Applied Time Series Econometrics ECO532

Term: **Spring 2024**
Department: **School of Economics**
Credit: **3 Hours**
Meeting: **Tues, Thurs 3:30-4:45 PM Aubert Hall 422**
Learning Modality: **In-Person; Traditional Lecture**
Professor: **Dr. Thomas F. P. Wiesen (thomas.wiesen@maine.edu)**
Office: **Winslow Hall 207C**
Office Hours: **Mondays 3:30-4:30pm or by appointment**

Class Details

Textbook and Materials

- Primary textbook: *Applied Econometric Time Series*, 4th edition by Walter Enders
- Secondary reference textbook: *Forecasting: Principles and Practice*, 2nd edition by Rob Hyndman & George Athanasopoulos
- Secondary reference textbook: *Time Series Analysis and Its Applications With R Examples*, 4th edition by Robert Shumway & David Stoffer
- Secondary reference textbook: *Time Series and Panel Data Econometrics*, by M. Hashem Pesaran

I will draw materials from multiple textbooks. However, the *primary* textbook will be Walter Enders' book. You do not have to buy any of the textbooks; all four are optional purchases. However, if you do buy a textbook, then I strongly recommend you buy Enders' book.

We will use R for our computational analysis. Download the R software here, then download RStudio (desktop version) as a user friendly interface. This software is free and open source. You should set up R to automatically download packages from the internet when your code requires them.

Course Details according to the UMaine Course Catalog

This is a graduate course in applied time series econometrics. We will work to develop both a significant understanding of the role of time series econometrics in empirical economics and a strong ability to execute applied time series econometrics in the development of economic models and in the analysis of economic policy. Identification, estimation, evaluation, hypothesis testing, forecasting, and simulation will be emphasized. Both univariate and multivariate time series processes will be covered and applications will include both microeconomic and macroeconomic models. Prerequisite: ECO530.

Course Description

This course is a graduate-level introduction to the statistical analysis of economic time series data, or more generally, data generated from dependent statistical processes across time. The focus is on fundamental models of time series processes, and how these models can be used to forecast and make inferences about economic questions. This will include econometric theory and applications in univariate and multivariate settings. Both reduced form (e.g., forecasting and Granger-causality) and structural (e.g., identification based on economic theory) techniques will be covered. Most of what we know empirically about the overall economy and financial markets is based on data that vary over time.

I will cover a healthy mix of theory and applications. In other words, I will cover the theory and assumptions behind the econometric tools. But I will also cover applications (in macroeconomics, finance, and other fields) and writing computer code in R. Thus, the general goal of this course is for students to both ***use*** and ***understand*** the tools of applied time series econometricians. Being able to both use the tools and understand the tools are critical; doing only one and not the other is insufficient. If students are only able to use the tools but do not fully understand them, then they do not fully comprehend where the tools came from, or the assumptions behind them, and are more likely to use the tools in inappropriate situations. Using statistical methods as a "black box" is a poor way to perform analysis. On the other hand, it is similarly problematic if students only understand the theory yet are incapable of actually running the analysis and interpreting the results.

I assume students have mastered the basic tools of probability and statistical inference, have a good understanding of linear regression models, and are comfortable with linear algebra. If needed, I will provide brief reviews of these topics.

Tentative Course Content and Outline

The outline below includes chapters and sections from Enders, Hyndman/Athanasopoulo (HA), Shumway/Stoffer (SS), and Pesaran textbooks. This is tentative and may change depending on time constraints and the pace of learning in the class.

- Introduction to time series data and analysis
  - -Motivation: Enders 1.1; HA 1; SS 1
  - -Time series graphs in R and fundamental concepts: HA 2; SS 2
  - -Difference Equations: Enders 1.2, 1.3, 1.9
- Univariate time series models
  - -Autoregressive moving average (ARMA) models: Enders 2.1-2.11; HA 8; SS 3
  - -Non-stationary processes: Enders 4.1-4.3, 4.5; HA 9.4; SS 5.2
- Multivariate time series models
  - -Time series regression & autoregressive distributed lag (ARDL): Enders 5.1, 5.2; HA 5, 9
  - -Vector autoregression (VAR) models: Enders 5.5-5.13; HA 11.2; SS 5.6; Pesaran 24
  - -Cointegration and vector-error-correction models (VECM): Enders 6.1-6.6

Lesson 1: Statistics and Cross-Sectional Review
- -Properties of expectations, variances, and covariances
- -Unbiasedness and consistency
- -Goals, assumptions, unbiasedness, and consistency in cross-sectional regressions
- -The cross-sectional bootstrap

Lesson 2: Fundamental Time Series Concepts
- -Time series moments and stationarity
- -Common data transformations and models
- -Difference Equations
- -Dynamic Multipliers

Lesson 3: ARMA Processes
- -AR(p), MA(q), and ARMA(p,q) models
- -Impulse response functions
- -Forecasting

Lesson 4: Modeling Nonstationary Processes
- -Unit roots

-Integrated processes and differencing
-Seasonality

Lesson 5: Model Selection and Estimation
-Box-Jenkins model selection method
-Dickey-Fuller test
-ACFs and PACFs
-Information criterion
-Ljung-Box test

Lesson 6: ARDL models
-Introduction to multivariate time series
-Autoregressive distributed lag models

Lesson 7: VARs
-Matrix linear algebra review
-Vector autoregressive models
-Forecasting
-Granger-Causality
-Impulse Response Functions
-Forecast Error Variance Decompositions
-Identification

Lesson 8: Cointegration and Vector-error-correction models

Grades

Grades will be determined by one midterm exam, a cumulative final exam, and a project paper/presentation with the following weights:

Midterm Exam	25%
Project Paper/Presentation	33%
Cumulative Final Exam	42%

The midterm will mostly cover econometric theory. The cumulative final exam will have two components—an in-person theory component and a take-home component assessing your statistical coding knowledge in R. The project paper & presentation will require you to use multiple tools to analyze an economic dataset and answer an economic question.

Total Points	**Letter Grade**	**Transcript GPA points**
100-93.3%	A	4.00
93.2-90.0%	A-	3.67
89.9-86.7%	B+	3.33
86.6-83.3%	B	3.00
83.2-80.0%	B-	2.67
79.9-76.7%	C+	2.33
76.6-73.3%	C	2.00
73.2-70.0%	C-	1.67
69.9-66.7%	D+	1.33
66.6-63.3%	D	1.00
63.2-60.0%	D-	0.67
59.9-0%	F	0.00

The above table gives the grade distributions. These are minimum scores and if need be, I will introduce a "curve." The curve will consist of lowering the minimum percentages required for a particular grade. For instance, a typical curve may consist of making the minimum score for an "A" 92% instead of 93.3%. However, you should in no way depend on the curve since the curve is NOT guaranteed, and if I do implement it, it may be very small.

All students should do all assignments. I will not drop any grades of any assessments. There will be no extra credit in this class.

Homework?

There is no graded homework in this class. However, to help you study for the exams and to provide opportunities to practice in R, I will post ungraded practice problems to Brightspace. You should treat these practice problems as ungraded homework.

These ungraded practice problems will cover both econometric theory and applications using R. Students are encouraged to work together. However, students should think for themselves; do not simply copy what your peers are doing.

Optional Supplemental Readings

Below is a list of key time series literature. Some of these papers will be mentioned in class. These readings are optional. But if you want to master time series econometrics, I recommend you give these papers a look.

- Bernanke, Boivin, and Eliasz (2005) Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach
- Blanchard and Quah (1989) The Dynamic Effects of Aggregate Demand and Supply Disturbances
- Coibion and Gorodnichenko (2015) Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts
- Diebold and Yilmaz (2014) On the network topology of variance decompositions: Measuring the connectedness of financial firms
- Engle (1982) Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation
- Engle, Ito, and Lin (1990) Meteor Showers or Heat Waves? Heteroskedastic Intra-Daily Volatility in the Foreign Exchange Market
- Faust (1998) The robustness of identified VAR conclusions about money
- Forni and Gambetti (2014) Sufficient information in structural VARs
- Francis, Owyang, Roush, and DiCecio (2012) A Flexible Finite-Horizon Alternative To Long-run Restrictions With An Application To Technology Shocks
- Fry and Pagan (2011) Sign Restrictions in Structural Vector Autoregressions: A Critical Review
- Gali (1999) Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?
- Gonzalo and Ng (2001) A systematic framework for analyzing the dynamic effects of permanent and transitory shocks
- Granger (1969) Investigating Causal Relations by Econometric Models and Cross-spectral Methods
- Jorda (2005) Estimation and Inference of Impulse Responses by Local Projections
- King, Plosser, Stock, and Watson (1991) Stochastic Trends and Economic Fluctuations
- Koop, Pesaran, and Potter (1996) Impulse response analysis in nonlinear multivariate models
- Lamoureux and Lastrapes (1990) Heteroskedasticity in Stock Return Data: Volume versus GARCH Effects
- Lamoureux and Lastrapes (1993) Forecasting Stock-Return Variance: Toward an Understanding of Stochastic Implied Volatilities
- Lastrapes (1992) Sources of Fluctuations in Real and Nominal Exchange Rates
- Pesaran and Shin (1998) Generalized impulse response analysis in linear multivariate models
- Rigobon (2003) Identification through Heteroskedasticity
- Rubio-Ramírez, Sargent, and Watson (2007) ABCs (and Ds) of Understanding VARs

- Sims (1980) Macroeconomics and Reality
- Sims (1986) Are Forecasting Models Usable for Policy Analysis?
- Sims and Zha (1999) Error Bands for Impulse Responses
- Stock and Watson (1988) Variable Trends in Economic Time Series
- Stock and Watson (2005) Implications of Dynamic Factor Models for VAR Analysis
- Stock and Watson (2005) Vector Autoregressions
- Uhlig (2005) What are the effects of monetary policy on output? Results from an agnostic identification procedure

The above links should work on UMaine computers. To access these articles off campus, you may have to sign into the UMaine library and use the "OneSearch" tool. When accessing these articles, I recommend you download the PDF. For some of the older papers, publishers have converted the PDFs into web text, which has sometimes introduced errors into the equations.

Project Paper & Presentation

Part of your grade will be based on a project paper and presentation. Students will research an economic question, find time series data, and analyze that data. Findings and methodology will be presented to the class and reported in a paper. Replication studies are acceptable. Your analysis must contain at least two of the following: a forecast, estimated parameters from an AR/MA/ARMA model, estimated parameters from a seasonal model, an ARCH model, a GARCH model, a unit root process, results from a type of hypothesis test (e.g., Dickey-Fuller, Ljung-Box, Granger-Causality), an ARDL model, a VAR impulse response function, a VAR forecast error variance decomposition, a cointegration analysis, a vector-error-correction model, or some other approved time series econometric tool. Students will be graded on their analysis (use the appropriate tool for the appropriate question), the interpretation of the results, the exposition of the economic question and data, the presentation delivery, and the quality of writing in the paper.

Let me know about the topic, economic question(s), data, and planned analysis for your project by the date indicated on the syllabus course calendar. You can make changes to these plans. But I want you to have a general idea for your project by then.

The total length of your presentation (including questions) should be approximately 15-18 minutes. Your presentation should be accompanied by presentation slides (emailed to the professor beforehand). Given the number of students enrolled in the course, these presentations will occur during the last five days of class, and the papers will be due after presentations are completed. Papers should be written with succinctness and clarity. Papers should be 6-11 pages in length (including figures & tables), be single spaced, use 12pt font, and have 1in margins. These papers should not be lengthy manuscripts with a superfluous amount of robustness checks, excess details, or unnecessarily longwinded multifaceted arguments. In that sense, your paper should be deliberately short—say what you need to say, tell me the relevance and results, get to the point, and say no more. These papers should exercise your ability to communicate with conciseness. Economists have a tendency to write uneconomically. This is why the AEA recently created *American Economic Review: Insights*, a journal specifically for shorter papers. See this Wall Street Journal article for context.
https://www.wsj.com/articles/economists-cant-write-economically-driving-demand-for-brevity-1532373648

Syllabus Course Calendar

Date	Description
Tuesday, January 16	First day of this class. Course introduction and syllabus review.
Thursday, January 18	Lecture.
Tuesday, January 23	Lecture.
Thursday, January 25	Lecture.
Tuesday, January 30	Lecture.
Thursday, February 1	Lecture.
Tuesday, February 6	Lecture.
Thursday, February 8	Lecture.
Tuesday, February 13	Lecture.
Thursday, February 15	Lecture.
Tuesday, February 20	Lecture.
Thursday, February 22	Lecture.
Tuesday, February 27	Lecture.
Thursday, February 29	Lecture
Tuesday, March 5	Lecture.
Thursday, March 7	**Midterm Exam.**
Tuesday, March 12	**No class. Spring break.**
Thursday, March 14	**No class. Spring break.**
Tuesday, March 19	Lecture.
Thursday, March 21	Lecture. Let the professor know the topic of your project.
Tuesday, March 26	Lecture.
Thursday, March 28	Lecture.
Tuesday, April 2	Lecture.
Thursday, April 4	Lecture.
Tuesday, April 9	Lecture.
Thursday, April 11	Project Presentations (3 or 4 students).
Tuesday, April 16	Project Presentations (4 students).
Thursday, April 18	Project Presentations (4 students).
Tuesday, April 23	Project Presentations (4 students).
Thursday, April 25	Project Presentations (4 students).
Friday, April 26	**Project Papers due at 11:59pm.**
Monday, April 29	**Take-Home Component of Final Exam becomes available on Brightspace at noon**
Wednesday, May 1	**Take-Home Component of Final Exam due at noon.**
Thursday, May 2	**In-Person Component of Final Exam 1:30pm - 3:30pm in Aubert Hall 422.**
Friday, May 10	Course grades due.

Class Policies

Attendance

You are expected to attend class according to the syllabus course calendar. Although you are generally expected to attend class, you should stay home if you are sick. One of the societal changes due to the COVID-19 pandemic is to alter expectations of working or attending school when ill. If you have a bad

cough, have a fever, are nauseous, or are generally feeling under the weather, please stay home. For obvious public health reasons, we do not want sick students in our face-to-face classes. Your classmates don't want to catch whatever is making you ill. If you do miss a class, be sure to get the missed notes from a classmate.

If you miss an exam or presentation due to an illness or personal/family emergency, please let me know as soon as possible (and no later than 5 days after the missed due date). If I deem the reason for the absence as excusable, then you will be allowed to make up the exam or presentation.

Late Policy

Late assignments will not be accepted unless you have an illness or legitimate personal emergency that prevented you from submitting the assignment on time. If an illness or personal emergency causes you to miss an exam or assignment, please let me know as soon as possible and no later than 5 days after the missed due date. If more than 5 days passes after the missed due date, a zero grade will be given for the missed assignment. A genuine medical emergency can include (but is not limited to) experiencing COVID-19 symptoms, testing positive for COVID-19, being exposed to someone with COVID-19, or needing to take care of someone with COVID-19.

Classroom conduct

You are expected to act professionally. This expectation includes, but is not limited to: being quiet when others are speaking, silencing your cell phone, respecting other students, respecting the instructor, and asking questions by raising one's hand. If you are acting disorderly and impeding other students' ability to learn, I reserve the right to ask you to leave the classroom.

Laptop computers are allowed in class for legitimate class-related tasks, such as taking notes, accessing course materials, or completing assignments. If I find you using your laptop computer in class for tasks not related to the course, then I will ask you to put your laptop away. Note that scrolling through social media on your laptop is extremely distracting to students sitting behind you.

Office Hours

My office is located on the second floor of Winslow Hall room 207C. My official office hours are listed on the first page of this syllabus. If those times do not work for you, just send me an email and we can set up an appointment. Feel free to use these office hours to come see me and ask questions.

Class Communication

I will use Brightspace to communicate announcements and distribute course materials. I strongly recommend you set up your Brightspace settings to automatically email you when a new announcement is posted. It's a good habit to periodically check Brightspace and your UMaine email. I'll occasionally give reminders for upcoming due dates.

Syllabus

This syllabus should be considered a contract between me (the professor) and you (the student). However, there may come a time when a change to the syllabus becomes necessary. In such an event, the change will be announced during class and posted online.

University Policies

Academic Honesty Statement

Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, or generated by software or systems without the explicit approval of the instructor, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University. Please see the University of Maine System's Academic Integrity Policy listed in the Board Policy Manual as Policy 314: https://www.maine.edu/board-of-trustees/policy-manual/section-314/

Students Accessibility Services Statement

If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, um.sas@maine.edu, 581-2319, as early as possible in the term. Students may begin the accommodation process by submitting an accommodation request form online and uploading documentation at https://umaine-accommodate.symplicity.com/public_accommodation. Once students meet with SAS and eligibility has been determined, students submit an online request with SAS each semester to activate their approved accommodations. SAS creates an accessibility letter each semester which informs faculty of potential course access and approved reasonable accommodations; the letter is sent directly to the course instructor. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with me (Thomas Wiesen) privately as soon as possible.

Course Schedule Disclaimer (Disruption Clause)

In the event of an extended disruption of normal classroom activities (due to COVID-19 or other long-term disruptions), the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Observance of Religious Holidays/Events

The University of Maine recognizes that when students are observing significant religious holidays, some may be unable to attend classes or labs, study, take tests, or work on other assignments. If they provide adequate notice (at least one week and longer if at all possible), these students are allowed to make up course requirements as long as this effort does not create an unreasonable burden upon the instructor, department or University. At the discretion of the instructor, such coursework could be due before or after the examination or assignment. No adverse or prejudicial effects shall result to a student's grade for the examination, study, or course requirement on the day of religious observance. The student shall not be marked absent from the class due to observing a significant religious holiday. In the case of an internship or clinical, students should refer to the applicable policy in place by the employer or site.

Sexual Discrimination Reporting

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a faculty or staff member who is deemed a "responsible employee" about an

experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, they are required to report this information to Title IX Student Services or the Office of Equal Opportunity. If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

- For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000.
- For confidential resources off campus: Rape Response Services: 800-871-7741 or Partners for Peace: 800-863-9909.
- Other resources: The resources listed below can offer support but may have to report the incident to others who can help: For support services on campus: Title IX Student Services: 207-581-1406, Office of Community Standards: 207-581-1406, University of Maine Police: 207-581-4040 or 911. Visit the Title IX Student Services website at umaine.edu/titleix/ for more information.