University of Toronto
ECO2104 Quantitative Macroeconomics
Fall 2017

Course Information

Instructor:	Sebastian Dyrda
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Lecture:	Tuesday 5pm-7pm at GE 100
Course webpage:	all course materials are on Blackboard

Grades. Grades will be based on three elements: (i) homeworks (weight 40%) (ii) referee review/class presentation (weight 20%) (iii) final project (weight 40%). The details of each element are as follows.

- **Homeworks.** For the first ten weeks there are going to be weekly problem sets, which are required for passing the course. Homeworks are due to the beginning of the class at the due date. You are eager to cooperate with each other in solving the problem sets, however each student has to turn in the uniquely written copy of the assignment. At the beginning of the lecture one or two students will be asked to present the solution of the problem set. Presentation should be done with the use of slides and should take no longer than 10 minutes. Depending on the size of the class and interests I might ask you to present a paper or more than one homework.

- **Referee review.** Every student is required to hand in the referee report on the paper from the list I will post around 5th week of the course. Alternatively, you can suggest a paper for the review based on your research interests (subject to my approval). Each student has to submit a referee report on a different paper. You have to submit the review before the last lecture.

- **Final assignment.** The final assignment would be to replicate the main results from the working paper or published paper. I will suggest a list of papers to choose from. Also you can suggest your own choice, which would be subject to my approval.

Textbook. There is no single textbook for this course. We will use various chapters from different books as well as the journal articles. The useful textbooks for this course would be

1. *Applied Computational Economics and Finance* by Mario J. Miranda and Paul L.Fackler (MIT Press, 2002).

2. *Numerical Methods in Economics* by Kenneth L. Judd (MIT Press, 1998).

3. *Computational Methods for the Study of Dynamic Economies*, edited by Ramon Marimon and Andrew Scott (Oxford University Press, 1999).

4. *Dynamic General Equilibrium Modelling: Computational Methods and Applications*, by Burkhard Heer and Alfred Maussner (Springer, 2005).

5. *Handbook of Computational Economics (Volume 3)*, edited by Karl Schmedders and Kenneth L. Judd (North-Holland, 2013).

Office hours. In order to arrange the meeting to discuss any topic related to the course just send me an email at sebastian.dyrda@utoronto.ca.

Software. This is **not a course in computer languages** so you are responsible to learn to write computer programs. You are also responsible for learning your way around University of Toronto computational facilities. In terms of languages I recommend so that you code either in Fortran 90 (or newer) or C++ (or some other fast language if you have preference for it). Most of the problem sets can be completed in Matlab/Python, however I would not recommend it, in particular for the PhD students. I would also suggest for you to become familiar with MPI or OpenMP libraries so that you can make use of the power of parallel computation. The purpose of this course is to force you to learn fast, scientific language to tackle the toughest research questions. For the statistical analysis you will need access to one of the popular statistical softwares: Stata, SPSS, SAS, R or GAUSS.

Course Outline

The course is divided into three parts. In the first part we will cover the basic numerical methods and techniques. In the second part we will apply these methods to solve the representative agent models and heterogenous agents/firms models. The third part of the course will be devoted to present the papers from the frontier of the quantitative macroeconomics with heterogeneity. In what follows I outline the set of topics I plan to cover during the course. Note, this schedule is subject to change and I might post the updated versions of the syllabus with detailed readings and references on the course website.

Part I: Basic Numerical Tools

Week 1: Introduction to Quantitative Macroeconomics. Calibration vs. estimation. The introduction to the micro data sets.

Week 2: Elementary concepts in numerical analysis. Numerical differentiation, numerical integration and algorithms for solving nonlinear equations.

Week 3: Numerical optimization. Local vs. global optimization algorithms. Application of low-discrepancy sequences to optimization.

Week 4: Estimation of the income and productivity processes from the data. Discretization of the estimated processes. New facts on income dynamics.

Part II: Solving equilibrium models

Week 5: Value and policy function iterations. Discretization of the state space. Application to the planner's problem in the RBC model.

Week 6: Perturbation methods. Linearization and log-linearization. Introduction to Dynare. Handling the occasionally binding constraints on endogenous variables. Application to the augmented RBC model.

Week 7: Approximation methods: finite elements method, spectral methods. Endogenous grid algorithm and envelope condition method. Smolyak method for solving dynamic economies. Application to the income fluctuations problem.

Week 8: Computing stationary distribution in heterogenous agents models. Solving for the stationary equilibrium. Application to Aiyagari and Hopenhayn models.

Week 9: Solving for the equilibrium of the heterogenous agents model with aggregate shocks. Alternative algorithms presentation. Accuracy measures. Application to the Aiyagari economy and Khan, Thomas firm dynamics model.

Week 10: Continuous time techniques for solving macro models with heterogeneity. Application to the model of entrepreneurship with financial frictions.

Part III: Frontiers of macroeconomics with heterogeneity

Week 11: Models with liquid and illiquid assets. Fiscal and monetary policy in heterogeneous-agents New Keynesian models.

Week 12: Quantitative models of firm dynamics with heterogeneity.