ECO376/511: Business and Economic Forecasting using Time Series Analysis
Spring, 2024 (Tuesday 5:45-9:00 PM)
updated: March 30, 2024

INSTRUCTOR: Prof. Jin Man Lee
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The best way to reach me is to send email. Please use ECO376/511 as a prefix on the subject line, and that will get my attention immediately. If you don't receive my reply within 24 hours, please remind me again. Due to many email filters and mass email, your email might be lost.

OFFICE HOURS: Tuesday & Thursday (Zoom only), 4:00-5:00 or by appointment (at DPC 6230), or
ZOOM Address for office hours:
https://depaul.zoom.us/j/95326652941

COURSE OBJECTIVES
We will cover time series regression models throughout the quarter. Instead of technical and theoretical sides, we will mostly focus on the practical applications of the time series regression models using macroeconomic and financial data.
The example data will be from the typical website, such as yahoo.com or wsj.com, and public websites, such as FRED (Federal Reserve Economic Data) maintained by St. Louis Federal Reserve Bank. We will use the latest available data from the website and read them into the R program. This course will help you develop a higher level of R program skills and methodologies to understand the time series process in economics and finance.

REQUIRED TEXTBOOK
Classnotes in D2L
Time Series for Data Scientists, Juana Sanchez, 2023, Cambridge University Press
ISBN: 978 1108837774

SUPPLEMENTARY MATERIAL
Applied Econometric Time Series Analysis, Walter Enders 3rd-4th Edition
Analysis of Financial Time Series, Ruey S. Tsay, 2-3rd Edition.
Along with the textbook and my lecture notes, I will assign mandatory readings of academic articles. The readings are available for download in PDF format from D2L.

SOFTWARE USED in CLASS (required for homework and lab classes)
This course will use the statistical package, R. R and Rstudio are free. Students need to bring their laptops with the latest R and Rstudio installed. For big financial data analysis, students will have the option to use the R server version from the big blue server: https://bigblue.depaul.edu:8787.

GRADE
Midterm Exam (25%), Final Project (30%), Attendance (5%), Weekly Homework (40%)

Scale of grade: A: 93 or above, A-: 88-92.9, B+: 85-87.9, B: 80-84.9, B-: 77-79.9, C+: 75-76.9, C: 70-74.9, C-: 68-69.9, D+: 65-67.9, D: 60-64.9, F: Below 60

EXAMS AND FINAL PROJECT SCHEDULE

- Midterm Exam and Project (April 30- May 6)

- Final Group Project (Written report submission to D2L on June 15 at 10:00 PM.)

ASSIGNMENTS

- Homework: Problem set will be posted in D2L and it is required to submit to Dropbox in D2L

  - All assignments are to be prepared individually. You risk an academic integrity violation if you submit the same work and answers with others. Group study is encouraged but not the submission of Assignments.
  - All statistical code needs to be submitted as a txt file, For example, assignment.R.txt.
  - All submitted codes should be tested without any error. If there are any errors, the assignment will get zero credit.
  - All weekly assignments should be uploaded to D2L by Monday at 10:00 PM
  - Late submission will get a steep penalty without prior approval by the instructor.

ACADEMIC HONESTY

Work done for this course must adhere to the University Academic Integrity Policy. Violations include but are not limited to the following categories: cheating; plagiarism; fabrication and academic misconduct.

- Cheating: any action that violates University norms or an instructor's guidelines for the preparation and submission of assignments. Such actions may include using or providing unauthorized assistance or materials on course assignments, or possessing unauthorized materials during an examination.

- Plagiarism: the representation of another's work as your own. You are to prepare your own homework assignments. Violations may result in the failure of the assignment, failure of the course, and/or additional disciplinary actions.

- Misconduct: This includes but is not limited to attempts to bribe an instructor for academic advantage; persistent hostile treatment of, or any act or threat of violence against, an instructor, advisor or other students. Violations may result in additional disciplinary actions by other university officials and possible civil or criminal prosecution.

You may review the Academic Integrity Policy in the Student Handbook or by visiting Academic Integrity at DePaul University (http://academicintegrity.depaul.edu)

ATTENDANCE POLICY

I do not take attendance. The attendance will be automatically checked by in-class lab reports.

CLASSROOM RULES & PROFESSIONAL POINTS

- Prohibitions: Cell phones must be turned OFF. Use of the internet is not permitted unless specifically directed by me. This includes checking of email and use of instant messengers. You must sit at the front of the classroom if you are using a computer. Tape recorders, unrelated reading materials, and food are also prohibited in the classroom.

- Behavior: You may not leave the classroom for any reason during an exam (go to the bathroom beforehand!). Further, unprofessional behavior such as inappropriate chatting, leaving in the middle of class, or showing up excessively late, etc. are disruptive and unacceptable. If you need to leave class early, let me know in advance.

- For first time violations you will receive a warning. In the event that violations continue, I will ask you to leave the classroom. (I reserve the right to add to this list as situations arise.)

Student with Disability: Students with Disability may register the The Productive Learning Strategies (PLuS) Program. You may request your exam schedule arrangement by requesting through the PLuS program. For more information on the PLuS program, you may visit http://studentaffairs.depaul.edu/plus/ or call: 312-362-8000.

SUMMARY OF WEEKLY SCHEDULE

1. Monday 10:00 AM : Weekly Class Material will be posted in D2L

2. Tuesday 5:45-9:00 PM: In-person Class (Require to attend), Weekly Lab Report due in class

3. Tuesday 4:00-5:00 PM: In-Person/ZOOM Open Office Hours, Thursday 4:00-5:00 Zoom Office Hour

4. Monday 10:00 PM : Weekly Assignment Due

TENTATIVE SCHEDULE OF TOPICS
(The instructor may change the order or contents by needs, any special material needs for class will be available on D2L)

- WEEK 1 - TOPIC 1: Introduction to R for Time Series Data (CH 1, 2)

  - Using R and Rstudio on Desktop and Server
  - Introdouction to R for Time Series Data
  - Application Examples:
    Amazon sales trend and Seasonality of electric products
    Home sales patterns in the Chicago Area
    Trends and seasonal patterns of Airbnb and Uber
    Historical stock market Trends and Pattern by Different Frequency
    Trends of Electric Car sales

- WEEK 2 - TOPIC 2: Properties of Time Series Data and Autoregressive (AR) Process (CH 3, 4, 5)

  - Simple Forecasting and Smoothing a Time Series: Naïve, Simple Average, Moving Average, Exponential Smoothing Methods
  - Time Trends and Seasonality
  - Stationary and Nonstationary Time Series
  - Unit root tests (DF and ADF tests)
  - White noise and Random Walk
  - Autoregressive (AR) Models
  - Application Examples:
    Stationarity on stock market, macroeconomic, housing, Airbnb, and Uber data
    Forecasting on the financial Market (Individual and Portfolio of Stocks)
    Forecasting on home prices
    Sales forecasting using AR models on Amazon, Airbnb, Google Trends, and Uber
    Inventory Management, Traffic Flow Prediction

- WEEK 3 - TOPIC 3: Time Series Models with Moving Average (MA) and ARMA, ARIMA Process (CH 5,6)

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- Moving Average (MA) Models
- Autoregressive Moving Average (ARMA), Autoregression Integrated Moving Average (ARIMA)
- Application Examples:
  Stock market and Macroeconomic Forecasting
  Forecasting on home prices using AR, MA, ARMA models
  Sales forecasting using AR, MA, ARMA models on Amazon, Airbnb, Google Trends, and Uber

- WEEK 4 - TOPIC 4: Financial Data Analysis (CH 6)

  - Volatility of Time Series
  - GARCH (Generalized Autoregressive Conditional Heteroskedasticity) family models
  - Application Examples:
    Volatility in the stock market indices
    Energy Markets: Commodity Pricing in oil and natural gas
    Economics: Uncertainty in macroeconomic variables such as GDP growth rates, exchange rate, and inflation rates
    Financial Market: Option Pricing, Risk Management to estimate Value at Risk (VaR), Portfolio Allocation, Asset Management

- WEEK 5 - TOPIC 5: Univariate Forecasting Project Week (April 30- May 6, No Class)

  - Midterm Online Exam on D2L and Midterm Project Due on May 6 at 10:00 PM

- WEEK 6 - TOPIC 6: Classical Regression Models using time series data (Part of CH 9)

  - Time Series Regression and the problem of Autocorrelation
  - Detection of Autocorrelation: the Durbin-Watson Test
  - Solutions to Autocorrelation Problems - GLS
  - Time Series Data and the Problem of Heteroskedasticity
  - Application Examples:
    Marketing and Sales and Operational Efficiency
    Relationship between Home sales and mortgage rates
    Relationship between mortgage application and mortgage rates
    Trade-off between Inflation and unemployment

- WEEK 7 - TOPIC 7: Dynamic Forecasting using Multivariate Time Series Model

  - Vector Autoregressive (VAR) Models for Multivariate Time Series (CH 8)
  - Granger Causality
  - Measurement of Accuracy in Forecasting

- – Application Examples:
  Macroeconomic Policy Analysis, Economic Forecasting, and Granger Causality Testing
  Finance: Asset return interaction, Portfolio Management, Credit Risk Analysis
  Energy: Demand Supply Shocks, Dynamic relationship in energy prices, oil, electric, and natural gas
  Environment: Climate Change Analysis
  Marketing: Sales and Marketing Campaign Analysis
  Health Economics: Disease Spread and Economic Factors

- WEEK 8 - TOPIC 8: Machine Learning Time Series Forecasting - Random Forest Model (CH 10)

  - – Machine Learning Applications to the Random Forest Model

  - – Application Examples:
    Stock Market Predictions using Machine Learning Techniques
    House Price Prediction and Sales Prediction
    Retail and Sales: Demand Forecasting, Inventory Management
    Energy: Electricity Price Forecasting, Renewable Energy Production
    Technology: Website Traffic Forecasting, User Engagement Prediction
    Manufacturing: Quality control, Maintenance Scheduling

- WEEK 9 - TOPIC 9: Deep Learning Time Series Forecasting - Neural Network Models (CH 10)

  - – Recurrent Neural Networks (RNNs)

  - – Long Short-Term Memory Networks (LSTMs)

  - – Application Examples:
    Stock Market Predictions, Algorithmic Trading, and Credit Scoring
    House Price Prediction and Sales Prediction
    Retail and Sales: Demand Forecasting, Inventory Management
    Energy: Load Forecasting, Renewable Energy Management
    Technology: Website Traffice Forecasting, User Behavior Analysis
    Manufacturing: Quality control, Maintenance Scheduling
    Entertainment: Content Recommendation

- WEEK 10 - TOPIC 10: Applications on the Time Series Forecasting Models

  - – Final Project Proposal Presentation via Zoom (Group Project) (June 4)
    https://depaul.zoom.us/j/95326652941

- Final Project Due
  Written report submission to D2L until June 15 at 10:00 PM