

Computational Methods for Macroeconomics (Official Title: Computable GE Modeling) (Spring 2006)

1 Basic Information

Instructor	Makoto Nakajima
Office	452 Wohlers Hall
Email	makoto@uiuc.edu
Course web site	http://www.compmacro.com/makoto/200601econ552/index.html
Office hours	Tuesdays 11:00-13:00 or by appointment (email me)
Class	Mondays & Wednesdays, 12:00-13:45
Classroom	137 Armory

2 Course Description

There are two goals: (1) learn computational methods which are extensively used to answer many interesting questions in macroeconomics, and (2) learn how the methods are applied in different interesting issues.

Corresponding to these two goals, there are two parts in the course. In The first part of the course, you will learn how to solve, computationally, standard models which are widely used in macroeconomics. There will be some problem sets, which give you a chance of learning-by-doing.

In the second part of the course, a series of recent papers which use the tools we cover in the first part of the course are presented and discussed. Some of the papers are presented by students. You will learn how the computational methods are used to answer variety of interesting questions in macroeconomics.

In order to answer a quantitative question, you need to *(i)* (of course) come up with a question, *(ii)* construct a relevant model, *(iii)* calibrate the model so that the model captures relevant features of the real world, *(iv)* solve the model, *(v)* use the model to answer the question. I hope that the first part of the course helps you with steps *(iii)* , *(iv)* , and *(v)* , and the second part helps you with step *(i)* (the core courses (Macro I and II) should have helped you with step *(ii)*).

3 Prerequisites

1. Students need to have completed the first two sequences of Ph.D. macro courses (Macroeconomic Theory I and II).
2. Students need to have a basic knowledge in writing programs in one of the languages used for scientific computing (Fortran, C, Matlab, Gauss, Octave, etc). If you want to

do serious research in this field, learn Fortran 90 (or later) or C. Otherwise, Matlab (its freeware sibling, Octave) is the most popular and safe bet.

4 Grading Policy

There are three requirements for satisfactorily completing the course:

1. **Problem Sets (60% of the final grade):** There will be four problem sets. All of them require writing small codes. I hope the experience to write baby codes for yourself helps you start your own project immediately.
2. **Student Presentations (20% of the final grade):** Each of you are asked to make a 90 minutes presentation of a paper from the list distributed in the first class (or alternative suitable paper proposed by you). You should present the summary of the findings of the paper, make a critical evaluation of the paper, and comment on the computational methods used in the paper. The presentations are in the second part of the course. If you decide to take this course, please let me know by email which paper you want to present.
3. **Original Research Proposal (20% of the final grade):** By the last day of the class, you need to submit a written proposal of an original project for which you can use the tools acquired in the course. You are expected to *(i)* survey important papers related to your research project, *(ii)* come up with a question that requires the tools acquired in the course to answer, *(iii)* write down the model, *(iv)* state computational algorithm and mention challenges in computation, if any. I am very happy to help you if you would like to keep on working on the project

5 Textbooks

There is no main textbook that I will closely follow. However, there are some books which are useful for this course, and for you future research. Below is the list.

1. **Press, Teukolsky, Vetterling and Flannery (2001):** Extremely useful book collecting various codes for numerical operations. Also there is a C language version. Available on-line.
2. **Heer and Maussner (2005) (HS):** Closest to the approach of the course, with a lots of examples.
3. **Judd (1998):** Dictionary of computational methods that are useful for economists.
4. **Marimon and Scott, eds (1999) (MS):** Collection of papers covering various branches of computational methods concisely.

5. **Ljungqvist and Sargent (2004)**: Standard textbook in macroeconomics.
6. **Cooley, ed (1995) (CO)**: Collection of papers on business cycles, occasionally mentions computational methods.
7. **Miranda and Fackler (2002)**: Relatively new textbook. Focusing on finance and spending considerable amount of pages on continuous time methods.
8. **Ada and Cooper (2003)**: Concise introduction on solving a dynamic model and estimating structural parameters of the model.

6 Course Outline

Part I: Computational Methods for Solving Macroeconomic Models

1. Solution Methods to Neoclassical Growth Models
 - (a) Value function iteration (Discretization). HS 1.2
 - (b) Value function iteration (Finite Elements and Weighted Residuals). HS 1.2,
 - (c) Speeding-up: Using properties of value function and policy functions. Howard algorithm.
 - (d) Policy function iteration. HS 1.2
 - (e) Policy functions as system of equations. HS 1.2
2. Solution Methods to Stochastic Growth Models
 - (a) Linear-Quadratic (LQ) approximation. HS 2.2, MS 2
 - (b) Linearizing Euler Equation. HS 2.3
 - (c) The general method. Uhlig (1997), MS 3
 - (d) Parameterized Expectation Approach (PEA) HS 3, MS 7
3. Solution Methods to Heterogeneous Agents Models
 - (a) Steady State. Aiyagari (1994), MS 11, HS 5
 - (b) Transition between steady states, MS 11, HS 6.2
 - (c) Aggregate uncertainty: Krusell and Smith (1998), MS 11, HS 6.3
4. Solution Methods to Overlapping Generation Models
 - (a) Steady State. Huggett (1996), HS 7.2
 - (b) Transition between steady states, HS 7.2

- (c) Aggregate uncertainty: Ríos-Rull (1996), HS 7.2
- 5. Calibration of the Model
 - (a) Classic example. CO 1
 - (b) More recent example. Chatterjee, Corbae, Nakajima and Ríos-Rull (2002)
 - (c) Estimation. Gourinchas and Parker (2002), Cagetti (2003)
- 6. Introduction to Parallel Computation with MPI

Part II: Applications

1. **Costs of business cycles:** Lucas (2003), Krusell and Smith (1999), Storesletten, Telmer and Yaron (2001b), Costain and Reiter (2005)
2. **Wealth inequality:** Chatterjee (1994), Díaz-Giménez, Quadrini and Ríos-Rull (1997), Castañeda, Díaz-Giménez and Ríos-Rull (2003), Quadrini (2000), De Nardi (2004)
3. **Asset pricing and stock market non-participation:** Kocherlakota (1996), Krusell and Smith (1997), Storesletten, Telmer and Yaron (2001a), Pijoan-Mas (2004), Constantinides, Donaldson and Mehra (2002) Guvenen (2004), Guvenen (2005)
4. **Macroeconomic effect of rising earnings inequality:** Heathcote, Storesletten and Violante (2003), Krueger and Perri (2003), Krueger and Perri (2005), Guvenen and Kuruscu (2005), Huggett, Ventura and Yaron (2005)
5. **Default and bankruptcy:** Chatterjee et al. (2002), Alvarez and Jermann (2000), Livshits, MacGee and Tertilt (2005b), Livshits, MacGee and Tertilt (2005a), Yue (2005)
6. **Distributional Effects of fiscal policy:** Conesa and Krueger (1999), Huggett and Ventura (1999), Aiyagari and McGrattan (1998), Heathcote (2005), Domeji and Heathcote (2004), Storesletten (2000)
7. **Distributional Effects of monetary policy:** Erosa and Ventura (2002), Bai (2005)
8. **Housing or durable goods:** Fernández-Villaverde and Krueger (2005), Jeske and Krueger (2005) Díaz and Luengo-Prado (2003), Nakajima (2005), Ortalo-Magné and Rady (2005)
9. **Family economics:** Cubeddu and Ríos-Rull (2003), Guner and Knowles (2003), Caucutt, Guner and Knowles (2002)
10. **Political economy:** Krusell, Quadrini and Ríos-Rull (1997), Krusell and Ríos-Rull (1999)
11. **Growth and Inequality:** Bénabou (1996), Galor and Zeira (1993), Lloyd-Ellis and Bernhardt (2000)

References

- Ada, Jerome and Russell W. Cooper**, *Dynamic Economics*, Cambridge, MA: MIT Press, 2003.
- Aiyagari, S. Rao**, “Uninsured Idiosyncratic Risk, and Aggregate Saving,” *Quarterly Journal of Economics*, 1994, *109*, 659–684.
- and **Ellen McGrattan**, “The Optimal Quantity of Debt,” 1998, *42*, 447–469.
- Alvarez, Fernando and Urban Jermann**, “Efficiency, Equilibrium, and Asset Pricing with Risk of Default,” *Econometrica*, 2000, *68*, 775–798.
- Bai, Jinhui H.**, “Stationary Monetary Equilibrium in a Baumol-Tobin Exchange Economy: Theory and Computation,” 2005. Unpublished Manuscript.
- Bénabou, Ronald**, “Inequality and Growth,” in Ben Bernanke and Julio Rotemberg, eds., *NBER Macroeconomics Annual 1996*, Vol. 11, Cambridge, MA: MIT Press, 1996.
- Cagetti, Marco**, “Wealth Accumulation Over the Life Cycle and Precautionary Savings,” *Journal of Business and Economic Statistics*, 2003, *21*, 339–353.
- Castañeda, Anna, Javier Díaz-Giménez, and J. V. Ríos-Rull**, “Accounting for the U.S. earnings and wealth inequality,” *Journal of Political Economy*, 2003, *111* (4), 818–857.
- Caucutt, Elizabeth, Nezh Guner, and John Knowles**, “Why do Women Wait? Matching, Wage Inequality and Incentives for Fertility Delay,” *Review of Economic Dynamics*, 2002, *5*, 815–855.
- Chatterjee, Satyajit**, “Transitional Dynamics and the Distribution of Wealth in a Neoclassical Growth Model,” *Journal of Public Economics*, 1994, *54*, 97–119.
- , **Dean Corbae, Makoto Nakajima, and José-Víctor Ríos-Rull**, “A Quantitative Theory of Unsecured Consumer Credit with Risk of Default,” 2002. Manuscript, University of Pennsylvania.
- Conesa, Juan C. and Dirk Krueger**, “Social Security Reform with Heterogeneous Agents,” *Review of Economic Dynamics*, 1999, *2*, 757–795.
- Constantinides, George M., John B. Donaldson, and Rajnish Mehra**, “Junior Can’t Borrow: A New Perspective on the Equity Premium Puzzle,” *Quarterly Journal of Economics*, 2002, *117*, 269–296.
- Cooley, Thomas F., ed.**, *Frontiers of Business Cycle Research*, Princeton, NJ: Princeton University Press, 1995.
- Costain, James S. and Michael Reiter**, “Business Cycles, Unemployment Insurance, and the Calibration of Matching Models,” 2005. Manuscript, Universitat Pompeu Fabra.

- Cubeddu, Luis and Jose-Víctor Ríos-Rull**, “Families and Shocks,” *Journal of the European Economic Association*, 2003, 1, 671–682.
- De Nardi, Mariacristina**, “Wealth Inequality and Intergenerational Links,” *Review of Economic Studies*, 2004, 71, 743–768.
- Díaz, Antonia and María J. Luengo-Prado**, “Durable Goods and the Wealth Distribution,” 2003. Unpublished Manuscript.
- Díaz-Giménez, Javier, Vincenzo Quadrini, and Jose-Víctor Ríos-Rull**, “Dimensions of Inequality: Facts on the U.S. Distributions of Earnings, Income, and Wealth,” 1997, 21, 3–21.
- Domeji, David and Jonathan Heathcote**, “On the Distributional Effects of Reducing Capital Taxes,” *International Economic Review*, 2004, 45, 523–554.
- Erosa, Andrés and Gustavo Ventura**, “On Inflation as a Regressive Consumption Tax,” 2002, 49, 761–795.
- Fernández-Villaverde, Jesús and Dirk Krueger**, “Consumption and Saving over the Life Cycle: How important are Consumer Durables?,” 2005. Unpublished Manuscript.
- Galor, Oded and Joseph Zeira**, “Income Distribution and Macroeconomics,” *Review of Economic Studies*, 1993, 60, 35–52.
- Gourinchas, Pierre-Olivier and Jonathan A. Parker**, “Consumption over the Life-Cycle,” *Econometrica*, 2002, 70 (1), 47–89.
- Guner, Nezih and John Knowles**, “Marital Instability and the Distribution of Wealth,” 2003. Unpublished Manuscript.
- Güvenen, Fatih**, “Learning Your Earning: Are Labor Income Shocks Really Very Persistent?,” 2004. Unpublished Manuscript.
- , “Reconciling Conflicting Evidence on the Elasticity of Intertemporal Substitution: A Macroeconomic Perspective,” 2005. forthcoming in *Journal of Monetary Economics*.
- and **Burhanettin Kuruscu**, “Understanding Wage Inequality: Ben-Porah Meets Skill-Biased Technical Change,” 2005. Unpublished Manuscript.
- Heathcote, Jonathan**, “Fiscal Policy With Heterogeneous Agents and Incomplete Markets,” *Review of Economic Studies*, 2005, 72, 161–188.
- , **Kjetil Storesletten, and Giovanni L. Violante**, “The Macroeconomic Implications of Rising Wage Inequality in the United States,” 2003. Unpublished Manuscript.
- Heer, Burkhard and Alfred Maussner**, *Dynamic General Equilibrium Modelling*, Heidelberg: Springer, 2005.

- Huggett, Mark**, “Wealth Distribution in Life-Cycle Economies,” *Journal of Monetary Economics*, 1996, 38, 469–494.
- and **Gustavo Ventura**, “On the DIstributional Effects of Social Security Reform,” *Review of Economic Dynamics*, 1999, 2, 498–531.
- , — , and **Amir Yaron**, “Sources of Life-Cycle Inequality,” 2005. Unpublished Manuscript.
- Jeske, Karsten and Dirk Krueger**, “Housing and the Macroeconomy: The Role of Implicit Guarantees for Government Sponsored Enterprises,” 2005. Unpublished Manuscript.
- Judd, Kenneth**, *Numerical Methods in Economics*, Cambridge, MA: MIT Press, 1998.
- Kocherlakota, Narayana R.**, “The Equity Premium: It’s Still a Puzzle,” *Journal of Economic Literature*, March 1996, 34 (1), 42–71.
- Krueger, Dirk and Fabrizio Perri**, “On the Welfare Consequences of the Increase in Inequality in the United States,” in Mark Gertler and Kenneth Rogoff, eds., *NBER Macroeconomics Annual 2003*, Vol. 18, Cambridge, MA: MIT Press, 2003.
- and — , “Does Income Inequality Lead to Consumption Inequality? Evidence and Theory,” 2005. Forcoming in *Review of Economic Studies*.
- Krusell, Per and Anthony Smith**, “Income and Wealth Heterogeneity, Portfolio Choice, and Equilibrium Asset Returns,” *Macroeconomic Dynamics*, 1997, 1 (2), 387–422.
- and — , “Income and Wealth Heterogeneity in the Macroeconomy,” *Journal of Political Economy*, 1998, 106, 867–896.
- and — , “On the Welfare Effects of Eliminating Business Cycles,” *Review of Economic Dynamics*, 1999, 2, 245–272.
- and **Jose-Víctor Ríos-Rull**, “On the Size of the U.S. Government,” *American Economic Review*, 1999, 89, 1156–1181.
- , **Vincenzo Quadrini**, and **Jose-Víctor Ríos-Rull**, “Politico-Economic Equilibrium and Growth,” *Journal of Economic Dynamics and Control*, 1997, 21, 243–272.
- Livshits, Igor, James MacGee, and Michele Tertilt**, “Accounting for the Rise in Consumer Bankruptcies,” 2005. Unpublished Manuscript.
- , — , and — , “Consumer Bankruptcy: A Fresh Start,” 2005. Unpublished Manuscript.
- Ljungqvist, Lars and Thomas Sargent**, *Recursive Macroeconomic Theory*, Cambridge, MA: MIT Press, 2004.

- Lloyd-Ellis, Huw and Dan Bernhardt**, “Enterprise Inequality and Economic Development,” *Review of Economic Studies*, 2000, *67*, 147–168.
- Lucas, Robert E.**, “Macroeconomic Priorities,” *American Economic Review*, 2003, *93*, 1–14.
- Marimon, Ramon and Andrew Scott**, eds, *Computational Methods for the Study of Economic Dynamics*, Oxford: Oxford University Press, 1999.
- Miranda, Mario J. and Paul L. Fackler**, *Applied Computational Economics and Finance*, Cambridge, MA: MIT Press, 2002.
- Nakajima, Makoto**, “Rising Earnings Instability, Portfolio Choice, and Housing Prices,” 2005. Unpublished Manuscript.
- Ortalo-Magné and Sven Rady**, “Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints,” 2005. forthcoming in *Review of Economic Studies*.
- Pijoan-Mas, Josep**, “Pricing Risk in Economies with Heterogeneous Agents and Incomplete Markets,” 2004. Unpublished Manuscript.
- Press, William H., Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery**, *Numerical Recipes in Fortran 77. Second Edition. The Art of Scientific Computing*, Cambridge: Cambridge University Press, 2001.
- Quadrini, Vincenzo**, “Entrepreneurship, Saving, and Social Mobility,” *Review of Economic Dynamics*, 2000, *3*, 1–40.
- Ríos-Rull, José-Víctor**, “Life Cycle Economies and Aggregate Fluctuations,” *Review of Economic Studies*, 1996, *63*, 465–489.
- Storesletten, Kjetil**, “Sustaining Fiscal Policy through Immigration,” *Journal of Political Economy*, 2000, *108*, 300–324.
- , **Chris I. Telmer, and Amir Yaron**, “Asset Pricing with Idiosyncratic Risk and Overlapping Generations,” 2001. Unpublished Manuscript.
- , —, **and** —, “The Welfare Cost of Business Cycles Revisited: Finite Lives and Cyclical Variation in Idiosyncratic Risk,” *European Economic Review*, 2001, *45*, 1311–1339.
- Uhlig, Harald**, “A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily,” 1997. Unpublished Manuscript.
- Yue, Vivian Z.**, “Sovereign Default and Debt Renegotiation,” 2005. Unpublished Manuscript.