Hamilton College

Economics 424: Time Series Econometrics using Python

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Class Time: MW 1-2:15 pm
Class Location: List Center, 122 LEC
Office Hours: Tuesday 3-5 pm (By appointment only: link)

Course Description

Time Series Econometrics uses statistical techniques to analyze data observed over time, with applications in macroeconomics, finance, and other dynamic settings. In this course, students will be introduced to a range of techniques used to estimate and evaluate economic models with time series data, with a focus on understanding the strengths, limitations, and assumptions involved in various methods. Successful students will become proficient in econometrics of time series analysis for forecasting and estimating dynamic causal effects, using Python to build and evaluate empirical models. The empirical applications in the course will be drawn primarily from macroeconomics.

Course Objectives and Goals

What would be the impact of a 1°C rise in global temperature on world GDP, and for how long? What impact would a 1% increase in interest rates have on inflation and GDP over the next year? How can a retail business predict sales for the next 3–5 years based on its current marketing strategy? Time series econometrics provides the tools to answer such questions by combining statistical methods and economic theory to analyze data over time.

The course will implement these tools using the programming language Python and will directly support several of Hamilton's educational goals including:

- **Disciplinary Practice:** Through applying and discussing empirical models throughout the semester, you will strengthen your ability to critically evaluate economic arguments and forecasts. The course equips you with the tools to analyze patterns, forecast trends, and argue for causal effects quantitatively and symbolically.
- **Intellectual Curiosity and Flexibility:** By examining economic phenomena in depth and from multiple perspectives, you will learn to question, adapt, and refine your views in light of new evidence—an essential skill for both academic inquiry and policy evaluation.

Prerequisite

ECON-275 Microeconomic Theory, ECON-285 Macroeconomic Theory, ECON-266 Introduction to Econometrics

Course Requirements

Short Quiz	5%	Sep. 18 (in class, 7-8 pm.)
Midterm I	20%	Oct. 6 (in class)
Midterm II	25%	Nov. 12 (in class)
Homework	20%	Submitted via GitHub*
Participation	5%	Active participation is required.
Empirical project	25%	Final project due on Dec. 19 at 7 pm (including individual questions)

*There will be seven problem sets in total. The problem set with the lowest grade will be weighted at 2%, while each of the remaining six problem sets will carry a weight of 3%.

Office Hours and Progress Meetings

Beginning in the second week of the semester, each student is expected to meet with me during office hours for a **minimum of 15 minutes once every two weeks**. These meetings will focus on reviewing your progress on problem sets and will provide an opportunity to ensure that you are developing a balanced understanding of both the time series econometrics concepts and the Python coding techniques used in the course.

If all the slots are taken, or if none of the available times work for you, just send me an email and we'll set up an appointment.

In addition, starting the week after the first midterm, these meetings will also include discussion of your progress on the Empirical Project. This structure is designed to support steady progress, clarify any difficulties you may encounter, and help you integrate the empirical and computational aspects of the course.

Exams and Deadlines

Please mark the exam dates on your calendar now. If you have an unavoidable conflict, notify me within **first two weeks of the course**. There will be no make-up exams or individual opportunities for extra credit. The only valid excuse for missing an exam or homework assignment is a verified medical and/or family emergency.

Late Submissions

Late problem set submissions will not be accepted. To ensure fairness, each student will receive **two late vouchers**. Each voucher allows you to submit the work up to **48 hours after the deadline** without penalty.

- If the assignment is not submitted within that window, it will receive a grade of zero.
- To use a voucher, you must email me *before the deadline* with the subject line: *424 LATE VOUCHER*.
- I strongly recommend saving your vouchers for unforeseen emergencies.
- **Note**: Vouchers cannot be used for the empirical project.

Empirical Project

The success of the empirical project will depend on how well it achieves the course objectives and goals stated above. To support this, we will meet weekly during office hours, as outlined in the previous subsection, to ensure that the project is broken down into manageable steps that align with the learning objectives of the course.

Projects may be completed individually or in pairs, at the discretion of the students. Detailed instructions and guidelines for the empirical project will be posted separately.

Software

- **Python and JupyterLab:** All submissions will be done in Jupyter notebooks using Python. There will be Data Science Tutors office hours to help with Python installation and getting started. Information about them will be available on Blackboard.
- **GitHub:** We will be using GitHub to access lecture notes, problem sets, solutions and homework submissions. Make sure you create an account. You will need to upload your JupyterLab notebooks both in `.pdf` and `.ipynb` formats.
- **Blackboard:** I will post information on Blackboard regularly. You are responsible for checking our class page often.

Resources

Hamilton College will make reasonable accommodations for students with documented disabilities. Students with disabilities should contact Allen Harrison in the Dean of Students Office (Elihu Root House, x4021). If you have a documented disability, please make an appointment to see me in the first two weeks.

If, at any time, you feel overwhelmed, anxious, depressed, or in danger of harming yourself or others, please reach out for support. The Hamilton community cares about you, and is available to help. Campus Safety (315-859- 4000) and the Counseling Center (315-859-4340 option 2) have people available 24/7. You can also contact: Associate Dean of Students for student support, Sarah Solomon at 315-859-4600, your faculty advisor, your RA or the Area Director in your residence hall.

Policies

- All rules and regulations of the Honor Code apply. This includes turning in assignments or exams that reflect your own understanding of the material. Copying someone else's work is a violation of the Honor Code and a waste of your time, as it will not help with your learning. Allowing someone else to copy your work or sending/sharing a copy of your assignments is also a violation of the Honor Code. If you worked with others, you should list their names at the top of the assignment and indicate any other sources of help. I encourage you to review the Hamilton College Honor Code. If you have any questions, please reach out so I can clarify what constitutes academic dishonesty in this class.

- Attendance is mandatory, and I expect students to be present at all class meetings. Attendance will count toward your **class participation grade**. Please let me know in advance if you plan to miss class for any reason.
- You are expected to check the Blackboard course pages regularly for announcements and assignments.

AI Use Policy

By enrolling in this course, you agree to use AI tools (such as ChatGPT) **only within the parameters set by me**.

- You are permitted to use code directly from the Jupyter notebooks provided in class. When doing so, you must include a comment in your problem set submissions and empirical projects indicating the source of the code (e.g., "from Lecture Note X").
- The goal of this policy is to ensure that you learn the correct implementation of code and fully understand how it works. Simply relying on AI tools to generate code without this understanding would hinder your learning. Since AI tools are widely used in industry to improve efficiency, this course encourages you to build on the code provided in class to stay efficient, rather than replacing your learning process with AI output.
- A good practice is to start with the provided code and, if anything is unclear, ask questions during office hours or after class. You may also use AI tools to better understand a specific piece of code by directly inputting it for explanation.
- If you have ideas for how to use AI tools productively or if you have used them in other ways to enhance your learning, please share them with me. I am open to adapting assignments to make use of these tools in new and effective ways.
- Any discovered use of AI tools to complete assignments in ways not previously discussed with me will result in an automatic grade of zero for that assignment.
- If you choose to use AI, you must cite it as you would any other referenced work, and you are required to document when and where you have used it. Please be aware that AI-generated material may vary in quality, and can often be inaccurate or incomplete.

Textbook

The lectures will be organized using slides that are a Jupyter notebook, which you can view and download on GitHub *here*.
While there is no textbook for the course, some of the time series material is sufficiently standard so that good textbook treatments are available. Good reference books include:

1. Enders, Walter (2015), *Applied Econometric Time Series*, 4th ed., Wiley.
2. Tsay, Ruey S. (2010), *Analysis of Financial Time Series*, Wiley.
3. Hansen, Bruce E. (2020), *Econometrics*, University of Wisconsin.

Another valuable resource for learning Python programming in economics and finance is Quantecon, which offers comprehensive tutorials and practical examples relevant to our course.

Additional Assistance

- Quantitative & Symbolic Reasoning Tutoring – Facilitated group study + Drop-in tutoring
- Data Science Tutors
- Writing Center
- Oral Communication Center

Check Blackboard for additional information and updates.

Class Schedule

*__Note__: The class schedule is subject to change. Any changes will be communicated via Blackboard.

Lect #	Date	Topic	PS Due
1	Sep. 1	Characteristics of Macro/Finance Time Series	
2	Sep. 3	Smoothing, Solving Difference Equations	
3	Sep. 8	Autocorrelation and Partial Autocorrelation	
4	Sep. 10	Unit Root/Stationarity	
5	Sep. 15	Models with Trend (Stochastic & Deterministic)	PS#1
6	Sep. 17	ARIMA Models	
	Sep. 18	**Short Quiz**	
7	Sep. 22	Forecasting with ARIMA	
8	Sep. 24	Invertibility I	
9	Sep. 29	Aggregate Demand and Supply Model	PS#2
10	Oct. 1	Invertibility II	
	Oct. 6	**Midterm Exam I**	
11	Oct. 8	Multivariate TS Analysis	
12	Oct. 13	Multivariate Models; Structural VAR I	
13	Oct. 15	Structural VAR II	
14	Oct. 20	Orthogonalized Impulse Response Functions	
15	Oct. 22	Model Simulations and Impulse Response Functions	PS#3
16	Oct. 27	Forecast Error Variance Decomposition	
17	Oct. 29	Cointegration and Error Correction Models	
18	Nov. 3	Bootstrap	
19	Nov. 5	SARIMA Models and ARMAX	PS#4
20	Nov. 10	Structural Change and Breaks. Perron's Test	
	Nov. 12	**Midterm Exam II**	PS#5
21	Nov. 17	Intro to Volatility Models	
22	Nov. 19	ARCH/GARCH	
23	Dec. 1	EGARCH and Other Volatility Models	
24	Dec. 3	Threshold Models	PS#6
25	Dec. 8	Empirical Paper Presentations	
26	Dec. 10	Empirical Paper Presentations	PS#7
	Dec. 19	**Empirical Project Due**	