University of Maryland
Department of Economics

Economics 630
Computational Methods in Macroeconomics

Fall 2011

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Office Hours :	W 11 – 12 or by appointment	M 11 - 12 or by appointment

Time : M W 9:30 – 10:45

Location : Tydings 0111 / Tydings 4104 (experimental lab)

Course Webpage : http://www.elms.umd.edu

Course Directory : H:\ECON630

(accessible from the department's network only)

OUTLINE AND OBJECTIVE OF THE COURSE

This course covers some of the essential computational methods frequently used in macroeconomics. It is divided in to two halves, broadly reflecting our own research interests and expertise. The first part will cover methods for solving representative-agent models and some topics in time-series econometrics. The second part will focus on solving heterogeneous-agent methods. At the end of this course, you will be able to solve and/or estimate most models that are widely used in macroeconomics.

TEXTBOOKS AND OTHER READING MATERIAL

Most of the course will be based on articles which are listed on the course outline and these will be available electronically on the course webpage.

The following books are required for the course.

Numerical Methods in Economics, Judd, MIT Press, 1998

Dynamic Economics: Quantitative Methods and Applications, Adda and Cooper, MIT Press, 2003

The following books may be useful in certain parts of the course.

Handbook of Computation Economics (Vol.1), edited by Amman, Kendrick and Rust, North-Holland, 1996

Methods for Applied Macroeconomic Research, Canova, Princeton University Press, 2007

Structural Macroeconometrics, Dejong and Dave, Princeton University Press, 2007

Simulation-Based Econometric Methods, Gourieroux and Monfort, Oxford University Press, 1996

Time Series Analysis, Hamilton, Princeton University Press, 1994

Computational Methods for the Study of Dynamic Economies, Marimon and Scott , Oxford University Press, 1999

Applied Computational Economics and Finance, Miranda and Fackler, MIT Press, 2002

Recursive Methods in Economic Dynamics, Stokey and Lucas, Harvard University Press, 1989

PREREQUISITES

ECON 601 and ECON 602. Students who have not taken these courses and/or students from other departments must talk to us before taking this course.

AUDITING POLICY

Upper-year students who have completed their course requirements are welcome to audit this course subject to the following stipulations: (1) Due to space restrictions, priority will be given to the registered students. (2) Auditing students will have to participate in the course as much as registered students, completing all requirements of the course, with the possible exception of the final projects, which will be decided on a case-by-case basis. We reserve the right to withdraw the auditing privileges of anyone who fails to follow the rules above.

GRADING

Problem Sets and In-class Exercises (60%)

Throughout the course we will assign about four problem sets per part. You will have about a week to work on these. You will work in groups of two or three that will rotate. The details will be set in the first lecture of the semester. These problem sets will require you to write codes in MATLAB and/or work with Eviews, both of which are installed on the department's network and available in the computer lab. In addition to turning in a nicely-formatted description of your findings with all the necessary tables and figures (preparing documents that are neat and easy to read is a necessary condition to being a good researcher), you will need to upload all the files you created to your directory in the department

network which will be under H:\ECON630\Students.

Below are the key dates for problem sets. You will have between 7 to 14 days to work on these problem sets, depending on their difficulty. Since they are very tightly spaced, no extensions will be given. The time it may take you to complete these problem sets is a stochastic variable which cannot be predicted beforehand. As such, we suggest you start working on them as soon as possible.

Prof. Aruoba

Problem Set 1 : Assigned on Sept 19. Due on **Sept 28 by 5 pm** via email.

Problem Set 2 : Assigned on Sept 28. Due on **Oct 5 by 5 pm** via email.

Problem Set 3 : Assigned on Oct 5. Due on **Oct 19 by 5 pm** via email.

Problem Set 4 : Assigned on Oct 19. Due on **Oct 31 by 9:30 am** via email.

Prof. D'Erasmo

Problem Set 1 : Assigned on Nov 2. Due on **Nov 9 by 5 pm** via email.

Problem Set 2 : Assigned on Nov 9. Due on **Nov 16 by 5 pm** via email.

Problem Set 3 : Assigned on Nov 16. Due on **Nov 23 by 5 pm** via email.

Problem Set 4 : Assigned on Nov 28. Due on **Dec 12 by 5 pm** via email.

We will also have a number of in-class exercises (such as presentations) that you will be graded on. These are noted in the Course Outline and more information will be given in lectures.

Final Project (40%)

You will have the option to choose between two projects, one corresponding to each part of the course. Ideally, we want an equal number of students doing each project. At first pass, at the end of the semester, we will ask you which project you would like to choose. If there is excess demand for one of the projects, we will randomly allocate students to projects to resolve the excess demand.

The final project will be substantially longer than a problem set and will involve replicating the results of a paper. The project will have two explicit deadlines, one for producing intermediate results and a final deadline which is January 24, 2012, Tuesday at 5 pm. No late submissions will be accepted.

POLICIES AND IMPORTANT NOTES

- Unless previously announced, the class will meet on all Mondays and Wednesdays the university is officially open.
- Our primary mean for communication outside the classroom is email. We will try to respond to your emails in a timely fashion. We will maintain an email list of all students and may use this list for relaying important information. Please check your email regularly.
- Completing all assignments by the deadlines (date and time) as clearly stated in the assignment is a requirement of the course and missing a problem set or a deadline of final projects without a valid excuse or late submissions of any sort will not be allowed.
- We will hold about half our classes in the EEL, our state-of-the-art experimental lab. There are very strict rules regarding using this facility and among other things you are not allowed to bring any **food** or **drinks** to the lab or use the computers for any other purpose such as checking email. Anyone violating these rules will be banned from the lab and thus will miss crucial parts of the course.

READING LIST

Papers with (*) are required readings. The others are optional. All papers are available on the course website. **Don't print all these papers immediately**. As we progress, it will become clear which ones you will study in greater detail.

PART 0 – Introduction and Numerical Preliminaries (Prof. Aruoba)

(a) Root Finding Algorithms, Numerical Optimization

(b) Finite Markov Chain Approximation

Chapters 1, 2, 5, and 7.7 in Judd (1998).

(*) Tauchen, George (1986), "Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions", *Economic Letters*, 20, 177-181

(*) Chapter 3 in Adda and Cooper (2003)

PART I – Representative-Agent Methods and Time Series Econometrics (Prof. Aruoba)

1) Estimation Methods

A – Vector Autoregressions (VARs)

(a) Review of Theory

(b) Applications of VARs

Christiano, Lawrence J., Martin Eichenbaum and Charles Evans (1999), "Monetary Policy Shocks: What Have We Learned and to What End?", *Handbook of Macroeconomics*.

Gali, Jordi (1999), "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?", *American Economic Review*

Christiano, Lawrence J., Martin Eichenbaum and Robert Vigfusson (2003), "What Happens After a Technology Shock?", *mimeo*.

(c) Structural VARs

Christiano, Lawrence J., Martin Eichenbaum and Charles Evans (2005), "Nominal Rigidities and the Dynamics Effects of a Shock to Monetary Policy", *Journal of Political Economy*.

Christiano, Lawrence J., Martin Eichenbaum and Robert Vigfusson (2006), "Assessing Structural VARs", *NBER Macroeconomics Annual*.

Chari, V.V., Patrick J. Kehoe and Ellen R. McGrattan (2007), "Are Structrual VARs with Long-Run Restrictions Useful in Developing Business Cycle Theory", *Unpublished manuscript*

Kehoe, Patrick J. (2006), "How to Advance Theory with Structural VARs: Use the Sims-Cogley-Nason Approach", *NBER Macroeconomics Annual*

B – Kalman Filter and Applications

(*) James H. Stock and Mark W. Watson (1991) "A Probability Model of the Coincident Economic Indicators," in G. Moore and K. Lahiri, eds., *The Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge: Cambridge University Press, 63-90

Diebold, Francis X., Glenn D. Rudebusch and S. Boragan Aruoba (2006), "The Macroeconomy and the Yield Curve," *Journal of Econometrics*, 131, 309-338

Aruoba, S. Boragan, Francis X. Diebold and Chiara Scotti (2009), "Real-Time Assessment of Business Conditions", *Journal of Business and Economic Statistics*, 27(4), 417-427.

Hamilton, James D. (1989), "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle", *Econometrica*, 57(2), 357-384.

2) Approximation Methods – Representative-Agent Models

A – Review of Local Approximation Methods and Dynare

Dynare User Guide by Tommaso Mancini Griffoli.

Judd, Kenneth L. and Sy-Ming Guu (1997), "Asymptotic Methods for Aggregate Growth Models", *Journal of Economic Dynamics and Control*

B – Global Approximation Methods

(*) Judd, Kenneth L. (1992), "Projection Methods for Solving Aggregate Growth Models", *Journal of Economic Theory*, 58, 410-452

McGrattan, Ellen R. (1999), "Application of Weighted Residual Methods to Dynamic Economic Models", in *Computational Methods for the Study of Dynamic Economies*, R. Marimon and A. Scott eds., Oxford University Press

(*) Christiano, Lawrence J. and Jonas D.M. Fisher. (2000), "Algorithms for solving dynamic models with occasionally binding constraints," *Journal of Economic Dynamics and Control*, 24, 1179-1232

(*)Judd, Kenneth L., Lilia Maliar and Serguei Maliar, (2010), "A Cluster-Grid Projection Method: Solving Problems with High Dimensionality," NBER Working Paper 15965

C – Comparison of Methods

(*) Aruoba, S. Boragan, Jesus Fernandez-Villaverde and Juan F. Rubio-Ramirez (2006), "Comparing Solution Methods for Dynamic Equilibrium Economies", *Journal of Economic Dynamics and Control*, 30, 2477-2508

3) Estimation of DSGE Models

(*) Ruge-Murcia, Francisco J. (2003), "Methods to Estimate Dynamic Stochastic General Equilibrium Models", *Unpublished working paper*

(a) GMM and GMM-Based Methods

(*) Hansen, L.P. and K.J. Singleton (1982), "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models", *Econometrica*, 50, 1269-86, and Errata: *Econometrica*, 52, 267-68

(*) Christiano, Lawrence J. and Martin Eichenbaum (1992), "Current Real-Business-Cycle Theories and Aggregate Labor-Market Fluctuations", *American Economic Review*, 82(3), 430-450

(b) Likelihood-Based Methods

McGrattan, Ellen R. (1994), "The Macroeconomic Effects of Distortionary Taxation", *Journal of Monetary Economics, 33(3)*, 573-601

Fernandez-Villaverde, Jesus and Juan F. Rubio-Ramirez (2007) "Estimating Macroeconomic Models: A Likelihood Approach", *Review of Economic Studies*, 74, 1059–1087.

An, Sungbae and Frank Schorfheide (2007), "Bayesian Analysis of DSGE Models", *Econometric Reviews*, 26, 113-172

(*) Smets, Frank and Rafael Wouters (2007), "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach", *American Economic Review*, 97(3), 586-606.

4) Calibration vs. Estimation

(*) Canova, Fabio (1994), "Statistical Inference in Calibrated Models", *Journal of Applied Econometrics*, 9, S123-S145

(*) Kydland, Finn E. and Edward C. Prescott (1996), "The Computational Experiment: An Econometric Tool", *Journal of Economic Perspectives*, 10, 69-85

(*) Hansen, Lars Peter and James J. Heckman (1996), "The Empirical Foundations of Calibration", *Journal of Economic Perspectives*, 10, 87-104

(*) Sims, Christopher A. (1996), “Macroeconomics and Methodology”, *Journal of Economic Perspectives*, 10, 105-120

(*) Dridi, Ramdan, Alain Guay and Eric Renault (2007), “Indirect Inference and Calibration of Dynamic Stochastic General Equilibrium Models”, *Journal of Econometrics*

(*) Candler, Graham and Edward Prescott (2008), “Calibration”, *New Palgrave Dictionary of Economics*

PART II – Heterogeneous-Agent Methods (Prof. D'Erasmo)

1) Value Function Iteration

(*) Chapter 2 in Adda and Cooper (2003)

(*) Chapters 12, 13, 16, and 17 in Judd (1998)

2) Models with Aggregation

(*) Chatterjee, S. (1994), "Transitional Dynamics and the Distribution of Wealth in a Neoclassical Growth Model," Journal of Public Economics 54, 97–119.

Caselli, F. and J. Ventura (2000), "A Representative Consumer Theory of Distribution," American Economic Review 90, 909–926.

Maliar, L. and S. Maliar (2003), "The Representative Consumer in the Neoclassical Growth Model with Idiosyncratic Shocks," Review of Economic Dynamics 6, 362–380.

Krusell, P. and V. Rios-Rull. 1999."On the Size of U.S. Government: Political Economy in the Neoclassical Growth Model", American Economic Review, 89, p. 1156-81.

3) Incomplete Markets: No Aggregate Uncertainty, Infinitely-Lived Agents

(*) Aiyagari, S.R. (1994), "Uninsured Idiosyncratic Risk and Aggregate Saving," Quarterly Journal of Economics 109, 659–684.

(*) Huggett, M. (1993), "The Risk-Free Rate in Heterogeneous-Agents, Incomplete Markets Economies," Journal of Economic Dynamics and Control 17, 953–969.

(*) Rios Rull (1999) "Computing of equilibria in heterogenous-agent models", Chapter 11 in Marimon, Ramon and Andrew Scott (1999)

Castaneda, A., J. Diaz-Gimenez, and J.-V. Rios-Rull (2003), "Accounting for the U.S. Earnings and Wealth Inequality," Journal of Political Economy 111, 814–857.

4) Incomplete Markets: No Aggregate Uncertainty, Overlapping Generations

(*) Huggett, M. (1996), "Wealth Distribution in Life-Cycle Economies," Journal of Monetary Economics 38, 469–494.

Storesletten, K., C. Telmer, and A. Yaron (2004), "Consumption and Risk Sharing

over the Life Cycle," Journal of Monetary Economics 51, 609–633.

5) Incomplete Markets: No Aggregate Uncertainty, Entrepreneurs

(*) Buera, Kaboski and Shin, (2011) "Finance and Development: A Tale of Two Sectors," American Economic Review.

Kitao (2008) "Entrepreneurship, taxation and capital investment," Review of Economic Dynamics, (11)1, 44-69.

7) Structural Estimation:

A. Simulated Annealing

B. SMM – Indirect Inference

(*) Chapters 4 and 9 in Adda and Cooper (2003)

(*) Lee, B.S. and B. Ingram. 1991 "Simulation estimation of time series models", Journal of Econometrics, 47, p. 197-205.

Chapters 1, 2 and 3 in Gourieroux and Monfort (1996)

8) Firm Dynamics

(*) Hopenhayn (1992) "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," Econometrica.

Jovanovic (1982) "Selection and the Evolution of Industry," Econometrica.

(*) Hopenhayn and Rogerson (1993) "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," Journal of Political Economy.

9) Incomplete Markets: Aggregate Uncertainty

(*) Krusell, Per and Anthony A. Smith, Jr. (1998), "Income and Wealth Heterogeneity in the Macroeconomy", *Journal of Political Economy*, 106, 867-896

Algan, Yann, Olivier Allais and Wouter den Haan (2007), "Solving Heterogenous-Agent Models with Parameterized Cross-Sectional Distributions", *Journal of Economic Dynamics and Control*, 875-908

COURSE OUTLINE

Lecture	Date	Topic	Who	Location
1	Aug 31	Syllabus, Some Numerical Results	B	0111
2	Sep 7	Introduction to Eviews	B	Lab
3	Sep 12	Data Sources (Group Presentations)	B/P	0111
4	Sep 14	VARs	B	0111
5	Sep 19	VARs	B	Lab
6	Sep 21	Kalman Filter and Applications	B	0111
7	Sep 26	Review of Local Approximation Methods and Dynare	B	Lab
8	Sep 28	Review of Local Approximation Methods and Dynare	B	Lab
9	Oct 3	Global Approximation Methods and Comparison of Solution Methods	B	0111
10	Oct 5	Global Approximation Methods	B	Lab
11	Oct 10	Global Approximation Methods	B	Lab
12	Oct 12	DSGE Estimation – Theory	B	0111
13	Oct 17	DSGE Estimation – Applications : GMM	B	Lab
14	Oct 19	DSGE Estimation – Applications : Likelihood-Based Methods	B	Lab
15	Oct 24	Calibration vs. Estimation (Group Presentations)	B	0111
16	Oct 26	Value Function Iteration	P	0111
17	Oct 31	Value Function Iteration	P	Lab
18	Nov 2	Value Function Iteration	P	Lab
19	Nov 7	Aggregation / Incomplete Market Models	P	0111
20	Nov 9	Incomplete Market Models	P	0111
21	Nov 14	Incomplete Market Models	P	Lab
22	Nov 16	Incomplete Market Models	P	0111
23	Nov 21	Incomplete Market Models	P	Lab
24	Nov 23	Structural Estimation – SMM	P	0111
25	Nov 28	Structural Estimation - Indirect Inference	P	Lab
26	Nov 30	Firm Dynamics	P	0111
27	Dec 5	Aggregate Uncertainty and Incomplete Markets	P	0111
28	Dec 7	Aggregate Uncertainty and Incomplete Markets	P	0111
29	Dec 12	Aggregate Uncertainty and Incomplete Markets	P	Lab