Course Syllabus

Eco 5375
Economic and Business Forecasting
Fall 2014

Prof. Tom Fomby
TTh 5:00 – 6:20 PM
250 Maguire

Purpose of Course:

This course is dedicated to teaching students tools in econometrics that are especially useful in forecasting economic and business time series such as sales, expenditures, and macroeconomic variables such as GDP, interest rates, inflation, stock market, etc.

Student Learning Objectives:

The student will learn the essentials of and demonstrate proficiency in

- Decomposition of Times Series into trend, seasonal, cyclical, and irregular components
- Deterministic Trend/Seasonal Forecasting Models
- Box-Jenkins Forecasting Models
- Exponential Smoothing Forecasting Models
- Unobservable Component Forecasting Models
- Vector Autoregressive Time Series Models
- Evaluation of the forecasting accuracies of competing forecasting methods
- Evaluation of the usefulness of a proposed leading economic/business indicator
- Forming efficient “combination” forecasts
- Running SAS, EVIEWS, and R Computer programs

Textbook for Course: The textbook for this course is Forecasting Examples for Business and Economics Using the SAS System (1996). In addition to this book I will be relying heavily on class notes, handouts, and posting on the class website. Note: You can ftp any of the programs contained in this textbook by going to http://ftp.sas.com/samples/A55512.

**Certification in SAS:** If you are an Applied Masters student in our department you might want to consider becoming certified in SAS. There are two levels of certification: Level I - SAS Certified Base programmer ([http://support.sas.com/certify/creds/bp.html](http://support.sas.com/certify/creds/bp.html)) and Level II – SAS Certified Advanced Programmer ([http://support.sas.com/certify/creds/ap.html](http://support.sas.com/certify/creds/ap.html)). If you take and pass either of these tests, the Richard B. Johnson Center for Economic Studies will cover the costs of the exam (approximately $90). Having a SAS certification on your resume can help you find a job in quantitatively oriented fields. All SMU students have access to free e-learning courses for the purpose of preparing for the certification tests. The URL for these free e-learning courses is at [https://support.sas.com/learn](https://support.sas.com/learn). You will need to set up an account with SAS and then contact the Office of Information Technology (OIT) ([http://www.smu.edu/BusinessFinance/OIT/Help](http://www.smu.edu/BusinessFinance/OIT/Help)) to obtain an activation code to have free access to the e-learning courses.

**Computer Usage:** We will mainly be using the computer program called SAS (Statistical Analysis System) produced by the SAS Institute located in Cary, North Carolina. There are two major ways to access SAS for your homework problems and instruction in class. First, for students who do not have personal computers or laptops, you can access SAS in the computer labs on campus. The computer labs of note are the ones in our department (301W in the Umphrey Lee Building), the computer labs located in Fondren Library West, Rooms 103B and 103C, and the computer lab located in the Cox School’s Business Information Center (BIC). Second, for students who own a laptop or personal computer, you can access SAS and other software programs through Access.SMU (SMU’s Virtual Computer Lab system). The delivery system to your computer is via Citrix. You can go to the website [http://www.smu.edu/BusinessFinance/OIT/Services/AppsSMU](http://www.smu.edu/BusinessFinance/OIT/Services/AppsSMU) and then look on the right of the page to find a link for instructions on how to install the Citrix Receiver to your computer or laptop. Before you can run SAS on your computer, **you have to install Citrix Receiver on your machine.** Citrix provides you with “virtual” access to the SAS software in that Citrix makes it appear that you have SAS installed on your own computer when, in fact, it is being accessed from an SMU server on campus. After you install the Citrix Receiver on your computer, you can then logon to the Citrix Receiver by entering your student ID and personal password. You will be asked if you wish to permit Citrix to access your computer. Each time Citrix asks you for permission to access your computer, you should give full permission to do so. Otherwise, the Citrix Receiver software will not be permitted to connect you to VCL and you will not be able to access SAS remotely.

**Evaluation of Student:**

The evaluation in the class consists of four parts:

- Quick Quizzes (20%)
- Exercises (20%)
- Mid-Term Exam (30%)
- Final Exam (30%)

The Quick Quizzes (QQs) will consist of a short answer and/or multiple-choice quiz that will be administered in the first five minutes of the class. The QQs are designed to see if you have retained the information of the previous lecture and if you have done any assigned readings that I may have asked you to do. In addition to keeping the students current in the class and providing review material for the mid-term and final exams, the QQs allow me to keep track of student attendance. It has been my experience that for each Quick Quiz a student misses before the mid-term exam the student, on average, loses 3% on his/her mid-term score. **The**
**bottom line is that it pays to come to class!** To reflect the fact that not every day is a good day, I will be dropping your lowest QQ grade before calculating a QQ average.

With respect to homework exercises, students can confer with each other with respect to programming advice and discussion of basic ideas but in the final analysis each student is expected to write up his/her own homework answers and not make copies of others’ homework. Copying someone else’s homework to hand in as one’s own work is a violation of the SMU Honor Code and will be dealt with according to the rules of the SMU Honor Code. It is important to know that the homework assignments are very important in that the basic ideas covered by them invariably show up on the mid-term and final exams. If you know you are going to be missing a class on the day a homework exercise is due, hand in your homework in advance to receive full credit for your work. Any homework that is handed in late will be given a one letter grade reduction for each day of tardiness. It is my policy to drop your lowest exercise score before calculating your exercise average.

Students will be excused from taking the mid-term exam or the final exam only with a note from a physician, or in the case of a death in the family, with a note from a parent or guardian. Even with an excused absence, either of these exams must eventually be taken before a course grade will be assigned to the student.

If you must miss a class due to legitimate circumstances beyond your control, be sure and contact me beforehand so that I will know of your circumstances. If excused, I will correspondingly excuse you from any QQ that is given that day. I want to emphasize that diligent attendance in this course is essential because a lot of the course material presented in class will be from my personal class notes and can’t be found in any textbook per se. **Note:** After 4 unexcused class absences, I reserve the right to administratively drop students from the class.

My grading scale in this course is as follows:

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>92-100</td>
<td>A</td>
</tr>
<tr>
<td>90-91</td>
<td>A-</td>
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<tr>
<td>88-89</td>
<td>B+</td>
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<tr>
<td>60-61</td>
<td>D-</td>
</tr>
<tr>
<td>0-59</td>
<td>F</td>
</tr>
</tbody>
</table>

**Classroom Website:** [http://faculty.smu.edu/tfomby/](http://faculty.smu.edu/tfomby/)

**Office:** Room 301M, Umphrey Lee, 214-768-2559. E-mail address: tfomby@smu.edu.

**Office Hours:** 3:00 – 4:30 PM TTh or by appointment.
My Graduate Teaching Assistant: Yixiang Zhang. His E-mail address is: yixiangz@smu.edu. If you should need extra tutorials or help outside of my office hours, contact Mr. Zhang and he will be happy to go over concepts that you may not fully understand.

Important Dates to Remember:

First Day of Class: August 26
Fall Break: Monday – Tuesday, October 13 – 14
Last Day to Drop Classes: Friday, November 7
Last Day of Semester in this Class: Thursday, December 4
Final Exam Date: Wednesday, December 17, 3:00 – 6:00 PM in Room 250 Maguire.

General comments on work and class etiquette:

In order to succeed in this class, constant work is essential. Come to class. Read all assigned readings and prepare for the Quick Quizzes. Don’t get behind. If there is something in class discussion or homework assignments that you don’t understand, don’t hesitate to ask me in class, after class, during office hours, or through e-mail.

Obviously, general rules of etiquette apply: cell phones are to be turned off during class and miscellaneous reading material stowed away.

Some Standard Stuff You Should Know

Excused Absences for University Extracurricular Activities:

Excused Absences for University Extracurricular Activities: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalogue)

Disability Accommodations:

Disability Accommodations: Students needing academic accommodations for a disability must first contact Disability Accommodations & Success Strategies (DASS) at 214-768-1470 or www.smu.edu/alec/dass.asp to verify the disability and to establish eligibility for accommodations. They should then schedule an appointment with the professor to make appropriate arrangements. (See University Policy No. 2.4)
Religious Observance:

Religious Observance: Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

Honor Code:

All SMU students are bound by the Honor Code (see SMU Student Handbook for a complete discussion of the SMU Honor Code). The code states that “any giving or receiving of aid on academic work submitted for evaluation, without the express consent of the instructor, or the toleration of such action shall constitute a breach of the Honor Code.” A violation can result in an “F” for the course and an Honor Code Violation on your transcript.
I. Introduction to Course
   A. Focus of this Course: Time Series Forecasting
   B. Field of Forecasting is meeting the Market Test
   C. Example 1: What is a p-value?
   D. Example 2: Sales Forecasting and Optimal Inventory
   E. Example 3: Four Competing Forecasting Models
   F. Example 4: Leading Indicators and Out-of-Sample Experiments

Reference: Class Notes and various SAS programs

II. A Brief Introduction to SAS
   A. APPS.SMU and Accessing Computer Programs on SMU’s Virtual Server – Downloading Citrix Receiver
   B. Introduction to SAS (SAS = Statistical Analysis System)
      i. Program Editor in SAS 9.4
      ii. Data Steps and Procedure Steps
      iii. Log and Listing Files
   C. Inputting Data
      i. Direct Input
      ii. Infile Statement

References: Class Notes and Chapters 1 and 2 in The Little SAS Book

III. Preparing Time Series Data for Forecasting
   A. Proc Expand in SAS
   B. Interpolating Missing Observations
   C. Changing the Frequency from Monthly to Quarterly
   D. Changing the Frequency from Quarterly to Monthly
   E. Transforming the Data

Reference: Example 8 in Forecasting Examples

IV. Additive Decomposition of Time Series
   A. Y = T + S + C + I (Additive Decomposition)
   B. Trend, Seasonal, Cycle, Irregular Components
   C. A Stylized Decomposition of a Time Series
   D. It is important to know which components are in your time series and to properly account for them. Otherwise, you will sacrifice forecasting accuracy.
V. A First Generation Forecasting Model – The Deterministic Trend/Deterministic Seasonal (DTDS) Model
   A. The Simple Trend Model – A Deterministic Trend
   B. Trend Model with Seasonal Dummies
   C. DTDS plus Autocorrelated Errors
   D. An Example: The Plano Sales Tax Data
   E. Tests for Trend and Seasonality – F-tests

Reference: Class Notes and Examples 10 and 13 in Forecasting Examples

VI. Some Important Concepts in Time Series Forecasting
   A. Mean, Variance, and Autocorrelation in Time Series
   B. Definition of Covariance Stationarity
   C. Example of a Stationary Time Series: the AR(1) model
      i. AR(1) Time Series Model \( y_t = \emptyset_0 + \emptyset_1 y_{t-1} + a_t \) when \( |\emptyset_1| < 1 \)
      ii. Mean, Variance, Autocovariance, and Autocorrelation
      iii. The Special Case of \( \emptyset_1 = 1 \). The Random Walk model.
      iv. The Random Walk Model in not Stationary
      v. Differing Prediction Profiles for the two cases: \( |\emptyset_1| < 1 \) versus \( \emptyset_1 = 1 \)
      vi. Do Stock Prices follow a Random Walk?

References: Class Notes, Example 1 in Forecasting Examples, and SAS program RW_IBM_data.sas

VII. Box Jenkins Models for Stationary, Non-Seasonal Time Series
   A. Some Simple Box-Jenkins Models and Their Properties
      i. ARMA(0,0)
      ii. MA(1)
      iii. AR(1)
      iv. ARMA(1,1)
      v. General Notation
      vi. Concepts of Stationarity and invertibility
   B. Identification Tools
      i. Autocorrelation Function (ACF)
      ii. Partial Autocorrelation Function (PACF)
   C. Pattern Table
   D. Sample Counterparts
   E. Information Criteria
   F. P/Q Box
   G. Overfitting Exercises
   H. Example: Lead Production Data

References: Class Notes and Example 1 in Forecasting Examples

VIII. Box-Jenkins Models – Forecasting for Stationary, Non-Seasonal Time Series
   A. Minimum MSE Forecasting
B. Various Forecast Profiles
C. Example: The Forecast Profile and Confidence Intervals for the Lead Production Data

References: Class Notes and Chapter 1 in Forecasting Examples

IX. Box-Jenkins Models for Non-Seasonal, Stochastically-Trending Time Series
A. Taking the First Difference to Control for Stochastic Trends
B. Taking, On Occasion, Second Differences of the Data
C. Augmented Dickey-Fuller Tests for Unit Roots: To Difference or Not To Difference?
D. Example: The Dow Jones Index
E. Forecasting Levels Based on Forecasts of Differences
F. The Log Transformation and how to use it

References: Class Notes, Examples 2 and 9 in Forecasting Examples, and SAS program Sales_forecast_2.sas

MID-TERM EXAM

X. Statistical Tests for Detecting Trend, Seasonality, and Cycle
B. Tests for Seasonality: Buys-Ballot Plots, ACF at lags s 2s, etc. and Friedman’s Non-Parametric Test of Seasonality
C. Test for Cycle: Box-Pierce-Ljung Portmonteau Test for Autocorrelation

References: Class Notes

XI. Box-Jenkins Models for Seasonal, Stochastically-Trending Time Series
A. Year-over-Year Differencing
B. Year-over-Year Differencing Combined with First Differencing
C. The Multiplicative Class of Box-Jenkins Models
D. The ACFs and PACFs of Multiplicative Seasonal Models
E. Examples: Airline Passenger Data and Electricity Production Data
F. Testing for Seasonal Differencing

References: Class Notes and Example 3 in Forecasting Examples

XII. Exponential Smoothing – An Old Favorite (Proc ESM)
A. Simple Exponential Smoothing (No Trend, No Seasonality)
B. Double (Brown) Exponential Smoothing (Trend, No Seasonality)
C. Additive Seasonal Exponential Smoothing (No Trend, Seasonality)
D. Winters Additive Method (Trend, Seasonality)
E. Plano Sales Tax Revenue Data – An experiment showing the importance of Determining the presence or absence of trend in your time series data
XIII. An Alternative to the Box-Jenkins Methods – The Unobservable Components Model (Proc UCM in SAS)
   A. Three Unobservable Components plus Noise
      i. Trend
      ii. Seasonal
      iii. Cycle
   B. Tests of the Significance of the Components
   C. Example: Airline Passenger Data
   D. Forecasting the Airline Passenger Data

References: Class Notes

XIV. Searching for an Extra Variable to Help Us Forecast: VARs (Proc VARMAX)
   A. Be careful: The Spurious Regression Problem
   B. The Equal-Lag Length Vector Autoregressive Model
   C. System-Wide Goodness of Fit Measures to Help Choose the Lag-Length
   D. Using Out-of-Sample Forecasting Experiments to Detect Useful “Extra” Variables for use in Forecasting a Variable of Interest
   E. Diebold-Mariano Test for Significant Differences in Forecasting Accuracies
   F. Example: The “Series M” Data Set

References: Class Notes

XV. Combining Forecasts
   A. Combination Forecasting
      i. Some Basic Theorems on Diversification of Forecasts
      ii. Nelson Combination Method
      iii. Granger-Ramanathan Combination Method
      iv. Combinations with Time-Varying Weights
   B. Application to Economic Time Series

References: Class Notes

FINAL EXAM
END OF COURSE