105.687 AKVWL Dynamic Macroeconomic Modelling

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Spring term 2021

Course content

This course is aimed at master students of mathematics and business informatics. It provides students with the tools necessary to independently solve modern macroeconomic models using numerical software. To this end, it also covers the necessary economic and methodological background.

After successful completion of the course, students are able to...

- numerically solve a wide range of determistic and stochastic macroeconomic models (DSGE),
- calibrate a model to empirical data,
- quantify the effects of economic shocks and policies and interpret them economically,
- write a master thesis in the field of macroeconomics.

Registration

Course registration is via TISS:
https://tiss.tuwien.ac.at/course/educationDetails.xhtml?courseNr=105687&semester=2021S

Course materials are available on TUWEL. Please also sign up for the TUWEL course:
https://tuwel.tuwien.ac.at/course/view.php?idnumber=105687-2021S

Organization and practical information

The course is split into two parts. The first one focuses on deterministic models, the second one on stochastic models with aggregate uncertainty. Each of the two parts consists of a number of classroom sessions (to be held online via Zoom) followed by group projects. Participation in the classroom sessions is strongly recommended. Dates and times of the sessions are indicated in the preliminary schedule at the end of this document.

Classroom sessions. The classroom sessions provide you with the economic, methodological, and computational background that is required to carry out the projects. Prior knowledge of dynamic economic models (in particular the Ramsey growth model) is advantageous but not necessary.

Since this is an applied course, understanding the economics behind the models and being able to practically solve them is emphasized over mathematical rigor. Nevertheless, you must be confident with manipulating equations and differentiation. In addition to the lecture slides, some step by step instructions of mathematical derivations will be provided in the form of short videos.

This semester, the classroom sessions take place via Zoom. Although the course type VU implies that your participation is mandatory, this will not be checked due to organizational reasons. Nevertheless, your participation is strongly recommended. The sessions will not be recorded and you are encouraged to turn your cameras on.

Project phase. In the projects you have to numerically solve and analyze variations of the models discussed in class. You will need to apply both the presented mathematical methods (to obtain a set of equations that characterize optimal economic behavior) and the computational methods (to numerically solve this set of equations). Code written during the classroom sessions will be made available on TUWEL and can be used for the projects. More detailed rules will be announced in time.

You have three weeks to work on each project. Based on your preferences, you can either work alone or together with another student. During the project phase, no classroom sessions are scheduled. I will provide assistance on a bilateral basis if necessary.

The computational implementation of the projects should be done in MATLAB. If you have never worked with MATLAB before or have not used it for a while, please go through an introductory guide by yourself, such as https://things.maths.cam.ac.uk/catam/MATLAB/manual/booklet.pdf. I recommend to do this before we discuss the computational implementation, such that you are to follow the lecture. The MATLAB software can be used in all computer rooms at TU Wien. Additionally, enrolled students may obtain a private copy for free. For more info see http://www.sss.tuwien.ac.at/sss/mla/.

Grading

Your grade is based on the two projects that you hand in. You will only be graded if you at least hand in one project. The points you earn on a project reflects the correctness of your results, the correctness of your programs, as well as the accuracy of the economic interpretations attached to your results. To pass this course, you must reach 50% of the total points.

Apart from the two projects, there are no homeworks, exams etc. After some classroom sessions, I will provide a small self-assessment task, which allows you to check whether you have understood essential parts of the lecture. You can voluntarily hand in your solution until the next session to receive feedback. This will not be graded, but may be valuable for you later when working on the project.

Course outline

The course is split into two parts. The first one focuses on deterministic models, the second one on stochastic models with aggregate uncertainty. Each part provides the economic foundations, the necessary methodological background, and the computational implementation, followed by independent project work.

Part I: The deterministic neoclassical growth model

- Model description and definition of equilibrium
  - decentralized version
  - social planner version
- Characterizing the equilibrium/solution paths
  - solving the firm's profit maximization problem
  - solving the household's utility maximization problem using the Lagrangian approach
  - characterizing the competitive equilibrium
  - characterizing the social planner solution
- Dynamic properties of the equilibrium/solution paths
  - stationary (steady) states
  - local dynamics near a steady state
  - properties of the steady state in the deterministic neoclassical growth model
  - properties of the equilibrium/solution path
- Numerical solution of the model
  - parameter choice and model calibration
  - computing the equilibrium path using the stacked Newton method
  - illustration: study the effects on an unanticipated shock on the economy
- Project 1: An epidemic in the deterministic neoclassical growth model

Part II: The stochastic neoclassical growth model

- Model description and definition of the planner's solution
- Characterizing the solution using dynamic programming
- Approximating the policy functions
  - projection methods
  - perturbation methods
    - non-stochastic steady state
    - linearized dynamics around the non-stochastic steady state
    - certainty equivalence and higher order approximations
- Numerical solution of the model using Dynare

  - policy functions and model simulation
  - impulse response functions
  - moments of the stationary distribution

- Project 2: Policy analysis in a DSGE model using Dynare

Schedule (preliminary)

All class sessions take place online via Zoom. The link can be found in TISS and TUWEL.

date	time	content
March 1	12:00–13:30	Initial meeting: administrative issues and course details
March 8	12:00–13:30	Model description and definition of equilibrium
March 15	12:00–13:30	Solving for the equilibrium/solution paths
March 22	12:00–13:30	Dynamic properties of the equilibrium/solution paths
April 12	12:00–13:30	Numerical implementation
April 19	12:00–13:30	Numerical implementation (ctd.)
April 19 to May 9		Project 1
May 10	12:00–13:30	Discussion of Project 1 in class
May 17	12:00–13:30	Model description and solution
May 31	12:00–13:30	Approximating the policy functions
June 7	12:00–13:30	Numerical solution with Dynare
June 7 to June 27		Project 2
June 28	12:00–13:30	Discussion of Project 2 in class

References

[1] Michel Juillard. *DYNARE: a program for the resolution and simulation of dynamic models with forward variables through the use of a relaxation algorithm.* CEPREMAP Working Paper, No. 9602, 1996.

[2] Lars Ljungqvist and Thomas J. Sargent. *Recursive Methods in Macroeconomic Theory, 4th edition.* MIT Press, 2018.

[3] Gerhard Sorger. *Dynamic Economic Analysis: Deterministic Models in Discrete Time.* Cambridge University Press, 2015.

[4] Klaus Wälde. *Applied Intertemporal Optimization.* Know Thyself – Academic Publishers, Johannes Gutenberg University Mainz, 2012.