Quantitative Macroeconomics  
(with heterogeneous agents)

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**Schedule.** Tuesday 9:30-11:00, 11:30-13:00, and Thursday 9:30-11:00

**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 biggest part of homework will be computer based. It is strongly recommended that you do the computer-based problem sets in pairs. Please, submit just one copy per group.

**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 Matlab or Julia; 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, and 5 sessions for the student workshops. But this plan depends on student enrolment, so we may need to fine
tune it.

**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, chapter 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 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 new intranet (https://master.cemfi.es/). I will update its contents throughout the course.
Part I. The Neoclassical Growth Model with Heterogeneous Households.

Estimated duration: 4 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) and Dávila et al. (2007). For a textbook exposition see
   (Ljungqvist and Sargent, 2004, chapters 16 and 17).

   (Ljungqvist and Sargent, 2004, chapter 8).

Part II. Numerical Methods Applied to Heterogeneous Agents Economies.

Estimated duration: 4 theory sessions

1. Solving the household problem
   • Projection methods.
   • An easy and useful application

2. Finding the steady state equilibrium.
   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.
Part III. Some Extensions of the Heterogeneous Households Model.

Estimated duration: 3 theory sessions

1. Life Cycle
   Huggett (1996)

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

3. Outside the Steady State

Part IV. Labour market uncertainty: characterizing labor earnings.

Estimated duration: 2 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. (2019), Arellano et al. (2017), De Nardi et al. (2016)

4. Endogenous earnings
   Huggett et al. (2011)
**Part V. Endogenous Market Incompleteness.**

Estimated duration: 2 theory sessions

1. Dynamic contracts and partial insurance.
   A textbook exposition (which I will not follow) can be found in (Ljungqvist and Sargent, 2004, chapter 20)
   - Public insurance may crowd-out private insurance.
     Attanasio and Ríos-Rull (2000)
   - Some empirical evidence in developing economies.
     Attanasio and Albarran (2002)

2. Models with default.
   - Accounting for default in consumer credit in the U.S.:
     Chatterjee et al. (2007)
   - Accounting for default in sovereign debt:
     Arellano (2008)

3. The diverging trends of income and consumption inequality.
   Krueger and Perri (2006), Athreya et al. (2009) and Heathcote et al. (2010b)

**Part VI. Firm Heterogeneity.**

Estimated duration: 5 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

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 sessions

1. Labor Market Uncertainty, Consumption Responses, and Welfare

2. Health Risks, Social Security, and the Savings of the Old

3. Human Capital Accumulation and Earnings Inequality

4. Wealth Inequality
   - J. Hubner, P. Krusell, and A. A. Smith. Sources of u.s. wealth inequality: Past, present, and future. working paper, 2019

5. Public Finance: Taxing Top Incomes
6. Entrepreneurship, Financial Frictions, and Inequality:

References


