

**Faculty of Science Course Syllabus  
Department of Economics  
Time Series in Economics, ECON 4440  
Winter 2023**

*Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.*

*We acknowledge the histories, contributions, and legacies of the African Nova Scotian people and communities who have been here for over 400 years.*

**Instructor:**

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**Timetable:**

Lecture Hours:

- Monday and Wednesday, 10:05-11:25, McCain Arts & SS 220

Office Hours (via MS Teams):

- Tuesday 09:30-11:00 (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.

**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", 3rd Edition, Updated version, Chapters 14-16.
- 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 17 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/2022/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%
- 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 50% 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).

**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 20<sup>th</sup>
- Last Day to Drop without “W”: February 6<sup>th</sup>
- Last Day to Drop with “W”: March 13<sup>th</sup>
- Winter study break: February 20<sup>th</sup>-24<sup>th</sup>
- **Midterm Exam:** February 12<sup>th</sup> (**in class**)
- **Final Exam:** Regular exam period (April 13<sup>th</sup>- April 25<sup>th</sup>)

**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.**

**Course contents:**

<b>Week 1</b>	
January 9 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Administrative Issues/ Software/Data Sources &amp; Transformation</li> <li>• Review of Probability and Statistical Concepts</li> </ul>
<b>Week 2</b>	
January 16 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Time Series Models and Ordinary Least Squares</li> </ul>
<b>Week 3</b>	
January 23 <sup>rd</sup>	<ul style="list-style-type: none"> <li>• ARMA Models: Description -Properties</li> </ul>
<b>Week 4</b>	
January 30 <sup>th</sup>	<ul style="list-style-type: none"> <li>• ARMA Models: Estimation and Forecasting</li> </ul>
<b>Week 5</b>	
February 6 <sup>th</sup>	<ul style="list-style-type: none"> <li>• ARIMA Models</li> </ul>
<b>Week 6</b>	
February 13 <sup>th</sup> February 15 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Unit Root Testing</li> <li>• <b>Midterm Exam</b></li> </ul>
<b>WINTER STUDY BREAK (February 20<sup>h</sup> to 24<sup>th</sup>)</b>	
<b>Week 7</b>	
February 27 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Unit Root Testing (cont.)</li> <li>• Spurious Regressions- Cointegration</li> </ul>
<b>Week 8</b>	
March 6 <sup>th</sup>	<ul style="list-style-type: none"> <li>• VAR Models: Estimation- Forecasting- Impulse Response Functions</li> </ul>
<b>Week 9</b>	
March 13 <sup>th</sup>	<ul style="list-style-type: none"> <li>• VEC Models</li> </ul>
<b>Week 10</b>	
March 20 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Structural VAR Models</li> </ul>
<b>Week 11</b>	
March 27 <sup>th</sup> March 29 <sup>th</sup>	<ul style="list-style-type: none"> <li>• Conditional Variance Models: ARCH/GARCH and variants;</li> <li>• Regime Switching Models</li> </ul>
<b>Week 12</b>	
April 3 <sup>rd</sup>	<ul style="list-style-type: none"> <li>• Graduate Student Presentations/Review</li> </ul>

## University Policies and Statements

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

### **Academic Integrity**

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of 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.

**Information:** [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### **Accessibility**

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

**Information:** [https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.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.

**Code:** [https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

### **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

**Statement:** <http://www.dal.ca/cultureofrespect.html>

### **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 (1321 Edward St) ([elders@dal.ca](mailto:elders@dal.ca)).

**Information:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Important Dates** in the Academic Year (including add/drop dates)

[https://www.dal.ca/academics/important\\_dates.html](https://www.dal.ca/academics/important_dates.html)

**University Grading Practices**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

## Student Resources and Support

### Advising

**General Advising** [https://www.dal.ca/campus\\_life/academic-support/advising.html](https://www.dal.ca/campus_life/academic-support/advising.html)

**Science Program Advisors:** <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

**Indigenous Student Centre:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Black Students Advising Centre:** [https://www.dal.ca/campus\\_life/communities/black-student-advising.html](https://www.dal.ca/campus_life/communities/black-student-advising.html)

**International Centre:** [https://www.dal.ca/campus\\_life/international-centre/current-students.html](https://www.dal.ca/campus_life/international-centre/current-students.html)

### Academic supports

**Library:** <https://libraries.dal.ca/>

**Writing Centre:** [https://www.dal.ca/campus\\_life/academic-support/writing-and-study-skills.html](https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)

**Studying for Success:** [https://www.dal.ca/campus\\_life/academic-support/study-skills-and-tutoring.html](https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)

**Copyright Office:** <https://libraries.dal.ca/services/copyright-office.html>

**Fair Dealing Guidelines** <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

### Other supports and services

**Student Health & Wellness Centre:** [https://www.dal.ca/campus\\_life/health-and-wellness/services-support/student-health-and-wellness.html](https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html)

**Student Advocacy:** <https://dsu.ca/dsas>

**Ombudsperson:** [https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html)

### Safety

**Biosafety:** <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

**Chemical Safety:** <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

**Radiation Safety:** <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

**Scent-Free Program:** <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

**Dalhousie COVID-19 information and updates:** <https://www.dal.ca/covid-19-information-and-updates.html>



### **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&loadusercredits=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.”