Numerical Methods and Analysis

Peking University HSBC Business School
Module 3 – 4, 2014

Instructor:

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TA:

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Lecture:

PHBS 231, Monday & Thursday 8:30 – 10:20 am, http://www.econ.re.kr/

Office hours:

PHBS 750, Monday & Thursday 7:30 – 8:30 pm or by appointment

Overview:

This is an introductory course for students with little or no previous knowledge of the practicalities involved in dynamic modelling. The intention of the course is not to train participants to become specialist model-builders but instead for them to be fully conversant in the main techniques involved in building and using dynamics models in their work. The aim is to make participants 'sophisticated consumers' of dynamic models and to provide a deeper framework and knowledge within which to frame their discussions. Although no prior knowledge is assumed it is a fast paced course and additional reading is provided to help students to consolidate material.

Course objectives:

By the end of the course students should (i) understand the foundations of dynamic models and how they relate to issues in economics and finance, (ii) be able to write dynamic models in a general form suitable for solution and simulation by computer, (iii) implement basic solution and simulation techniques to analyse dynamic models, showing how the model economies behave and how they respond to different shocks, (iv) be aware of how to extend simple models to answer more complex questions, and (v) feel confident in discussing model-based analysis, evaluating the strength of models used and engaging in conversation with people building economic models.

Organisation:

The course runs over a series of nine weeks. Each lecture will be a mixture of teaching and practical exercises using MATLAB software to solve and simulate dynamic models. TA sessions are therefore free, allowing students time to reflect and consolidate the understanding. The instructors will be available throughout each evening to answer any questions or queries that arise.

Pre-readings:

Some pre-course readings will be assigned for those students who wish to prepare in advance. The issues involved in the pre-reading will be dealt with in the course so there is no need to understand everything. The pre-reading is as much about getting students to gauge what they do and don't understand as it is to get ideas and issues across.

Problem sets and in-class exercises:

Doing computation by trial and error is the only way to learn computation. The problem sets are designed to get you to apply various numerical methods. You are welcome to work in groups of two or three. More generally, I strongly encourage you to discuss the problem sets with your classmates. Classmates are also a valuable source for tips on programming and general computer advice.

A write-up of your solution (one write-up per group) is due in class on the date indicated on the problem set. The write-up should

- provide a brief and clear verbal description of the methods employed;
- use tables and/or graphs to describe your results;
- contain your computer programs in an appendix.

Just handing in computer programs (m-file) and their output is not acceptable. Please remember to indicate the names of all group members on the write-up.

During class I will call on one or more students to present their solution to the in-class exercises. You will explain your solution to your classmates and illustrate it on the classroom computer. This means that you will have to bring your computer programs to class on a memory stick or your laptop.

Term paper:

You have considerable freedom to follow your interests in choosing a topic for a term paper (group work). The paper should

- motivate and formulate a research question;
- explain why numerical methods are needed to answer the question;

- present a model;
- discuss a computational strategy for solving the model;
- present the results;
- evaluate the accuracy of the results.

The term paper should be at most 15 double-spaced pages excluding tables, graphs, and appendices (12 point font, 1 inch margins).

I urge you to start thinking of a topic early in the module. The term paper could involve replicating a computational paper. Another way to develop a topic is to think of a theoretical paper that does not compute any (other than perhaps trivial) examples and to compute a small set of interesting examples. Ideally, however, the term paper would ask (and answer) an original research question. Once you have identified a topic, please write a short (at most one page) proposal. Email the proposal to me and make an appointment to discuss the suitability of the topic. I expect all students to have discussed a topic with me before Week 4, 2013 – 2014 Module 4.

You will give a short presentation of your term paper in the last session. The goal is to help you organize your thoughts and obtain feedback from your classmates. The final version of the paper is due Week 8, 2013 – 2014 Module 4.

References:

Ahn, K., 2014. Numerical Methods and Analysis for Financial Economist. Course Pack, Peking University – HSBC Business School.

An, S., Schorfheide, F., 2007. Bayesian Analysis of DSGE Models. Econometric Reviews, 59(4): 1481-1509.

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Brandimarte, P., 2013. Numerical Methods in Finance and Economics: a MATLAB-Based Introduction. John Wiley & Sons.

Fernández-Villaverde, J., Rubio-Ramírez, J. F., 2006. Solving DSGE Models with Perturbation Methods and A Change of Variables. Journal of Economic Dynamics and Control, 30(12): 2509-2531.

Gali, J., 2005. Lectures on Monetary Policy, Inflation, and the Business Cycle – A Simple Framework for Policy Analysis. Lecture Notes, MIT.

Griffoli, T. M., 2007. Dynare User Guide. Unpublished Manuscript.

Klein, P., 2000. Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model. Journal of Economic Dynamics and Control, 24(10): 1405-1423.

Ljungqvist, L., Sargent, T. J., 2004. Recursive Macroeconomic Theory. MIT press.

Rachev, S. T., Hsu, J.S.J., Bagasheva, B. S., 2008. Bayesian Methods in Finance. John Wiley & Sons.

Ohanian, L. E., Prescott, E. C., Stokey, N. L., 2009. Introduction to Dynamic General Equilibrium. Journal of Economic Theory, 144(6): 2235-2246.

Uhlig, H., 1998. A Toolkit for Analysing Nonlinear Dynamic Stochastic Models Easily. Working Paper, University of Tilburg.

Software

The default computer language for this course is Matlab. The complete documentation of Matlab and its toolboxes can be freely downloaded at

http://www.mathworks.com

A tutorial to get you started and programming tips are available at http://www.econ.re.kr/. Mario Miranda and Paul Fackler have written a Matlab toolbox called CompEcon. The toolbox includes equation solvers and optimization routines, a set of routines for function approximation, a set of numerical integration routines, routines for solving ordinary differential equations (both initial and boundary value problems), and routines for solving discrete- and continuous-time dynamic programming problems. The toolbox can be freely downloaded at

http://www4.ncsu.edu/~pfackler/compecon/toolbox.html

There is no point in re-inventing the wheel, and I encourage you to use canned code whenever possible. The web is a valuable resource of ready-made code which is often written by professional programmers and/or applied mathematicians and has been debugged and optimized over many years. However, part of this course is to acquaint you with different numerical methods and programming a method is the best way to understanding how it works. Using canned code is not. I ask you to rely on your own judgment in making this decision. As a rule of thumb I suggest that in a session on optimization, say, you do not use an existing optimization routine but instead code your own.

Grading:

The course grade will be based on assignment (40%), quiz (20%), class participation (5%), term paper (20%), and final exam (15%).

Extra help:

Dot not hesitate to come to me by appointment to discuss any aspect of the course.

Class schedule:

Lecture 1: April 24, 2014 Course overview, Placement test, Introduction to dynamic modelling (Gali, 2005)	**Lecture 2: April 28, 2014** Introduction to MATLAB, Monte-Carlo simulation, i.e. AR(1) process, Support class: NK Paradigm
Lecture 3: April 30, 2014 Taking a model to the computer, i.e. State-Space form (Klein, 2000) Assignment 1 due…	**Lecture 4: May 5, 2014** Simulating a Markov switching process, Log-linearization of baseline model, Log-linearization of RBC model
Lecture 5: May 8, 2014 Solution techniques, i.e. Jordan decomposition (Lecture Note) Assignment 2 due…	**Lecture 6: May 12, 2014** The CRRA utility function when $\sigma = 1$, BK conditions in baseline model, BK conditions and δ
Lecture 7: May 15, 2014 Simulation techniques, i.e. IRFs, FEVD, etc. (Lecture Note) Assignment 3 due on…	**Lecture 8: May 19, 2014** BK conditions in RBC model, Stylized facts, Impulse response functions, Term paper proposal due…
Lecture 9: May 22, 2014 Advanced dynamic models, i.e. QZ decomposition (Klein, 2000) Assignment 4 due…	**Lecture 10: May 26, 2014** FEVD, Multi-shock DSGE model, Optimized Taylor rule, Q&A session
Lecture 11: May 29, 2014 Quiz 1 Written part: lectures 1, 3, 5, 7, 9 Oral part: lectures 2, 4, 6, 8, 10	**Lecture 12: June 4, 2014** Undetermined coefficient methods Quadratic matrix equations – computing (Uhlig, 1998)
Lecture 13: June 5, 2014 Dynamic programming, i.e. value function iterations, envelope theorem, etc. (Stokey, Lucas and Prescott, 1989)	**Lecture 14: June 9, 2014** Perturbation methods, i.e. 2nd and 3rd order. (Fernandez and Rubio, 2005) Assignment 5 due…
Lecture 15: June 12, 2014 Quiz 2 Written part: lectures 12, 13, 14 Support Class: VAR	**Lecture 16: June 16, 2014** Bayesian Numerical Computation Asset Pricing Model & Return Predictability (Rachev and Bagasheva, 2008)
Lecture 17: June 19, 2014 Bayesian Estimation of DSGE models (An and Schorfheide, 2007) Support Class: Bansal and Yaron, 2004	**Lecture 18: June 23, 2014** Introduction to Dynare DSGE-BVAR (Griffoli, 2013) Review for final exam