Course Syllabus

Eco 5375
Economic and Business Forecasting
Fall 2016

Prof. Tom Fomby
TTh 5:00 – 6:20 PM
110 Dedman Life Sciences Building

Purpose of Course:

This course is dedicated to teaching students tools in econometrics that are especially useful in forecasting 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

- **Graphical Examination of Time Series**
- **Decomposition of Times Series into trend, seasonal, cyclical, and irregular components**
- **Stable Seasonal Pattern Forecasting Model**
- **Deterministic Trend/Seasonal Forecasting Model**
- **Unobservable Component Forecasting Model**
- **Box-Jenkins Forecasting Model**
- **Exponential Smoothing Forecasting Model**
- **Transfer Function Model**
- **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**

Evaluation of the Student:

There will be **two mid-term exams**, a **double-point homework assignment** due in lieu of a final exam, **homework assignments, and class attendance**. The weights of each of these items are as follows: mid-term exams (30% each), homework assignments (30%),

and class attendance (10%). I will be assigning a maximum of 10 points for class attendance – 10 points for no unexcused absences, 8 points for 1 or 2 absences, and 6 points for more than 2 absences. After 4 or more absences in class attendance, I reserve the right to administratively drop the student from the class. My policy is to drop the lowest homework score you have before forming a homework average to be used in calculating your overall average in the class. The empirical project due in lieu of a final exam will be a double-point (20 points) assignment that will be included in the homework part of your grading scale. (The usual homework problems are valued at 10 points each.) Finally, you must obtain a doctor's letter if you are to be excused from **any** exams or homework assignments due to illness.

Textbook for Course: I am going to be relying more on classroom presentations and pdf handouts to teach this course than on any one textbook. To this point in my many years of teaching time series forecasting, I have not found any textbook that closely enough matches the topics that I think are important for this course. However, there is a nice open source (free) book that can serve as a useful supplementary textbook for this course. It is Forecasting Principles and Practice (FPP) by Rob. J. Hyndman and George Athanasopoulos. You can find it at the website https://www.otexts.org/fpp. In particular, if you are interested in learning some R programming language you should run some of the R programs that are detailed in the FPP book.

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. The main access to this software is through Apps.smu (SMU's virtual Computer Lab system). The delivery system to your computer is via **Citrix Receiver**. You can go to the website 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 able to access SAS remotely. (Note: For those of you are **MAC users**, I would advise that you go to the student help desk in the Office of Information Technology (OIT) in Fondren Library West (next to Hughes-Trigg Student Center) and ask the technicians there to help you with the loading of Citrix Receiver to your computer and how to make your MAC processor compatible to a Windows environment.)

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) and

Level II – SAS Certified Advanced Programmer (http://support.sas.com/certify/creds/ap.html). If you take and pass either of these tests, the Department of Economics 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. Contact me if you want more information on the free e-learning courses.

Office: Room 301M, Umphrey Lee Bldg., 214-768-2559

Office Hours: Tuesday and Thursday, 1:30 – 2:30 PM or by appointment

E-mail: tfomby@smu.edu

Class Website: http://faculty.smu.edu/tfomby

My Graduate Teaching Assistant: Igor Zhadan. His E-mail address is: izhadan@smu.edu. If you should need extra tutorials or help outside of my office hours, contact Mr. Zhadan and he will be happy to help you.

Important Dates to Remember:
First Day of Class: Tuesday, August 23.
Labor Day Holiday: Monday, September 5
Fall Break: Monday – Tuesday, October 10-11
Last Day to Drop a Class: Friday, November 4
No Classes on Wednesday, November 23
Thanksgiving Break: Thursday – Friday, November 24-25
Last Day of Class: Tuesday, December 1
When double-point homework assignment is due (in lieu of final exam): Monday, December 5 by 5:00 pm. Assignment can be turned in at my office or to my mailbox in the 301 Office Suite in Umphrey Lee Building.

My grading scale in this course is as follows:

A: 92-100; A-: 90-91; B+: 88-89; B: 82-87; B-: 80-81; C+: 78-79; C: 72-77; C-: 70-71; D+: 68-69; D: 62-67; D-: 60-61; F: 0-59.

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.

Classroom Website: http://faculty.smu.edu/tfomby/

- **Disability Accommodations**: Students needing academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit http://www.smu.edu/Provost/ALEC/DASS to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

- **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.)

- **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)

TOPICS

I. Introduction to Course

A. Focus of this Course: Time Series Forecasting
B. Field of Forecasting is meeting the Market Test
C. Definitions of Time Series, Point Forecasts, and Prediction Interval Forecasts
D. Evaluation of Competing Forecasting Accuracy
   i. Forecasting Accuracy Measures
   ii. Naïve Forecasting Methods as Benchmarks
E. Example: The Plano City Manager Planning Problem

Reference: Class Notes, SAS programs, and Chapters 1 and 2, FPP.

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

III. Salient Characteristics of Time Series Data

A. Trend, Seasonal, Cycle, Irregular Components
B. $Y = T + S + C + I$ (Additive Decomposition)
C. $\log(Y) = T + S + C + I$ (Multiplicative Decomposition)
D. A Stylized Decomposition of a Time Series
E. Importance of knowing which components are in your time series

References: Class notes, SAS programs, and Chapter 6, FPP

IV. Brief Interlude on the Detection of Seasonality, Trend, and Cycle

A. Trend Tests: Hirsch, et. al. Non-parametric test, HAC Non-Parametric Tests of Mean of Differences and Time Trend tests
B. Seasonality Tests: Buys-Ballot Plots, Friedman's Non-parametric test, and F-Test in DTDS model
C. Cycle: The Autocorrelation Function and Box-Pierce-Ljung Portmonteau Test

D. Example: Plano Sales Tax Revenue Data

References: Class notes and SAS programs

V. A Beginning Time Series Model: The Stable Seasonal Pattern Model

A. Determination of Seasonal Proportions
B. Test of Equal Proportions
C. Estimation of Trend
D. Example: Plano Sales Tax Revenue Data

Reference: Class Notes

VI. 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. Example: Plano Sales Tax Revenue Data
E. Tests for Trend and Seasonality – F-tests

Reference: Class Notes, SAS programs, and Chapter 5, FPP

VII. A Sophisticated Time Series Decomposition Model: The Unobserved Components Model (Proc UCM in SAS)

A. Three Unobservable Components
   i. Trend
   ii. Seasonal
   iii. Cycle
B. Test of the Significance of the Components
C. Example: Airline Passenger Data
D. Forecasting the Airline Passenger Data

References: Class Notes and SAS programs

VIII. Some Important Concepts Leading up to Box-Jenkins Modeling

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, SAS program RW_IBM_data.sas, and Chapter 8, FPP

IX. 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, SAS programs, and Chapter 8, FPP

X. 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, SAS programs, and Chapter 8, FPP

XI. 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, RW_Data_and_Differencing.sas, other SAS programs, and Chapter 8, FPP

XII. 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, SAS Programs, and Chapter 8, FPP

XIII. 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

References: Class Notes, SAS programs, and Chapter 7, FPP

XIV. Searching for an Extra Variable to Help Us Forecast: VARs (Proc VARMAX)

A. Be careful: The Spurious Regression Problem
B. The Transfer Function Model
C. The Equal-Lag Length Vector Autoregressive Model
D. System-Wide Goodness of Fit Measures to Help Choose the Lag-Length
E. Using Out-of-Sample Forecasting Experiments to Detect Useful "Extra" Variables for use in Forecasting a Variable of Interest
F. Diebold-Mariano Test for Significant Differences in Forecasting Accuracies
G. Example: The "Series M" Data Set

References: Class Notes, SAS programs, and Chapter 9, FPP

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 and SAS programs

LECTURE SCHEDULE
(Note: This schedule is only approximate and will be modified if necessary)

August 23: Review of Course Outline and Focus of Course

August 25: Some Basic Concepts, Apps.smu, and Introduction to SAS

August 30: Some Practice with SAS programming

September 1: Salient Characteristics of Time Series Data

September 6: Detection of Seasonality, Trend, and Cycle in Time Series Data

September 8: Detection of Seasonality, Trend, and Cycle in Time Series Data continued.

September 13: The Stable Seasonal Pattern Model

September 15: The Stable Seasonal Pattern Model continued.

September 20: Deterministic Trend/Deterministic Season Model

September 22: Deterministic Trend/Deterministic Season Model continued.

September 27: Unobserved Components Model

September 29: Unobserved Components Model continued.

October 4: Review for Mid-term I exam

October 6: Mid-term I exam

October 11: Fall Break

October 13: Important Concepts Leading up to Box-Jenkins Modeling

October 18: Important Concepts Leading up to Box-Jenkins Modeling continued.

October 20: Box-Jenkins Modeling

October 25: Box-Jenkins Modeling continued.

October 27: Box-Jenkins Modeling continued.

November 1: Box-Jenkins Modeling continued.

November 3: Box-Jenkins Modeling continued.

November 8: Exponential Smoothing

November 10: Searching for an Extra Variable to Help us Forecast

November 15: Searching for an Extra Variable to Help us Forecast continued.

November 17: Searching for an Extra Variable to Help us Forecast continued.

November 22: Combination Forecasting

November 29: Review for Mid-term II exam

December 1: Mid-term II exam

Double-Point Homework in lieu of final exam due at 5:00 pm on Monday, December 5 in my office or mailbox.