McMaster University
Department of Economics

ECON 766 **Computational methods** **Fall 2021**

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Office hours (in-person): Thu 2:30 - 3:30 pm or by appointment

Class times: Tue & Thu 1:00 - 2:30 pm
Lecture (in-person): KTH 334

Background and Course Description

Most models used in economics today do not have analytical solutions. Hence, computational methods and algorithms to solve economic models are important tools. This course has three goals. Provide an introduction to computational methods for solving economic models with representative (or heterogeneous) consumers (or firms); learn how to map model to data by assigning parameter values; compare the economic behavior implied by the model with data, and run counter factual exercises for policy and welfare. Major sub-topics: Dynamic programming and Value Function Iteration, Function Interpolation, Numerical Integration, Discretization of Continuous Processes, Optimization, Simulation, Calibration

Textbooks and other reading materials

The course does not follow a specific textbook, hence there is no book to purchase. The required readings will be a mix of lecture notes prepared by the instructors, journal articles, research papers, and chapters from books. You will find links to these items on Avenue to Learn.

Course web site and communication

In this course we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Programming language

- Highly recommended: FORTRAN (free)
  - Download and install a text editor (recommended: Kate)
    - Link: https://kate-editor.org/get-it/
  - Download and install Microsoft Visual Studio Community (applies only for Windows users)
    - Link: https://visualstudio.microsoft.com/downloads/
    - Check Desktop development with C++ under Workloads (fig1)
    - Search and check C++ Windows XP Support for VS 2017)v141) tools [Deprecated] under Individual components (fig2)
  - Download and install Intel oneAPI HPC Toolkit
    - Link: https://software.intel.com/content/www/us/en/develop/articles/free-intel-software-developer-tools.html
    - First click on the Get the Base Kit and install it.
    - Second click on Get the HPC Kit and install it.
- Other options: Matlab (free through university), Python (free), C++ (free)
  - Link for matlab: https://www.mathworks.com/academia/tah-portal/mcmaster-university-31501097.html

Assessment and Grading Scheme

We will solve the Aiyagari model and Hopenhayn model. As we work on methods to solve these models, there will be 7 assignments (1 - 7). Towards the end of the semester, we will discuss how these models have been extended for research in various directions (8 - 9).

1. Discretization of earnings/productivity processes (20 points)
   - Tauchen, Tauchen and Hussey, Rouwenhorst
   - Reference: Finite state Markov-chain approximations to highly persistent processes by Kopecky and Suen (2010)
2. Solving Consumer's problem (Aiyagari model) and Firm's problem (Hopenhayn model) (20 points)
   - Optimization methods: Grid search, Golden section search, Brent
   - Associated tools: Bisection, One dimensional interpolation, Spline interpolation
3. Simulation and general equilibrium (Aiyagari model, Hopenhayn model) (15 points)
4. Backward indudction for transitions (Aiyagari model, Hopenhayn model) (15 points)
5. Simulation and general equilibrium for transitions (Aiyagari model, Hopenhayn model) (15 points)
6. Calibration (5 points)
7. Welfare analysis (Aiyagari model) (10 points)
8. Multi-dimensional optimization: Nelder-Mead
9. Parallel processing

10. Extensions of Aiyagari model

    - Earnings/income/wealth inequality: The evolution of wealth inequality over half a century: The role of taxes, transfers and technology by Kaymak and Poschke (2016)
    - Consumer credit (credit cards, student loans): Accounting for the rise in consumer bankruptcies by Livshits, MacGee, and Tertilt (2010)
    - Estimating earnings processes from micro data: What Do Data on Millions of U.S. Workers Say About Life Cycle Labor Income Risk? by Guvenen, Karahan, Ozkan, and Song (2019)
    - Housing: Mortgage Debt, Consumption, and Illiquid Housing Markets in the Great Recession by Hedlund and Garriga (2020)
    - Entrepreneurship/tax policy: Higher Taxes at the Top: The Role of Entrepreneurs by Bruggemann (2020)
    - Directed labor market search: Efficient Search on the Job and the Business Cycle by Menzio and Shi (2011)
    - Shocks to higher order moments: The Nature of Countercyclical Income Risk by Guvenen, Ozkan, and Song (2014)
    - Macro healthcare/Social Security with overlapping generations: Implications of Increasing College Attainment for Aging in General Equilibrium by Conesa, Kehoe, Nygard, and Raveendranathan (2020)
    - Constrained efficiency: Constrained Efficiency in the Neoclassical Growth Model with Uninsurable Idiosyncratic Shocks by Davila, Hong, Krusell, and Rios-Rull (2012)
    - Monetary policy: Monetary Policy According to HANK by Kaplan, Moll, and Violante (2018)

11. Extensions of Hopenhayn model

    - Market power/concentration: How Costly Are Markups? by Edmond, Midrigan, and Xu (2019)
    - Estimation of productivity processes: The Nature of Firm Growth by Pugsley, Sedlacek, and Sterk (2020)
    - Financial frictions: Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity by Khan and Thomas (2013)
    - Shocks to higher order moments: Really Uncertain Business Cycles by Floetotto, Jaimovich, Saporta and Terry (2018)
    - Monetary policy: Financial Heterogeneity and the Investment Channel of Monetary Policy by Ottonello and Winberry (2020)

Academic Dishonesty

You are expected to exhibit honesty and use ethical behavior in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behavior can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.

2. Improper collaboration in group work.

3. Copying or using unauthorized aids in tests and examinations.

At certain points in the course it may make good sense to modify the course content described on page 1. The instructor reserves the right to modify elements of the course and will notify students accordingly (in class and post any changes to Avenue to Learn).

UNIVERSITY POLICIES

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/ The following illustrates only three forms of academic dishonesty: • plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained. • improper collaboration in group work. • copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using

these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

FACULTY OF SOCIAL SCIENCES EMAIL COMMUNICATION POLICY

Effective September 1, 2010, it is the policy of the Faculty of Social Sciences that all e-mail communication sent from students to instructors (including TAs), and from students to staff, must originate from the student's own McMaster University e-mail account. This policy protects confidentiality and confirms the identity of the student. It is the student's responsibility to ensure that communication is sent to the university from a McMaster account. If an instructor becomes aware that a communication has come from an alternate address, the instructor may not reply at his or her discretion.

COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check his/her McMaster email and course websites weekly during the term and to note any changes.

August 24, 2021