

Econ 483: Applied Time Series Analysis

Vipul Bhatt

SP 2024

Office: Showker 6014

Class Room: Hartman 3043

Class Hours: TuTh 11:10AM-12:25PM

E-mail: bhattvx@jmu.edu

Office Phone: 540-568-3220

Web: sites.google.com/view/vipulbhatt

Office Hours

Location: Showker 6014

Tuesday 9:30-11:00AM & 1:00-2:10PM

Thursday 9:30-11:00AM & 1:10-2:10PM

Course Description and Objectives

This is an advanced level course in the Econometrics sequence with an explicit focus on understanding dynamic properties of a time series of interest. Most of our discussion will be based on key macroeconomic and financial variables such as inflation, interest rates, exchange rates, output, and stock prices. Some of the time series techniques we will cover include smoothing methods, ARIMA, Vector Autoregression (VAR) model, and ARCH/GARCH models. Given the quantitative nature of this course a solid understanding of calculus, linear algebra, and Econometrics is a necessary condition for success. My expectations from the students taking this class are as follows:

1. Understanding the properties of time series data
2. Learning time series methods commonly used for macroeconomic and financial market analysis
3. Develop a solid working knowledge of the statistical software *R* to:
 - estimate various time series models using real world data
 - evaluate alternative models in terms of their forecast accuracy, data fit, and economic relevance
 - generate relatively accurate forecasts based on the chosen time series model and present them in an easy to understand manner

Course prerequisites and Catalog Description

This is an advanced level class in Econometrics with an emphasis on time series techniques. This course covers a broad range of time series methods commonly used in research and industry for generating short term forecasts for important economic and financial variables. Some of the topics covered are time series decomposition methods, smoothing methods, ARIMA, ARCH/GARCH and VAR.

Prerequisite: A minimum grade of “B-” in ECON 385.

Readings

- Lecture Notes: I have been developing a book for this course. The beta version is now available as an eBook and at present it is organized the same way as my lecture notes. You can access it from the following website:

<https://vipul-bhatt.github.io/Econ-483-Notes/>

Please note that this is a work in-progress. I haven't even edited the whole document yet. So expect a lot of spelling mistakes and grammatical errors. Also it is still not complete and I will be adding more topics during the course of the semester.

- Supplementary Textbook: *Elements of Forecasting (4th Edition.)* by Francis Diebold

There are two options:

1. Buy/rent the textbook. **Amazon link for the textbook:**

You can buy this book from Amazon or any other website. Here is the link for the Amazon:

https://www.amazon.com/Elements-Forecasting-Book-Francis-Diebold/dp/0324359047/ref=dp_ob_title_bk

2. Download the free eBook version of this book from the following website:

<http://www.ssc.upenn.edu/~fdiebold/Teaching221/FullBook.pdf>

- In addition we may use various published journal articles and other sources during the semester. Complete citation and/or pdf versions will be posted on Canvas in a timely fashion.

- Resources for the Statistical Software R:

We will be using the statistical software called R extensively. R supports both Windows and Mac operating systems. You are expected to develop deeper understanding of R on your own using abundant resources available on R on the Internet. I have been working on a video course for learning basic R. These videos are available

on Canvas. To access them go to Modules and view all the videos posted under R Tutorials. Here are the instructions for setting up R on your computer:

1. For Windows:

- Step 1: Download and Install latest version of R. You can find the link here: <https://cran.r-project.org/bin/windows/base/R-4.2.2-win.exe>

- Step 2: Download and install latest version of Rstudio. You can find the link here: <https://download1.rstudio.org/electron/windows/RStudio-2022.12.0-353.exe>

****IMPORTANT:** You must install R first and then install Rstudio on your computer.**

2. For Mac:

- Step 1: Download and Install latest version of R. You can find the link here: <https://cran.r-project.org/bin/macosx/>

- Step 2: Download and install latest version of Rstudio. You can find the link here: <https://download1.rstudio.org/electron/macos/RStudio-2022.12.0-353.dmg>

****IMPORTANT:** You must install R first and then install Rstudio on your computer.**

Important Deadlines

Grading Item	Date	Time	Location
Research Project: Proposal	Feb. 17 th , 2024	8:00PM	Canvas
Midterm	March 21 st , 2024	11:10AM-12:25PM	Hartman 3043
Research Project: First Draft	Apr. 14 th , 2024	8:00PM	Canvas
Research Project: Completed Paper	Apr. 27 th , 2024	8:00PM	Canvas
In-class presentations	Last week week and half of classes	11:10AM-12:25PM	Hartman 3043
Final	May 9 th , 2024	10:30AM - 12:30PM	Hartman 3043

Course Policy

Below I summarize important policies related to this course. Read them carefully and let me know in case you have a clarifying questions.

Grading Structure

Item	Max Points
Participation and Attendance	20
Problem Sets	80
Research Project:	
Proposal	10
First Draft	40
Completed Paper	25
Meetings, Presentation, and Participation	20
Midterm	80
Final Exam	90
Total Points	365

Details on Grading Items

- **Attendance and Participation:** Given that this is an advanced elective in Econometrics, I assume that you are interested in this course. I will be taking regular attendance and you will lose 2 points (out of 20 reserved for this item) for every class you miss. One way to recover these points would be to provide a brief written summary of the material covered in class which you will have to work on yourself using the online textbook and/or lecture notes posted on Canvas.
- **Problem Sets:** There will be several problem sets that you will be assigned throughout the semester. Some of them will be theoretical and others will have a strong emphasis on data analysis using R. In empirical problem sets, you will be applying techniques learned in class to real world data and answer questions related to your main findings. The exact number of the problem sets depends on the progression of the material during the semester but they will contribute a total of 80 points toward your final grade. These problem sets will be posted on Canvas and you will be uploading your assignments as a pdf on Canvas. There is no make up for missed problem sets. You will get sufficient time to complete them and I will not entertain any late submissions as that will not be fair to other students in the class.
- **Research Paper:** You are expected to write a group term paper that will utilize one or more of the time series models covered in class during the semester. Right now we have 19 students enrolled, so we will have maybe 9 groups. You are free to form your group (2 persons per group) and choose your topic but you must get it approved by me before starting your analysis. Your research paper will contribute a total of 95 points toward your final grade. I have posted a document on Canvas that contains detailed guidelines for your research project such as content, format, page limit, citation style etc. This project is divided into four parts with their respective deadlines. Please go over the guidelines carefully. But here is a gist:
 - Your proposal should be detailed. What is your main research question, and

why it is of interest? Are you updating an existing study? If yes, give citation of the base paper, and explain what aspects you plan to update and why you think that will be useful. If you are not updating an existing paper explain what you plan to do. Clearly indicate the methodology (from the syllabus) you plan to use and why it is suitable for your research question. Finally, share details about the data you plan to use, frequency, duration, variable definitions etc.

- Your first draft should be as close to completion as possible. The more complete your paper is, less surprised you will be with your final grade.
- I am expecting you to meet with me regularly during the semester to discuss your paper with me and share your progress. Both frequency and quality of discussions (in terms of your progress) will be rewarded here.
- Your own presentation as well as your participation in other group's presentations matters. Again quality of participation will be rewarded, not quantity.
- **Midterm Exam:** There will be one midterm exam worth 80 points. The details about the exam format will be provided to you in a timely fashion.
- **Final Exam:** The comprehensive final examination will count towards the remaining 90 points of your final grade.

Make-up Policy

- There will be no make-up for missed problem sets. No exceptions.
- I will not accept late submissions for any component of your data project. No exceptions.
- If you are not able to take the midterm exam during the assigned time, it is your responsibility to contact me AT LEAST a week in advance to discuss the appropriate solution. This rule applies to both the midterm exam as well as the final.
- There will be no make-up for the midterm exam. In the most extreme of circumstances I may decide to make an exception and shift the weight of the missed midterm to the final exam. For example, if you miss your midterm then the final will count for 180 points instead of 90 points. However, this will depend solely upon my discretion and you would need to provide the appropriate and valid documentation to support your situation. If a student misses the exam, and does not furnish an acceptable official document, or if the student's excuse is not valid according to me regardless of the documentation, then the student will receive a grade of 0 for the midterm exam.
- For the Final exam, a make-up will be given if an acceptable official document such as a medical statement from a doctor is supplied as soon as possible. I will not accept any document after one week has passed from the date of the exam except under extreme circumstances. If a student misses the exam and does not furnish an acceptable official document, or if the student's excuse is not valid according to me

regardless of the documentation, the student will receive a grade of 0 for the final exam and hence will fail this class.

Use of Canvas

Materials pertaining to the course such as important announcements, lecture slides etc will be posted on Canvas. It is your responsibility to keep a track of such announcements and postings on Canvas at\

<https://canvas.jmu.edu/>

You should check Canvas at least twice per week to stay abreast of the course.

Use of AI

A) Permitted use of AI

The use of generative AI tools such as ChatGPT is permitted with conditions. Here is a list of activities where you can use this resource:

- a) Finding information on a particular topic
- b) Checking grammatical errors in your work
- c) Searching for a way of implementing a particular data analysis in R

Note that if you use such a resource, it is your responsibility to ensure that there are no errors in your work. You are also responsible for ensuring that it does not violate any intellectual property rights and does not contain misinformation. Saying that you obtained it from ChatGPT does not absolve you from the responsibility for ensuring that your work is error free and meets JMU's honor code policy. You must acknowledge use of such AI resource properly so that you meet the academic honesty standards set by JMU. Include a short paragraph in a footnote or maybe as an endnote explaining how you used AI for an assignment. In case of obtaining a code snippet for R or text generated from ChatGPT, use direct quotes or different color font so that I know how much of your work is generated by AI and what your contribution over and above this tool.

Here is a golden rule: when in doubt about permitted usage, ask me for clarification!

B) Non-permitted use of AI

The use of AI is not permitted in this course for the following activities:

- a) Exams and quizzes
- b) Writing a draft for your research project
- c) Copying and pasting entire sentences, paragraphs, or papers to complete any class assignments.
- d) Copying and pasting entire R code for an assignment. You can (after acknowledging and annotating) use ChatGPT for some portions of the code but using it to answer the entire assignment is not permitted.

Caution in using ChatGPT

I think of ChatGPT as a tool and like any tool, its effectiveness depends on how well you understand your problem and what kind of input you provide from your end to ChatGPT. Think of Google search—the effectiveness of this tool depends on the preciseness of your search phrase. Same thing is true for ChatGPT. Here are some tips in using ChatGPT in general:

1. ChatGPT requires a prompt from you. That is what you bring to the table. The importance of a refined and polished prompt cannot be overstated. The vaguer and more ill-informed your prompt is, the more gibberish you should expect from ChatGPT.
2. Like any other free internet resource, your default should be to always doubt the veracity and accuracy of anything ChatGPT produces, even factual statements or snippets of R code. Unless you know it to be error free yourself or can verify from a credible third-party resource, assume that the information you have obtained will contain significant errors and would need your input to make it error free.
3. Your goal should be to save time and use of ChatGPT should allow you to improve your assignments in substantive ways using the freedup time. If that is not happening, and you are wasting a lot of time then maybe ChatGPT is not an appropriate tool for that assignment.

Withdrawing from the Class

- In case you wish to withdraw from the class please follow the University guidelines and make sure to meet the corresponding deadlines. These are available at:
<https://www.jmu.edu/syllabus/index.shtml#adding>
- If you miss the deadline for withdrawing with a grade of W, then your grade will be solely based on your class performance. CoB has a very strict policy against awarding WP or WF. Below I provide the CoB policy and I will strictly adhere to this policy for any such requests:
 - *CoB Policy: Withdrawals (WP or WF) after the course adjustment period are not permitted except in extraordinary situations in which a student can demonstrate that circumstances (such as hospitalization) rendered him or her unable to meet course requirements. Changes of major or merely not performing well in a class are not sufficient reasons to permit withdrawals after the course adjustment deadline.*

Preferred method for contacting me

The best way to reach me is via email. I will do my best to respond to e-mail within 24 hours on a weekday, 48 hours on a weekend, according to the following policy:

- I will not reply to e-mails that request information that can be found on the syllabus and/or Canvas.

- Make your queries brief. I will only respond to questions that can be answered in a sentence or two. For detailed questions, please see me during office hours.

Inclement Weather Policy

Classes will be held unless canceled by the JMU administration for reasons of bad weather, bomb threats, or fire alarms.

JMU Honor Code Policy

All students are expected to be aware of and adhere to the JMU Honor Code. Students will be expected to be academically honest and properly credit all source materials used. For the official documentation on the honor code policy see:\

<https://www.jmu.edu/syllabus/index.shtml#honesty>

Other University policies

To read about JMU's policy regarding Disability Accommodations, and Religious Observation Accommodations, please see:

<http://www.jmu.edu/syllabus>

Tentative Course Outline

Week	Content and Readings
	<p>Topic 0: Self-review (Not covered in Class)</p> <ul style="list-style-type: none"> • Prediction vs Unbiasedness • Regression error dynamics: <ul style="list-style-type: none"> – Autocorrelation (or Serial Correlation) – Heteroscedasticity • Readings: <ul style="list-style-type: none"> – Appendix A of online textbook – Your Econ 385 notes – Diebold. Ch. 2
	<p>Topic 1: Regression Based Forecasting and Machine Learning</p> <ul style="list-style-type: none"> • Regression-based forecasting • Machine Learning and Regression Models • Readings: <ul style="list-style-type: none"> – Lecture Notes: Ch. 1, 2 and lecture slides – Diebold Ch. 3, 11

	<p>Topic 2: Univariate Time Series Analysis of Conditional Mean</p> <ul style="list-style-type: none">• Components of a time series• Smoothing-methods and forecasting• Modeling Trend• Modeling Seasonality• Modeling Cycle:<ul style="list-style-type: none">– Math Concept 1: Difference Equations– Box-Jenkins approach for ARIMA(p,d,q)• Evaluating and Combining Forecasts• Readings:<ul style="list-style-type: none">– Lecture Notes: Ch. 3,4, 5 and 6– Diebold Ch. 5-10, 12, 13
	<p>Topic 3: Vector Autoregression (VAR) Model</p> <ul style="list-style-type: none">• Impulse Response Analysis• Variance Decomposition Analysis• Readings:<ul style="list-style-type: none">– Lecture Notes
	<p>Topic 4: Modeling Volatility</p> <ul style="list-style-type: none">• ARCH/GARCH• News Impact Curve• Readings:<ul style="list-style-type: none">– Lecture Notes: Ch. 7– Diebold Ch. 14