Res-Econ 497T

Topics in Time-Series and Forecasting

Spring 2020 – Three Credits

Instructor:

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. Office Hours: Drop me an e-mail or come on in.

Prerequisites:

An introductory statistics course such as Res-Econ 212 or Stat 240. Competence in regression at a basic level as taught in Res Ec 213. Res Ec 312 or Stat 505 offer training in regression at a more advanced level.

Objectives:

We develop and apply important time-series methodologies and quantitative forecasting techniques to different kinds of data. We cover a wide range of single-variable (i.e., univariate) techniques and a limited range of regression-based (i.e., multivariate) models.

Readings:

. Introductory Business and Economic Forecasting by Paul Newbold and Theodore Bos. Second Edition (South-Western), 1994. ISBN 0-538-82874-9.

. This text is ideal for presenting and explaining univariate time-series techniques at their most rudimentary levels. It is a great introductory text. It is out of print. It can be purchased through Amazon for around $1.

. I will make this reading material available in Moodle.

. I have my own detailed notes for this course. They will be available in Moodle.

Assignments:

There will be 10 or 11 assignments, each spaced approximately one week apart from the next. These must be done in a timely fashion. The purpose of each assignment is to ensure that you are mastering and digesting the topics as they are being covered. Assignments are worth 30% of your final grade.

Computer Software:

We will be doing a lot of preliminary things using spreadsheets. SAS is particularly useful for forecasting techniques. We may use the econometric time-series (ETS) software in SAS to do many of the forecasting procedures. As an alternative to SAS, we will do a lot of modeling in R.

Exams:

There will be two exams during the semester in addition to a final exam. Each of the two exams will be outside of class and be two hours in length. Each is scheduled for 6:00-8:00 p.m. Each is on a Tuesday. Exam 1 is on **March 3.** Exam 2 is on **April 7**. The venue for both is Stockbridge 124. Each exam contributes 20% toward your final grade. Exam 2 will concentrate on material *since* the previous exam.

A final exam will be scheduled during finals week. The final is worth 30% of your final grade. I will let you know about the topics on the final exam as the time approaches.

Grading Summary:

Item	***Weight***
2 exams during the semester (each worth 20%)	40%
Final Exam	30%
Homeworks	30%

The *minimum* percentages needed for course grades are as follows. These are tentative but good benchmarks.

Percentage	92	89	86	83	79	76	73	69	65	58
Grade	A	A–	B+	B	B–	C+	C	C–	D+	D

Course Organization:

The material will be presented in a lecture format. Implementation of the appropriate computer software will be explained as we proceed through the lectures. You will not be required to make in-class presentations nor will you have to do a paper for this course.

Course Outline:

I will begin with background material on forecasting. This includes terminology, followed by simple and common univariate estimation procedures found in Newbold and Bos. We then move to several not-so-simple univariate methods. All of this paves the way for exploring the behavior of univariate time series and, in particular, testing for their stationarity. I will show you how to derive forecasts using each univariate technique. After covering univariate techniques in depth, we will address econometric forecasting models. We begin with simple trend regression. We may get to more sophisticated vector autoregression (VAR) models. At the end of the course, I will address what happens to forecasts when we combine forecasts from different methods and models. We complete the course by comparing the forecasting performance of all of the techniques that we've studied through the semester.

Individual Topics:

Background Issues and Vocabulary; Basic Forecasting Methods

- Components of a time series: level, trend, seasonality, white noise
- Forecasting vocabulary: univariate; multivariate; data generating process (DGP); random walk
- Performance measures: MSE, MAE, MAPE, and Theil's U
- Forecasting accuracy measures that penalize for increased numbers of parameters
- Simple forecasting methods: naive no-change; naive change; naive seasonal change
- No updating versus updating when making forecasts in the post-sample period
- Regression-based forecasting models
- The simple moving average and seasonality
- The basics of decomposing a series; seasonal adjustment; the seasonal index method
- Getting within-sample and post-sample forecasts when using the decomposition method
- Exponential smoothing methods: simple; Holt; Holt-Winters

Methodology for Discovering the Data Generating Process of a Series

- Difference equations
- First-order difference equations
- General, homogeneous, and particular solutions
- Stability and equilibrium conditions
- Second-order difference equations
- Stability and stationarity
- Theoretical behavior of time-series models
- Autocovariances and autocorrelations for autoregressive and moving average processes
- The theoretical autocorrelation function (ACF) and the partial autocorrelation function (PACF)
- Using the ACF and PACF to make a decision about the data generating process

Box-Jenkins Approach

- Box-Jenkin (ARIMA) Modeling: Identification, Estimation, Diagnostic Testing, Forecasting
- Testing for the stationarity of a *non-seasonal* series and a *seasonal* series
- Using the Q-statistic to test if a series is white noise
- Analyzing the ACF and PACF of a series as a precursor to model development
- Estimating a model; analyzing the model's residuals
- Writing an ARIMA model in backshift operator notation
- Writing an ARIMA model in a form used for forecasting

The Econometric Approach

- The unit root problem
- Spurious regressions: background for unit root tests; Granger and Newbold's finding
- Unit root tests: the appropriate hypotheses and appropriate test statistics
- Model procedure when testing for unit roots
- Dickey-Fuller tests; augmented Dickey-Fuller tests
- Choosing deterministic regressors in augmented models; testing for white noise
- Vector autoregression (VAR): unrestricted and restricted VAR models

Putting Everything Together

- Combining forecasts; how to put together a combined forecast; benefits of combining

Course Policies:

1. **Class Attendance:** Class attendance is expected and critical to your success in this course. You are expected to attend and participate in all lectures. **You are responsible for all material covered in lectures.** The way to avoid any conceivable misunderstanding associated with this course is by attending classes. We will cover a large amount of material. If your plan is to "cram before the exam," you'll most likely be in trouble. A course like this requires regular practice, and more practice. To use the statistical concepts taught in the course effectively, you need a steady exposure to readings, activities, and problems. The course is set up with exercises that lead you through small amounts of material before and after each lecture. Stay on schedule. My best advice: ***Don't Fall Behind.***

2. **Academic Honesty:** I follow closely the University Academic Honesty Policy. You are expected to be familiar with the University policy and the commonly accepted standards of academic integrity. For more information, please see the Dean of Students' website: http://www.umass.edu/dean_students/codeofconduct/acadhonesty/

3. **Disability:** The University is committed to providing an equal educational opportunity for all students. If you have a documented disability on file with the University's Disability Services Department that requires accommodations, please notify me within the first two weeks of the semester so we can make the appropriate arrangements.

4. **Conduct and Courtesies:** I ask that you follow the University Code of Conduct and help create an environment of civility and respect in the classroom. Please observe common courtesies by **arriving before the start of class** and quickly finding an open seat. **The class starts promptly at the designated time** and lasts 75 minutes, not an unreasonable amount of time to expect you to sit still. Please do not leave during class or chat with your friends; these things are very distracting. (If you must leave during class, sit near one of the exits). You will find that I pay attention to your faces during class. Your "look" is a mighty barometer for me regarding whether or not you are engaged in the class and grasping the material. At the same time, I tend to lose my train of thought if members of the audience sleep, play with their technology toys during class, and exhibit behavior that appears to disturb those around them. I am not bashful about letting someone know that he or she is distracting me. (If you exhibit behavior of this sort, don't be surprised if I approach you during class and request that you leave.) If you have tendencies like these, I urge you not to take the course.