Universitat Pompeu Fabra Barcelona

Advanced Techniques in Macroeconomics I: Numerical Techniques in Macroeconomics

2021-22 Academic Year
Master of Research in Economics, Finance and Management

Description of the subject

Advanced Techniques in Macroeconomics I
Total credits: 3 ECTS

Type of subject: Optative
Department of Economics and Business
Teaching team: Edouard Schaal

Code: 32706
Workload: 75 hours
Term: 1st

2. Teaching guide

- **Objective**

The main objective of this course is to equip the student with key numerical techniques to solve models that can be used to answer important questions in quantitative macroeconomics. The course has two parts. In the first part, I will teach basic numerical methods (rootfinding, optimization, etc.). In part two, we will study the general principles behind important classes of resolution methods (perturbation and projection methods) with applications to standard dynamic macroeconomic models (neoclassical growth, RBC, NK).

- **Contents**

1. **Basics of numerical analysis.**
   Numerical differentiation and Integration. Rootfinding. Unconstrained and Constrained Optimization.
   Applications: The Diamond-Mortensen-Pissarides model.
   Deterministic Ramsey growth model.

2. **Perturbation Methods.**
   Linearization. Higher-order perturbation. Pruning. Dynare.
   Application: Medium-scale DSGE models.
   Models with Occasionally Binding Constraints.

3. **Discretization.**
   Discretization of stochastic processes. Value function and policy function iteration. Howard improvement. Endogenous grid method.
   Application: the Income Fluctuation problem.

4. **Projection Methods.**
   Finite elements (linear and cubic splines). Spectral methods (Chebyshev polynomials). Colocation. Smolyak quadrature.
   Application: RBC model. \

- **Teaching methodology**

Approach and general organization of the subject

The focus of the course will be on the numerical solution of macroeconomic models, as a complement to the theoretical aspects covered in other courses (e.g. Topics in Macroeconomics, International Economics, Topics in Corporate Finance). Previous knowledge of specific models is not required, as they will be described in class, or specific notes will be distributed. However, students should be familiar with general concepts of dynamic models, as taught for example in Macroeconomics or Advanced Macroeconomics courses.

For each topic covered, lectures will be divided into the following parts: (i) theoretical description of the numerical technique; (ii) application of the technique to a standard model; (iii) application of the technique to specific models (see list above).

This is not a course about computer languages. Students will have to learn how to write computer programs to implement the techniques discussed in class using whichever language they like (MATLAB, Fortran, C, Julia, Python, etc.). The programming language used in the course will be MATLAB. Basic knowledge of MATLAB (or another programming language) is highly recommended. Students who are serious about computing may want to use this course as an opportunity to learn more advanced languages (Fortran, C, Python or Julia).

Training activities
Lectures, proposed readings, study and development of computer programs.

- **Assessment and Grading System**

The grade of the course will be determined on the following basis:

- (30%) A short final exam, about the theoretical concepts and algorithms covered during lectures.
- (70%) A series of homeworks, requiring to write computer programs to solve standard problems and models. Homeworks could be performed in small groups (max. 3 people, one solution per group).

- **Textbook and References**

My slides are the main resource for this course. They will be regularly posted on Box. They build on a previous course taught at NYU from 2012-2016 and lectures notes by Davide Debortoli and Gianluca Violante.

Important references for the **numerical techniques** covered in class is the book

Miranda, M. J. and Fackler, P. L. (2002), *Applied Computational Economic and Finance*, MIT Press (henceforth MF).

Judd, K. L. (1998), *Numerical Methods in Economics*, MIT Press, Cambridge and London.

Other valuable resources are:

Sargent, T. and Stachurski, J. (2019), *Lectures in Quantitative Economics*, https://lectures.quantecon.org/.

Other references for **numerical methods for macroeconomic models** are

Fernandez-Villaverde J. and J. Rubio Ramirez (2016), "Solution and Estimation Methods for DSGE Models", *Handbook of Macroeconomics,* Vol. 2.

Aruoba, S. B., Fernandez-Villaverde, J., & Rubio-Ramirez, J. F. (2006). Comparing solution methods for dynamic equilibrium economies. *Journal of Economic dynamics and Control*, *30*(12), 2477-2508.

Aruoba, S. B., & Fernández-Villaverde, J. (2015). A comparison of programming languages in macroeconomics. *Journal of Economic Dynamics and Control*, *58*, 265-273.

Guerrieri, L. and M. Iacoviello (2015), "OccBin: A toolkit for solving dynamic models with occasionally binding constraints easily", *Journal of Monetary Economics*, 70, 22-38.

Maliar L. and S. Maliar, (2014). "Numerical Methods for Large Scale Dynamic Economic Models" in: Schmedders, K. and K. Judd (Eds.), Handbook of Computational Economics,

Volume 3, Chapter 7, 325-477, Amsterdam: Elsevier Science.

Marcet, A. and G. Lorenzoni, (1998), "Parametrized expectations approach: some practical issues", in R. Marimon and A. Scott (eds), *Computational Methods for the Study of Dynamic Economies*, Oxford University Press.

Sims, C. A. (2001), "Solving linear rational expectations models", *Computational Economics* 20(1-2), 1-20.