DALHOUSIE UNIVERSITY

Faculty of Science Course Syllabus
Department of Economics
Time Series in Economics, ECON 4440
Winter 2025

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Instructor:
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Timetable:
Lecture Hours:

- Tuesday and Thursday, 13:05-14:25, McCain Arts & SS 2019

Office Hours:

- Wednesday 09:30-11:30 (or by appointment)

Course Description:
This is a course in econometrics that focuses on time series models. The topics cover estimation and inference procedures for univariate and multivariate time series models with stationary and nonstationary data, including stationary univariate time series models (ARMA), unit-root testing, vector autoregressive and vector error correction models, autoregressive heteroscedasticity (ARCH/GARCH), and Markov switching models.

Course Prerequisites:
ECON 3338 (grade of C or higher), ECON 3339 (grade of B or higher)

Course Objectives:
This course introduces the econometric analysis of time series. The emphasis is on the development of standard time series models, the study of their properties, and their application to economic and financial data, using practical examples.

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Learning Outcomes and competences:

After having followed the course the students should be able:

- to estimate and perform hypothesis testing on the parameters of all the discussed models using standard econometric software packages
- to associate the different models with relevant economic and financial applications
- be able of forecasting time series variables either individually or within a model

In terms of the econometric models presented in the course, the students should be able:

- to identify the dependence and stationarity properties of time series data,
- to describe and relate the features and linkages between different kinds of ARMA processes, and to do calculus for specific processes using difference equation and lag operator techniques including the purpose of forecasting
- to identify and compare different types of non-stationary processes, and to analyze their relative features
- to describe and apply the testing procedure for unit root processes (Dickey-Fuller test)
- to formulate the VAR, and to derive the properties of VAR models including the calculation of impulse response functions
- to discuss the notion of spurious regression for integrated processes
- to define and analyze the co integrated VAR model, and the VECM model
- to interpret the output of the VAR estimation procedure for cointegrated variables, and to discuss the hypothesis testing approach for the cointegration rank
- to introduce approaches in modeling heteroskedasticity in time series using the GARCH family of models
- introduce Regime Switching Models, and discuss estimation procedures and inference about the number of regimes

Material:

- Instructor notes
- James H. Stock and Mark W. Watson "Introduction to Econometrics", 4th Edition, Chapters 15-17.
- Jeffrey M. Wooldridge, "Introductory Econometrics: A Modern Approach", 7th Edition, South-Western College Pub.
- Hamilton (1994), Time Series Analysis (reference textbook, not required)
- Mills, and Markellos (2008), The Econometric Modeling of Financial Time Series (simpler than Hamilton, not required)
    + Hamilton (1994) and Mills and Markellos (2008) are on a 2-hr reserve on Killam Library.

Software:

- **Gretl**
    + Gretl is freeware econometric software, which can be downloaded in http://gretl.sourceforge.net/.
- **R**
    + R is freeware software used by many researchers for econometrics and statistics. It is available in: http://www.r-project.org/
- **STATA**

+ A one-year STATA/SE Student license is available to all Dalhousie Students. Students can download Stata/SE 18 at: https://software.library.dal.ca/

A short discussion about the above packages and other statistical software will take place during the first class. Although students are free to choose the statistical package of their preference, demonstration of concepts will be based on Gretl.

Data Sources:

The course focuses on economic and financial time series data. The following sources provide macroeconomic and financial data for United States, Canada, and other countries:

1. Federal Reserve Economic Data- FRED-St. Louis FED:
   - https://research.stlouisfed.org/fred2/
   - One of the most comprehensive data sources regarding macroeconomic data for United States. It includes data for other countries as well.
   - Examples: Real Gross Domestic Product, 10-year Treasury Constant Maturity Rate
   - Bonus: Free App that you can access the site via your mobile device, and an excellent Excel add-in for downloading and manipulating data.
2. Statistics Canada- Key socioeconomic Database-CANSIM:
   - https://www150.statcan.gc.ca/n1/en/type/data
   - The equivalent of FRED for all things Canadian. It includes a host of data for Canada and the individual provinces organized in tables.
   - Example: Consumer Price Indices exist in Table 18-10-0004-01. The table contains Price Indices for a variety of goods and services categories, for Canada and provinces (access to the individual components by Add/Remove Data). Data can be exported into MS Excel.
3. IMF World Economic Outlook Database:
   - https://www.imf.org/en/Publications/WEO/weo-database/2024/October
   - It contains selected macroeconomic data series from the statistical appendix of the World Economic Outlook report, which presents the IMF staff's analysis and projections of economic developments at the global level, in major country groups and in many individual countries.
4. International Monetary Fund (IMF) International Financial Statistics (IFS):
   - http://dal.ca.libguides.com/economics, click on "International Financial Statistics."
   - (http://data.imf.org/?sk=5dabaff2-c5ad-4d27-a175-1253419c02d1)
   - Primarily financial statistics for countries members of IMF; exchange rates, monetary statistics, prices, interest rates.
   - Access via Data Tables, when you can select the country or series of interest, and ability to export to Excel.
5. World Bank World Development Indicators:
   - http://data.worldbank.org/data-catalog/world-development-indicators
   - Most current and accurate global development data available, and includes national, regional and global estimates.

- Access via Data Tables, when you can select the country or series of interest, and ability to export to Excel.

6. Organisation for Economic Co-operation and Development (OECD)
   - https://data.oecd.org/
   - A variety of data for OECD countries.
7. Canadian Housing Market Outlook & Statistics
   - https://www.cmhc-schl.gc.ca/en/data-and-research/data-tables
   - https://www03.cmhc-schl.gc.ca/hmip-pimh/en#Profile/1/1/Canada
   - Teranet-National Bank House Price Index: https://housepriceindex.ca/#maps=c11

Format:

- Lectures
- Computer Exercises

Assessment:

Academic Calendar regulation 16.1: "In order to complete a course satisfactorily, a student must fulfill all the requirements as set down in the course outline."

- Data Assignments (5): 25% (individual)
  + Details in separate documents throughout the term.
  + The worst assignment won't count towards grade.
- Midterm Exam: 25%
- Final Exam (scheduled by RO): 50%
  + The final exam will have two parts: Theory & Computer Application.

- Notes:

  ➢ Data Assignments

  + At the beginning of the term each student will be assigned to download several macroeconomic and financial variables for a country. Assignments will be about implementing the theory taught in class to the specific variables.
  + Assignments will be posted online (Brightspace course page).
  + Scanned pdf files of completed regular assignments are submitted to specific folders under "Assessments" tab in Brightspace.

  ➢ Exams

  + Examinations are "closed book" and materials other than those mentioned should not be used. There is no supplemental privilege in this course.

  ➢ To pass the course, a student must achieve an overall passing grade and a minimum grade of 40% on the final examination, which covers material drawn from the entire course.

- Missing assessment elements:
  - Assignments
  + Late assignments will be marked down by 20 percent per day. Any exception requires a legitimate reason listed in the Dalhousie University Calendar under section 16.8 of "Academic Regulations."
  + Students unable to submit a regular assignment, they must contact the instructor by email prior to the date and time of the assessment and submit a completed Student Declaration of Absence (SDA) form via Brightspace or by email (no medical note is required). The weight of the missed assignment will be equally distributed among the other assignments.
  - Exams
  + If a student is unable to attend the midterm exam, they must contact the instructor by email prior to the date and time of the exam and submit a completed Student Declaration of Absence via Brightspace or by email (no medical note is required). The weight of the midterm exam will be added to the final exam.
  + If a student misses the final exam for a valid reason, (Section 16.8 of the University Calendar), they must notify the instructor immediately. The student will have the opportunity to write up a make-up exam.

Note that the SDA form can only be used twice during the term.

Policies related to Academic Integrity:

- Assignments
  + Assignments are individual assignments. Copying and/or cooperation is not permitted, and it constitutes a serious academic offence (see Academic Integrity).
  + You should refrain from using generative AI and large language models (e.g., ChatGPT).

Grading scheme:

A+	A	A-	B+	B	B-	C+	C	C-	D	F
90-100	85-89	80-84	77-79	73-76	70-72	65-69	60-64	55-59	50-54	<50

Important Dates (midterm date is tentative):

- Last Day to Change and Add Classes for registered students: January 20th
- Last Day to Drop without "W": February 3rd
- Last Day to Drop with "W": March 5th
- Winter study break: February 17th-21st
- **Midterm Exam**: February 13th (**in class**)
- **Final Exam**: Regular exam period (April 9th- April 26th)

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Course Policies:

Email Policy:

- Weekdays: emails received by 18.00 would be responded by the end of the day. Anything after that hour would be responded in the following day.
- Weekends: emails are to be checked sporadically, thus you should not expect a response within the same day.
- Lengthy questions are easier and preferable to be answered during office hours.
- **Make sure that you have checked the course outline and all material available in Brightspace prior to asking a question.**

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Course contents:

	Week 1
January 7th	• Administrative Issues/ Software/Data Sources & Transformation • Review of Probability and Statistical Concepts
	Week 2
January 14th	• Time Series Models and Ordinary Least Squares
	Week 3
January 21st	• ARMA Models: Description -Properties
	Week 4
January 28th	• ARMA Models: Estimation and Forecasting
	Week 5
February 4th	• ARIMA Models
	Week 6
February 11th February 13th	• Unit Root Testing • **Midterm Exam**

WINTER STUDY BREAK (February 17th to 21st)

	Week 7
February 25th	• Unit Root Testing (cont.) • Spurious Regressions- Cointegration
	Week 8
March 4th	• VAR Models: Estimation- Forecasting- Impulse Response Functions
	Week 9
March 11th	• VEC Models
	Week 10
March 18th	• Structural VAR Models
	Week 11
March 25th March 27th	• Conditional Variance Models: ARCH/GARCH and variants; • Regime Switching Models
	Week 12
April 1st	• Graduate Student Presentations/Review

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University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate.

Recognition of Mi'kmaq Territory
Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization
At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity
At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility
The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect
Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect
Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and

inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.

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Student Resources and Support

University Policies and Programs
Important Dates in the Academic Year (including add/drop dates): http://www.dal.ca/academics/important_dates.html
Classroom Recording Protocol: https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html
Dalhousie Grading Practices Policies: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html
Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html
Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html
Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Learning and Support Resources
General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html
General Academic Support – Advising (Truro): https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html
Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html
On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html
Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html
Indigenous Connection: https://www.dal.ca/about-dal/indigenous-connection.html
Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at elders@dal.ca or 902-494-6803: https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf
Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html
International Centre: https://www.dal.ca/campus_life/international-centre.html
LGBTQ2SIA+ Collaborative: https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html
Dalhousie Libraries: http://libraries.dal.ca/
Copyright Office: https://libraries.dal.ca/services/copyright-office.html
Dalhousie Student Advocacy Services: https://www.dsu.ca/dsas?rq=student%20advocacy
Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html
Human Rights and Equity Services: https://www.dal.ca/dept/hres.html
Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
Faculty of Science Advising Support: https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html

Safety
Biosafety: http://www.dal.ca/dept/safety/programs-services/biosafety.html
Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html
Radiation Safety: http://www.dal.ca/dept/safety/programs-services/radiation-safety.html
Laser Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html

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DEPARTMENT OF ECONOMICS STATEMENT ON ACADEMIC INTEGRITY

At Dalhousie University, we respect the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, adherence to the values of academic integrity and related policies is a requirement of being part of the academic community at Dalhousie University.

What does academic integrity mean?

Academic integrity means being honest in the fulfillment of your academic responsibilities, thus establishing mutual trust. Fairness is essential to the interactions of the academic community and is achieved through respect for the opinions and ideas of others. "Violations of intellectual honesty are offensive to the entire academic community, not just to the individual faculty member and students in whose class an offence occurs." (http://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=1&chapterid=89&topicgroupid=381&loaduseredits=False)

How can you achieve academic integrity?

- Make sure you understand Dalhousie's policies on academic integrity.
- While discussion with your fellow students is valuable, do not submit an assignment or essay that is essentially identical to an assignment or essay submitted by another individual or group.
- In assignments or essays, use an approved method of citation for any material taken directly from an existing source or any material that is a paraphrase of an existing source.
- Do not download the work of another from the Internet and submit it as your own.
- Do not submit work that has been completed through collaboration or previously submitted for another assignment without permission from your instructor.
- Do not have someone else write a test for you, or write a test for someone else.
- During a test, do not talk with other students and do not try to copy the work of another student.

What will happen if an allegation of an academic offence is made against you?

Instructors are required to report any suspected offence. The full process is outlined in the Discipline flow chart (found at http://academicintegrity.dal.ca) and includes the following:

- Each Faculty has an Academic Integrity Officer (AIO) who receives allegations from instructors.
- The AIO decides whether to proceed with the allegation and you will be notified of the process.
- If the case proceeds, you will receive a PENDING grade until the matter is resolved.
- If you are found guilty of an academic offence, a penalty will be assigned ranging from a warning to suspension or expulsion from the University and can include a notation on your transcript, failure of the assignment, or failure of the course. All penalties are academic in nature.

Where can you turn for help?

- If you are ever unsure about ANYTHING, contact your instructor.
- See http://academicintegrity.dal.ca for links to policies, definitions, online tutorials, and tips on citing and paraphrasing.
- See http://writingcentre.dal.ca for assistance with proofreading, writing styles, and citations.
- See http://libraries.dal.ca/research.html for a set of research tools including Subject Guides, Assignment Calculator, and RefWorks.
- See http://studentservices.dal.ca for assistance with appeals and discipline procedures.
- See http://senate.dal.ca for a list of Academic Integrity Officers, a discipline flow chart, and the Senate Discipline Committee.

The Policy on Student Submission of Assignments & Use of Originality Checking Software states that "any instructor may require student assignments to be submitted in both written and electronic (computer-readable) form, e.g., a text file or as an email attachment, as defined by the instructor. Use of third-party originality checking software does not preclude instructor use of alternate means to identify lapses in originality and attribution. The results of such assessment may be used as evidence in any disciplinary action taken by the Senate."