

Macroeconomics I

Pau Roldan-Blanco

CEMFI, September-December, 2022

Syllabus

Schedule. Tuesdays 9:30h-11:00h and 11:30h-13:00h, and Thursdays 9:30h-11:00h.

Course Description. This course is the first section of the macroeconomics sequence at CEMFI. The goal of the course is to learn about some seminal theoretical works in macroeconomics, and to confront them to the data. The material will be presented primarily from a theoretical point of view, with a secondary focus on empirical topics. As an introduction, we will devote the first three lectures to reviewing optimization methods in continuous time, which will provide you with the tools necessary to solve the models that we will see later in the course.

Topics. (see detailed contents below)

1. Dynamic Optimization in Continuous Time
2. Neoclassical Growth
3. Multi-Sector Growth
4. Endogenous Growth
5. Overlapping Generations
6. Investment

Homework. There will be 8 problem sets for you to work at home. Of those, seven will be paper-and-pencil style and one (Problem Set 3) will be computational. Please hand in your work electronically (via Moodle) by 9.30am on Tuesdays.

- For the paper-and-pencil problem sets, every student will have to submit their own solutions individually. Only a few exercises will count toward your homework grade. These will be marked with the word “graded” on the problem set itself. Failure to submit solutions to the “graded” exercises will penalize the overall homework grade. The remaining problems are optional (intended as practice material for the final exam), and you may choose not to submit answers for them.
- For the computational problem set (PS#3), solutions will be submitted in teams of two people, and it will be graded. Teams will be asked to prepare a small presentation of their results to show to the rest of the class during the recitation session.

Calendar. The course is 10 weeks long, with three 90-minute sessions per week. Typically, two will be theory sessions with me, and one will be a practice session with the T.A., where you will go through the weekly homework. See a tentative calendar below.¹

¹Please note there are changes on the regular schedule planned for Week 6 (the first week of November), as November 1st (Tuesday) is a national holiday.

	Day	Time	Type	Topic	Notes
Week 1	27-Sep (Tu)	9.30h – 11h	Theory	Cont.-time Optimization 1	
		11.30h – 13h	Theory	Cont.-time Optimization 2	
	29-Sep (Th)	9.30h – 11h	Theory	Cont.-time Optimization 3	
Week 2	4-Oct (Tu)	9.30h – 11h	Theory	Neoclassical Growth 1	
		11.30h – 13h	Theory	Neoclassical Growth 2	
	6-Oct (Th)	9.30h – 11h	Theory	Neoclassical Growth 3	
Week 3	11-Oct (Tu)	9.30h – 11h	Homework	PS#1	PS#1 due
		11.30h – 13h	Theory	Neoclassical Growth 4	
	13-Oct (Th)	9.30h – 11h	Theory	Neoclassical Growth 5	
Week 4	18-Oct (Tu)	9.30h – 11h	Theory	Multi-Sector Growth 1	PS#2 due
		11.30h – 13h	Theory	Multi-Sector Growth 2	
	20-Oct (Th)	9.30h – 11h	Homework	PS#2	
Week 5	25-Oct (Tu)	9.30h – 11h	Theory	Multi-Sector Growth 3	PS#3 due
		11.30h – 13h	Homework	PS#3	
	27-Oct (Th)	9.30h – 11h	Theory	Endogenous Growth 1	
	28-Oct (Fri)	9.30h – 11h	Theory	Endogenous Growth 2	
Week 6	3-Nov (Th)	9.30h – 11h	Theory	Endogenous Growth 3	PS#4 due
	4-Nov (Fri)	9.30h – 11h	Homework	PS#4	
Week 7	8-Nov (Tu)	9.30h – 11h	Theory	Endogenous Growth 4	PS#5 due
		11.30h – 13h	Homework	PS#5	
	10-Nov (Th)	9.30h – 11h	Theory	Endogenous Growth 5	
Week 8	15-Nov (Tu)	9.30h – 11h	Theory	Overlapping Generations 1	PS#6 due
		11.30h – 13h	Homework	PS#6	
	17-Nov (Th)	9.30h – 11h	Theory	Overlapping Generations 2	
	18-Nov (Fri)	9.30h – 11h	Theory	Overlapping Generations 3	
Week 9	22-Nov (Tu)	11.30h – 13h	Homework	PS#7	PS#7 due
	24-Nov (Th)	9.30h – 11h	Theory	Investment 1	
Week 10	29-Nov (Tu)	9.30h – 11h	Theory	Investment 2	PS#8 due
		11.30h – 13h	Homework	PS#8	
	1-Dec (Th)	9.30h – 11h	Theory	Investment 3	

Notes: Problem Set 3 is computational. All other problem sets are pencil-and-paper. All problem sets are due by Tuesdays 9.30am (electronic submission via Moodle).

Teaching Assistants. The TAs for the course are Tomás Budí-Ors (tomas.budi@cemfi.edu.es) and Tao Wang (tao.wang@cemfi.edu.es).

- Tomás will be in charge of teaching the weekly homework sessions, where he will go over the solution to relevant exercises from the problem sets. You can also use this session to ask him questions that remain unresolved from the theory lectures.
- Tao will take care of grading the exercises marked as “graded” on each week’s problem set.

Exam. There will be a 3-hour final exam on December 22, 2022, from 10am to 1pm.

Grading. The final exam counts 85% of the final mark, homework grade counts 10%, and class participation counts 5%.

Contact. Feel free to contact me at any point during the course if you have questions or comments. Please do not hesitate to contact me via email, at pauoldanb@gmail.com. We can also arrange an in-person meeting if you prefer.

Contents of the Course

Part I. Dynamic Optimization in Continuous Time.

- **Duration:** 3 theory sessions and no homework sessions.
- **Description:** In this part, we will introduce the mathematical tools necessary to solve dynamic optimization problems in continuous-time settings, which will be useful for the rest of the class.
- **Program:**
 1. Calculus of Variations
 2. Optimal Control Theory (Hamiltonians)
 3. Dynamic Programming (Hamilton-Jacobi-Bellman Equations)
 4. Brief Introduction to Stochastic Calculus
- **References:** This will be a math-intensive section with not a lot of economics. Chiang (1984) and Chiang (1992) are good help for the less initiated. The mathematical appendix in Barro and Sala-i-Martin (1999), as well as Acemoglu (2009, chapter 7 and Appendix B), are also good references.

Part II. Neoclassical Growth.

- **Duration:** 5 theory sessions and 3 homework sessions.
- **Description:** In this section, we will look at foundational one-sector, exogenous growth models based on capital accumulation, and we will assess their empirical performance.
- **Program:**
 1. Stylized Facts of Economic Growth
 2. The Solow Model
 3. The Ramsey Model
 4. Growth and Development Accounting
- **References:** The class notes for the Solow and the Ramsey models will follow Barro and Sala-i-Martin (1999, chapters 1 and 2) quite closely. For the Solow model, additional references are Romer (1996, chapter 1) and Acemoglu (2009, chapter 2). For the Ramsey model, additional references are Blanchard and Fischer (1991, chapter 2), Romer (1996, chapter 2) and Acemoglu (2009, chapter 8). For growth accounting, you can have a look at Barro and Sala-i-Martin (1999, chapter 10), and for development accounting at Caselli (2005). The empirical performance of the Solow and Ramsey models is in Acemoglu (2009, chapter 3) and Barro and Sala-i-Martin (1999, chapters 11 and 12). Several empirical facts seen in class come from Jones (2015).

Part III. Multi-Sector Growth.

- **Duration:** 3 theory sessions and 1 homework session.
- **Description:** In this section, we will extend the Neoclassical framework to a multi-sector setting, and will study questions related to structural change.
- **Program:**
 1. The Multi-Sector Ramsey Model
 2. Different Productivity Growth across Sectors
 3. Non-Homothetic Preferences
- **References:** The class lectures do not follow any specific textbook, but you can find a good survey of structural change with data and a review of models in Herrendorf, Rogerson, and Valentinyi (2014). The section “Different Productivity Growth across Sectors” follows Ngai and Pissarides (2007), and “Non-Homothetic Preferences” follows Kongsamut, Rebelo, and Xie (2001). This part can also be found in Acemoglu (2009, chapter 20).

Part IV. Endogenous Growth.

- **Duration:** 5 theory sessions and 2 homework sessions.
- **Description:** In this part, we will study models in which growth stems not from capital accumulation, but from the generation of ideas as a by-product of firm-level decisions.
- **Program:**
 1. The AK Model
 2. Growth from Knowledge Externalities
 3. Growth from Expanding Varieties
 4. Directed Technical Change
 5. Schumpeterian Growth Models
- **References:** This part will track the development of endogenous growth theory in roughly chronological order, covering the most seminal papers along the way. The exposition will follow Barro and Sala-i-Martin (1999, chapters 4, 6 and 7) and Acemoglu (2009, chapters 11 through 15) closely. The basic model of growth with knowledge externalities is due to Romer (1986), and the foundational expanding-varieties growth model is due to Romer (1990). The first neo-Schumpeterian growth model with quality-ladder innovation is due to Aghion and Howitt (1992), and further developed by Grossman and Helpman (1991).

Part V. Overlapping Generations (OLG) Models.

- **Duration:** 3 theory sessions and 1 homework sessions.
- **Description:** In this part, we will study models in which households have finite horizons and are born at different points in time, to study questions related to social security and insurance.
- **Program:**
 1. The Basic OLG Model
 2. Optimality
 3. Altruism
 4. Social Security
- **References:** The class lectures will loosely follow Blanchard and Fischer (1991, chapter 3), but with very different notation. For a slightly different approach but with good intuitions, see the material in Romer (1996, chapter 2) and a very formal (and short) exposition in Barro and Sala-i-Martin (1999, chapter 3).

Part VI. Investment.

- **Duration:** 2 theory sessions 1 homework session.
- **Description:** In this section, we will study models of investment and firm behavior, as well as open-economy models.
- **Program:**
 1. The q Theory of Investment
 2. An Equilibrium Open Economy
- **References:** The basic model of the q Theory can be easily followed in Romer (1996, chapter 8), Acemoglu (2009, chapter 7) or in Adda and Cooper (2003, chapter 8). The *Open Economy* case follows Blanchard and Fischer (1991, chapter 2), although in the book they solve for the social planner problem. You can also look at Barro and Sala-i-Martin (1999, chapter 3).

Keywords.

- **Part I:** Calculus of Variations, Optimal Control, Dynamic Programming, Control and State Variables, Transversality Condition, Hamiltonian, Pontryagin's Maximum Principle, Mangasarian's Sufficiency Conditions, Bellman's Principle of Optimality, Hamilton-Jacobi-Bellman Equation, Poisson Point Process, Weiner Process, Itô's Lemma.
- **Part II:** Balanced Growth Path, Transitional Dynamics, Saddle-Path Stability, Speed of Convergence, Diminishing Returns to Capital Accumulation, Neoclassical Production Function, Golden Rule, Modified Golden Rule, Dynamic Inefficiency, First and Second Welfare Theorems.
- **Part III:** Structural Change, CES Aggregator, Homothetic Demand, Baumol's Cost Disease.
- **Part IV:** Learning-By-Doing, Externalities, Non-Rivalry, Non-Excludability, Knowledge Spillovers, Love-for-Variety, Expanding Varieties, Product Innovation, Increasing Returns to Scale, Patents, Price Effects vs. Market Size Effects, Creative Destruction, Quality Ladder, Business-Stealing Effect, Arrow Replacement Effect, Appropriability Effect, Step-by-Step Innovation, Technology Gaps.
- **Part V:** PAYG Social Security, Fully Funded Social Security.
- **Part VI:** Tobin's Q , Convex Adjustment Costs, Small Open Economy, Horioka-Feldstein Puzzle.

References

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