COMPUTATIONAL MACROECONOMICS

Bachelor in Economics BIE SEP-2023 ETCH-Ec.3.M.A

Area Economics

Number of sessions: 15

Academic year: 23-24

Degree course: THIRD

Number of credits: 3.0

Semester: 1º

Category: COMPULSORY

Language: English

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SUBJECT DESCRIPTION

Throughout this course, we will explore the state-of-the-art computational methods used in macroeconomics to answer questions related to innovation and technological transformation over the long-run and business cycle fluctuations. This course will introduce you to computational methods for solving and simulating economic models with applications to innovation. You will be exposed to fundamental outcomes and methodologies in numerical analysis, gain practical proficiency in programming with Matlab (or a similar language), and develop the ability to utilize these tools for analyzing quantitative implications within established macroeconomic dynamic models.

On completion of the module, the student will have a good appreciation the relevance of computational analysis in economics, understand basic techniques, and be able to write intuitive algorithms and clear computer code, as well as address questions related to innovation within economics.

We will start by setting the theoretical foundations before delving into exploring the set of computational and numerical methods used in modern macroeconomics and innovation subfield. We will use concrete example related to innovation, climate change, inequalities, fiscal and monetary policy. Throughout the course, we will emphasize the concepts and analytical tools employed by computational macroeconomists when studying macroeconomic phenomena.

The material for the course will be available on Blackboard.

LEARNING OBJECTIVES

By the end of this course, students will have developed a comprehensive understanding of the main computational tools used macroeconomic and how to treat question related to innovation. They will also acquire proficiency in utilizing various analytical frameworks employed by economists to explore questions related to the economics of innovation.

Throughout the course, students will cultivate the following abilities:

- To analyse and interpret data using state of the art computational methods.
- To successfully collaborate with others in a group on programming assignments.

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**
Lectures	33.33 %	25.0 hours
Discussions	13.33 %	10.0 hours
Exercises in class, Asynchronous sessions, Field Work	13.33 %	10.0 hours
Group work	20.0 %	15.0 hours
Individual studying	20.0 %	15.0 hours
TOTAL	100.0 %	75.0 hours

PREREQUISITES

Students must have completed the following courses:

1. Foundation of Macroeconomics.
2. Mathematics for economists.
3. Computer programming I and II.

SOME IMPORTANT RESOURCES

The lecture notes/slides for the course are self-contained! The following books are useful to study the methods introduced in this course and are strongly recommended:

- Judd, Handbook of Computational Economics, Volume 1, Chapter 12, 1996.
- Judd, Numerical methods in economics, The MIT Press, 1998.
- Ljungqvist and Sargent, Recursive Macroeconomic Theory, MIT Press, 2004.
- Galor, Discrete Dynamical Systems, Springer Science & Business Media, 2007.
- Maliar and Maliar, Handbook of Computational Economics, Volume 3, Chapter 7, 2014.

Here are some links to websites of researchers who share useful codes:

Discrete Time Sequential Approach Macro Codes (mainly Matlab/Dynare):

- Gauthier Vermandel (Ecole Polytechnique): https://vermandel.fr/dsge-dynare-model-matlab-codes/
- Johannes Pfeifer (University of Bonn): https://github.com/johannespfeifer/dsge_mod
- Volker Weiland (Goethe University Frankfurt) https://www.macromodelbase.com/about

Continuous Time Recursive Approach Macro Codes (mainly Matlab, Python and Julia) – Advanced Methods:

- Ben Moll (LSE): https://benjaminmoll.com/codes/
- Matthieu Gomez (University of Columbia): https://www.matthieugomez.com/software.html
- Serguei and Lilia Maliar (University of Stanford): https://web.stanford.edu/~maliars/
- Alisdair McKay (Federal Reserve Bank of Minneapolis) https://alisdairmckay.com/
- Adrien Auclert (University of Stanford): https://aauclert.people.stanford.edu/teaching

HOW TO APPROACH YOUR STUDIES

How will I run the classes and how should you approach the study of this course?

You will have lectures, readings, and problem sets every week, and you will be expected to produce a group project (including a presentation) and sit an exam. It is of utmost importance that you diligently read the assigned material every week. Even more importantly, it is highly recommended that you read the material at the suggested time, as this will greatly enhance your comprehension during lectures. Additionally, it will significantly contribute to your productivity when working on problem sets and the group project. Each problem set will require you to apply the concepts and tools covered in the lectures and assigned readings.

By following these guidelines, you will optimize your learning experience in this course, ensuring that lectures and classes are more accessible, and that problem sets, and the group project contributes meaningfully to your overall understanding. Below we outline a methodology to be successful on this course.

PROGRAM

SESSIONS 1 - 2 (LIVE IN-PERSON)

Discrete Time Dynamic Optimization

- After a short introduction to the topic, we will start by setting and solving a simple example of the consumption-savings problem.
- We will use the sequential approach.
- We will mainly show the deterministic case (and touch base on the stochastic setup).
    - Readings:

- Lecture notes 1 and 2
- Judd, Handbook of Computational Economics, Chapters 12, Subchapters 1 – 3.4
- Galor, Discrete Dynamical Systems, Chapters 1 and 2

SESSIONS 3 - 4 (LIVE IN-PERSON)

Numerical Solution - Perturbation Method

- We will show how to derive the solution for a simple model using the perturbation method.
- In the second part we will implement the solution on Matlab (or equivalent programming software (e.g. Python and Julia)
  - Readings:
    - Lecture notes 3 and 4
    - Maliar and Maliar, Handbook of Computational Economics, Chapters 7, Subchapters 9 – 9.2

SESSIONS 5 - 6 (LIVE IN-PERSON)

Solving Medium-Scale Macro Models Using Perturbation Methods (with Dynare)

- We will recall the standard Real Business Cycle (RBC) model and solve it using Dynare in Matlab.
- We will discuss the shortcomings of the method and where to go from there.
  - Readings:
    - Lecture notes 5 and 6.
    - Introduction to Dynare: https://www.dynare.org/manual/introduction.html
    - A great video series by Willi Mutschler: https://mutschler.eu/dynare/intro-dsge-dynare/intro-dynare-solution-simulation/

SESSIONS 7 - 8 (LIVE IN-PERSON)

Discrete Time Dynamic Programming

- We will use the same example as in session 1 and 2 and then we will solve it using the recursive approach (modern macro).
- We will introduce the projection method (i.e., global method) to solve recursive problems.
  - Readings:
    - Lecture notes 7 and 8
    - Ljungqvist and Sargent, Recursive Macroeconomic Theory, Part III Chapters 7.1 – 7.2.1
    - Judd, Numerical methods in economics, Chapters 12.1

SESSIONS 9 - 10 (LIVE IN-PERSON)

Solving Medium-Scale Models Using Projection Methods (with Matlab)

- We will start by solving the Solow model using the projection method and value function iteration in Matlab.
- We will then solve the Romer endogenous growth model with research and development innovations.
    - Readings:
        - Lecture notes 9 and 10

SESSIONS 11 - 12 (LIVE IN-PERSON)

The Case of Continuous Time

- In these sessions we will revisit the two cases of sequential and recursive discrete time dynamic modeling using the continuous time approach.
    - Readings:
        - Lecture notes 11 and 12
        - Judd, Handbook of Computational Economics, Chapters 12, Subchapters 4 – 4.3

SESSION 13 (LIVE IN-PERSON)

Applications to the Economics of Innovation

- We will use these sessions to explore different models of R&D and Innovation of Acemoglu, Romer, and Aghion.
    - Readings:
        - Lecture notes 13

SESSION 14 (LIVE IN-PERSON)

Presentations

SESSION 15 (LIVE IN-PERSON)

Exam

EVALUATION CRITERIA

The assessment methods will be a combination of a final exam and a group project (which will include a presentation).

criteria	percentage	Learning Objectives	Comments
Final Exam	40 %		

Group Work	30 %		
Group Presentation	30 %		

RE-SIT / RE-TAKE POLICY

BIBLIOGRAPHY

Recommended

- Judd. (1996). *Handbook of Computational Economics, Volume 1, Chapter 12.* Science Direct. ISBN 978044489857 (Digital)
- Judd. (1998). *Numerical methods in economics.* The MIT Press. ISBN 9780262547741 (Digital)
- Ljungqvist and Sargent. (2004). *Recursive Macroeconomic Theory.* 2nd. MIT Press. ISBN 9780262122740 (Digital)
- Galor. (2007). *Discrete Dynamical Systems.* Springer Science & Business Media, 2007.. ISBN 978364207185 (Digital)
- Maliar and Maliar. (2014). *Handbook of Computational Economics, Chapter 7.* Volume 3. ISBN 978044452980 (Digital)

ABOUT THE GROUP PEOJECT AND PRESENTATION (60%)

You and your teammates will collaborate on a project. Your primary objective will be to offer an interpretation and replication/extension of the assigned reading, applying the knowledge and concepts acquired throughout the course.

Detailed instructions regarding the project, the assigned reading, and the formation of groups will be provided on Blackboard. The deadline for the project submission will be communicated at that time.

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code here. The Program Director may provide further indications.