlab, etc).

Course Material:

- Lectures will be based on the instructor's lecture notes
- Complementary readings
- Textbook References:
    1. (KJ) Kenneth L. Judd, Numerical Methods in Economics (1998), MIT Press
    2. (HM) Burkhard Heer and Alfred Maußner (2009), Dynamic General Equilibrium Modeling, 2nd edition, Springer
    3. (MS) Ramon Marimon and Andrew Scott (2001), Computational Methods for the Study of Dynamic Economies, Oxford University Press.
    4. (LS) Lars Ljungqvist and Thomas J. Sargent,Recursive Macroeconomic Theory 3nd edition

Grading:

30% Problem sets (3 Problem sets)
70% Final Project

For the final project you will be asked to replicate the main results of an influential paper. Talk to me if you have a paper in mind.

TA sessions:

Coding, Problem Set Solutions, Paper Discussions and Replications

Overview

1. Introduction

1.1. What is quantitative macro.
1.2. Computational basics. (git!)
1.3. Review of the theory, the neoclassical growth model.

References and Readings:
- LS Chapter 3.
- Browning, Martin, Jim Heckman, and Lars Hansen (1999). Micro Data and General Equilibrium Models.

2. Numerical Methods

First Part

2.1. Numerical differentiation and integration.
2.2. Root finding methods.
2.3. Unconstrained and constrained optimization.
2.4. Function approximations, the projection methods algorithm
- Local methods.
- Global methods.
- Neural networks and Deep learning

References:
- KJ Chapters 4,5,6,7,11
- HM Chapters 6,11

Second Part

2.5. Review of dynamic programming.
2.6. Discretization
2.7. Value function methods.
2.8. Perturbation methods.
2.9. Parametrized expectations.
2.10. Euler equation methods.
2.11. Endogenous grid method.

References:
- KJ Chapters 6,12.
- HM Chapters 2,5.
- MS Chapters 2,6,7.

Readings:
- Guvenen, Fatih (2009). An empirical investigation of labor income processes.
- Kopecky, K. and R. Suen (2010). Finite State Markov Chain Approximations to Highly Persistent Processes
- Barillas and JF-Villaverde (2006). A generalization of the endogenous grid method.

3. **Heterogeneous Agent Models (ABHI)**
   - 3.1. Benchmark incomplete markets economy.
   - 3.2. Precautionary savings.
   - 3.3. Consumption, income and wealth inequality.
   - 3.4. Firm dynamics and entrepreneurship.
   - 3.5. Aggregate shocks, and the business cycle.

   References:
   - HM Chapters 7,8.
   - MS Chapter 11.

   Readings:
   - Aiyagari, S. R. (1994). Uninsured idiosyncratic risk, and aggregate saving.
   - Marcet, Albert and Obiols, Francesc and Weil, Philipp (2007) Incomplete Markets, Labor Supply and Capital Accumulation.
   - Quadrini, V. (2000). Entrepreneurship, saving and social mobility.
   - Krusell, P. and A.Smith (1998). Income and wealth heterogeneity in the macroeconomy.

4. OLG Models
   - 4.1. Benchmark life-cycle model.
   - 4.2. Business cycles in OLG models.
   - 4.3. Demographics, life-cycle earnings profiles.
   - 4.4. Demographics, economics of the family.
     - Housing and durable goods.
     - Fertility and children's education.
     - Marital status.
   - 4.5. OLG and optimal taxation.

   References:
   - LS Chapters 9.
   - HM Chapters 9,10

   Readings:
   - Weil, Philipp (1989) Overlapping Families of Infinitely-Lived Agents.
   - Ríos-Rull, J.-V. (1996). Life cycle economies and aggregate fluctuations.
   - Hong, J.H. and J.-V. Ríos-Rull (2004). Life insurance and household consumption.
   - Conesa, J.C., Kitao, S., and Krueger, D. (2009). Taxing Capital? Not a Bad Idea after All!

5. **Topics in Quantitative Macro**
   - 5.1. Job stability and lifetime inequality.
   - 5.2. Precautionary job search motives.
   - 5.3. (internal) Migration.
   - 5.4. Optimal tax progresivity.

   Readings:
   - Sepahsalari and Eeckhout (2021) The effect of wealth on worker productivity.
   - Lull and Miller, (2018) Internal migration and work experience in dual labor markets.
   - Zoi, (2022) Optimal progresivity over the business cycle.

Class Schedule

Day	Topic	Assignments
1	Introduction to the basics and review of the neoclassical growth model	
2	Numerical methods I: Montecarlo integration, Nelder-mead	
3	Numerical methods I: Taylor, Spectral methods, Chebyshev, Machine learning	
4	Numerical methods II: Discretization, Value Function Iteration	HW1 Due
5	Numerical methods II: Reiter's method, Dynare	
6	Numerical methods II: Endogenous grid method	
7	ABHI: Recursive stationary equilibria and transitional dynamics	
8	ABHI: Savings, social mobility and the creation and destruction of firms	HW2 Due
9	ABHI: Krusell Smith algorithm	
10	OLG: Lifecycle income dynamics, finite vs infinite horizon	
11	OLG: Dual earner households and commitment	
12	OLG: Optimal taxation	HW3 Due
13	Discussion Papers	
	FINAL	