Quantitative Macroeconomics
(with heterogeneous agents)

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Schedule. Monday 09:30-11:00, Monday 11:30-13:00, and Thursday 15:00-16:30.

Objective. This course introduces the techniques of modern quantitative macroeconomics to study economies with either (a) household heterogeneity –with a special focus on the life cycle dimension– or (b) firm heterogeneity –with a special focus on firm dynamics. One important aspect of the course is the emphasis on learning how to solve these economies in the computer. To this end, there is sequence of problem sets that will guide you to solve the canonical models of Aiyagari (1994) and Huggett (1996) for the household heterogeneity part, and Hopenhayn and Rogerson (1993) for the firm heterogeneity part.

Requirements. Before taking the course you need to understand three things: (1) dynamic programming, (2) a little bit of measure theory and (3) Markov chains. There are several references to refresh the basics of dynamic programming: a simple one is (Ljungqvist and Sargent, 2004, chapter 3). Obviously, the most complete source is Stokey et al. (1989). Its first chapter is a very easy help. All the measure theory you need to know for this course is contained in some short notes I will provide to you. But if you want more you can check (Stokey et al., 1989, chapter 7) or even better Royden (1988). For Markov chains, a good reference is (Ljungqvist and Sargent, 2004, chapter 2) and I will also give you some notes. A very comprehensive treatment can be found in (Stokey et al., 1989, chapter 8).

Homework. The homework will be computer based. Problem sets have to be solved in (stable) teams of two, but only one copy per team needs to be handed in.

Computer languages. During the course you will have to do a substantial amount of programming. I do not care which language you use, it is your choice and your responsibility. Students taking a course like this at CEMFI and elsewhere tend to choose Julia or Matlab, but this might as well be a good moment to invest in learning Fortran.

Student workshops. Students will be asked to present a paper related to the topics covered during the course. Presentations will last for 45 minutes, and everybody in the class is expected to read the paper in advance. The idea is that these workshops are like a reading group.

Structure. As all CEMFI courses, we have 30 ninety-minute sessions spread over 10 weeks. My plan is to use 20 sessions for theory, 5 sessions to discuss your homework, 4 sessions for the student workshops, and 1 session with some Julia and programming introduction.

Books and references. There is no basic textbook for this course and most of the material comes from papers and chapters of different books. I list the basic references for each part in the next pages. Regarding numerical methods, easy introductions can be found in (Adda and Cooper, 2003, chaper 3) and (Ljungqvist and Sargent, 2004, chapter 4). In depth coverage of some very useful methods for economists can be found in Marimon and Scott (1999). Judd (1998) is very comprehensive (encyclopedic) and is a very good reference. Finally, Heer and Maussner (2009) is a more recent textbook also worth looking at.

Evaluation. The final mark will be an average of the final exam (70%), the homework (25%), and the student presentations (5%).

More information. This syllabus, exercise lists, and any other supporting material can be found in the intranet (https://intranet.cemfi.es/). I will update its contents throughout the course.

Part I. The Neoclassical Growth Model with Heterogeneous Households.

Estimated duration: 3 theory sessions

1. The neoclassical stochastic growth model: recursive formulation.

   Brock and Mirman (1972) and (Stokey et al., 1989, chapter 1)

2. Stylized facts on inequality.

   Kuhn and Ríos-Rull (2016), Krueger et al. (2010) and Heathcote et al. (2010a)

3. The heterogeneous agents model in steady state.

   Huggett (1993), Aiyagari (1994), Dávila et al. (2012)

   For a textbook exposition see (Ljungqvist and Sargent, 2004, chapters 16 and 17).

Part II. Numerical Methods Applied to Heterogeneous Agents Economies.

Estimated duration: 4 theory sessions

1. Solving the household problem

   - Projection methods

     Judd (1992), (Judd, 1998, chapter 11) and McGrattan (1998)

   - A simple application: policy function iteration w/ piecewise linear approximation

2. Finding the steady state equilibrium.

   - Finding the stationary distribution: Montecarlo simulation, Young's method

     Young (2010)

   - Finding the equilibrium prices

     Aiyagari (1994) and Ríos-Rull (1998)

3. Accuracy.

   Judd (1992)

4. Solving non-linear equations

   (Judd, 1998, chapter 5) or (Heer and Maussner, 2009, section 11.5)

5. Classical calibration, modern calibration and estimation.

   Cooley and Prescott (1995) and Castañeda et al. (2003)

Part III. Some Extensions of the Heterogeneous Households Model.

Estimated duration: 4 theory sessions

1. Complete markets.

   (Ljungqvist and Sargent, 2004, chapter 8)

2. Life Cycle

   Huggett (1996)

3. Endogenous Labor

   Pijoan-Mas (2006), Heathcote et al. (2010b)

4. Outside the Steady State

   Krusell and Smith (1998), Ríos-Rull (1998). Textbook exposition: Krusell and Smith (2006)

Part IV. Labour market uncertainty: characterizing labor earnings.

Estimated duration: 1 theory sessions

1. The standard income process and the evolution of earnings inequality

   Storesletten et al. (2004), Storesletten et al. (2001), Heathcote et al. (2010b)

2. Heterogeneous income profiles

   Guvenen (2009), Guvenen (2007) and Guvenen and Smith (2014)

3. Non-linear earnings processes

   Guvenen et al. (2021), Arellano et al. (2017), De Nardi et al. (2020)

4. Endogenous earnings

   Huggett et al. (2011)

Part V. Wealth Inequality.

Estimated duration: 2 theory sessions

1. Some facts

2. Non-linear earnings

   Castañeda et al. (2003), De Nardi et al. (2020)

3. Heterogenous returns to savings

   Angeletos (2007), Hubmer et al. (2021)

Part VI. Firm Heterogeneity.

Estimated duration: 6 theory sessions

A good survey on the topic can be found in Hopenhayn (2014b)

1. Some data
2. Entrepreneurship

   Lucas (1978), Guner et al. (2008)
3. Firm dynamics

   Hopenhayn (1992), Hopenhayn and Rogerson (1993), Restuccia and Rogerson (2008)
4. Misallocation

   Hopenhayn (2014a), Hsieh and Klenow (2009), Bartelsman et al. (2013)
5. Financial frictions

   Moll (2014), Midrigan and Xu (2014)

Part VII. Student Workshops.

Estimated duration: 5.5 sessions

1. Recessions

   (Week 6, Thursday)

   - G. Kaplan, K. Mitman, and G. Violante. The housing boom and bust: Model meets evidence. *Journal of Political Economy*, 9(128):3285–3345, 2020

     Presented by Eugenio Renedo
   - M. Nakajima and J.-V. Ríos-Rull. Credit, bankruptcy, and aggregate fluctuations. Mimeo, 2019

     Presented by Ana Paula Satorres

2. Heterogeneous MPCs and the Aggregate Economy

   (Week 7, Monday)

   - G. Kaplan and G. Violante. A model of the consumption response to fiscal stimulus payments. *Econometrica*, 4(82):1199–1239, 2014

     Presented by Phillip O'Riordan
   - A. Auclert and M. Rognlie. Inequality and aggregate demand. mimeo, 2020

     Presented by Tomas Opazo

3. Inequality trends

   (Week 9, Monday)

   - J. Heathcote, K. Storesletten, and G. Violante. The macroeconomic implications of rising wage inequality in the united states. *Journal of Political Economy*, 118(4): 681–722, 2010b

     Presented by Magdalena Llompart
   - J. Hubmer, P. Krusell, and A. A. Smith. Sources of u.s. wealth inequality: Past, present, and future. In M. Eichenbaum, E. Hurst, and J. A. Parker, editors, *NBER Macroeconomics Annual 2021*, volume 35, pages 391–455. University of Chicago Press, Chicago, 2021

     Presented by Hong-Yu Lai

4. Health inequality

   (Week 9, Monday)

   - M. De Nardi, S. Pashchenko, and P. Porapakkarm. The lifetime costs of bad health. NBER Working Paper 23963, 2018

     Presented by Eduardo Espuny

5. Financial Frictions, Misallocation, and Macro Development

   (Week 10, Monday)

   - V. Midrigan and D. Xu. Finance and misallocation: Evidence from plant level data. *American Economic Review*, 104(2):422–58, 2014

     presented by Marta Dominguez
   - L. Allub and A. Erosa. Financial frictions, occupational choice and economic inequality. *Journal of Monetary Economics*, 107:63–76, 2019

     presented by Andrea Guccione

6. Firm Financing

   (Week 10, Thursday)

   - F. Kochen. Finance over the life cycle of firms. Mimeo University of New York, 2022

     Presented by Yameng Gao
   - A. Peter. Equity frictions and firm ownership. mimeo, 2021

     Presented by Juan Segura

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