Carnegie Mellon University
Graduate School of Industrial Administration

45-921 Business Forecasting with Time Series Models Spring 2004
(6 units)

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Class Meetings: Tuesday & Thursday 1:30pm - 3:20pm rm 153 Posner Hall

TEXTBOOKS

1. Introduction to Time Series Analysis and Forecasting with Applications of SAS and SPSS, by Robert Yaffee with Monnie McGee, ISBN 0-12-767870-0.
2. SAS for Forecasting Time Series, second edition, by John C. Brocklebank and David A. Dickey, ISBN 0-471-9566-8.
3. I am not requiring a textbook for SAS. If you would like an introductory book, I would recommend The Little SAS Book, third edition, by Lora D. Delwiche and Susan J. Slaughter, ISBN 1-59047-333-7.

Both of the required textbooks are available at the CMU bookstore.

DELIVERABLES

Students will be able to take a new time series and determine its trend and seasonal characteristics. They will be able to determine if the series has conditional heteroskedasticity.

After accounting for trend and seasonal characteristics, the students will be able to estimate an ARMA model and when appropriate, an ARCH or GARCH model. For these estimated models the students will be able to make forecasts and summarize the uncertainty inherent in the forecasts.

OBJECTIVE AND OVERVIEW

The goal of this course is to give students an introduction to the basic time series models. The students will learn the basic summary statistics, i.e. autocovariances, trends, seasonals. The course will focus on forecasting observed series and the estimation of both summary statistics and parameters of time series models such as ARMA, ARCH and GARCH. The students should be able to interpret the uncertainty in the forecasts and in the estimated parameters. Diagnostic statistics and model selection criteria will be presented.

GRADING

Your course grade will be determined by a paper that you will write during the mini. You will apply the different estimation techniques presented in the lectures to a data series. You will report the parameter estimates and forecasts for the series.

Your paper will grow over the mini and will be due periodically. A brief description of your data, a SAS plot of the series and summary statistics are due on March 25 (no more than two pages, one page is likely sufficient). A midterm paper will be due on April 8 and will be worth half your course grade. The midterm paper will be the first part of the final paper and should include:

1. A general description of the data.
2. A plot of the series.
3. Summary statistics.
4. A brief description of the process that generated the series.
5. Any problems with the series. (Are there any outliers or unusual events?)
6. Related to the previous item, explanations of any simplifying assumptions used in modeling the series. (How are outliers treated?)
7. At least one set of forecasts and confidence intervals for the series from a model presented in the first three weeks of the course. The paper should be at the level of an actual business document.
8. A digital copy of the data and the SAS programs that you used in preparing your paper should be emailed to me in one zip file.

The final paper will be due by 5:00 pm on Sunday May 2. The final paper will include at least one additional set of forecasts and confidence intervals from the most appropriate model presented in the course.

SCHEDULE FOR SPRING 2004

WEEK	DATES	TOPICS	Yaffee	Brocklebank	SAS PROC's
1	March 16 March 18	Intro to Forecasting, Overview, Exponential Smoothing	Chapters 1 & 2		PROC's FORECAST, MEANS, GPLOT, SUMMARY
2	March 23 March 25	Intro to ARIMA models	Chapters 3 & 4	Chapters 1 & 2	PROC ARIMA
	MARCH 25	ASSIGNMENT: DATA DESCRIPTION, PLOT & SUMMARY			
3	March 30 April 1	Selecting ARIMA models	Chapters 3 & 4	Chapter 3	PROC ARIMA
4	April 6 April 8	Seasonal ARIMA Models	Chapter 5	Chapter 4	PROC ARIMA
	APRIL 8	ASSIGNMENT: MIDTERM PAPER			
5	April 13 April 15	Multivariate Models Transfer Functions	Chapter 9	Chapter 4	PROC ARIMA
6	April 20 April 22	Regression with time series errors and Models w/ Conditional Variance	Chapter 10	Chapters 2 & 5	PROC AUTOREG
7	April 27 April 29	Modeling Unique Events	Chapter 5	Chapter 4	PROC ARIMA
	MAY 2	ASSIGNMENT: Final Paper Due at my office by 5:00 PM			

Optional Help Sessions

This course will have an optional recitation. The recitation will be run by my TA, Steve Lugauer. These are basically designed for providing students assistance with SAS. Of course, Steve can also answer your basic time series questions.

The (SAS help sessions) recitations will always be in room 153 of Posner Hall. The schedule is:

Sunday	March 21	1:00pm-3:00pm
Saturday	March 27	10:00am-Noon
Saturday	April 3	10:00am-Noon
Saturday	April 10	10:00am-Noon
Saturday	April 17	10:00am-Noon
Sunday	April 25	1:00pm-3:00pm

Note that the first and last sessions are on Sunday afternoon from 1:00 to 3:00 but all the others are on Saturday morning from 10:00 to noon.

Course Summary

Week 1: Start with an overview of the course structure so that the students know what to expect, how the lectures will be organized and how their course grade will be determined.

Introduce the basic idea of a time series, deterministic and stochastic. The students should be able to give numerous examples.

The four basic Approaches to time series analysis and forecasting.

Basic introduction to SAS.

Exponential Smoothing as a forecasting technique. Start with a basic model, then add a trend, end with a series that has a trend and a seasonal cycle.

Week 2: Start with a review of conditioning with normal errors. The main point is that the needed information is the variance-covariance matrix. This section makes the connection between the introductory statistics courses and time series models. We simply need a covariance structure to determine the conditional expectation and this is our forecast.

Introduce some basic time series models the associated forecasting problem. For most of these simple model the forecasts can be determine based on the student's knowledge from prior courses.

The issue of model selection is then presented. Given all the possible variables, and hence models, how do we select between them.

Introduction to the lag operator. Write the AR model with lag operator notation. Note that an AR(1) can be written as an MA(∞) with only one parameter.

Basic idea of stationarity. This is needed to give some structure to the time series model.

Introduce the Wold Representation Theorem and think of the ARMA(p, q) model as an approximation to the Wold representation for a weakly stationary time series.

Week 3: Start with different transformation that are needed to obtain a weakly stationary series. Weak stationarity is needed to apply the Wold Decomposition theorem presented in Week 2. The log transformation and the first difference are considered. The Ljung-Box Q-statistic is introduced as a test for white noise.

The structure of the autocovariance function and the partial autocorrelation function for different models is presented. This is guidance in the selection of the appropriate ARMA(p, q) model.

The main focus of this week is the identification of the appropriate ARMA(p, q) model for a given series.

Week 4: Start with how to have SAS forecast once an ARMA model is selected. Models with seasonal variation are then presented. Tests for seasonal unit roots are presented. The roots of the AR and MA polynomial are studies to give insights into possible seasonal variation.

Week 5: This week we extend the ARIMA model into a multivariate transfer function. Students learn how to use other variables to help model and hence forecast the time series they are studying.

Week 6: This week we consider regression models with time series. The conditional variance models are presented, ARCH and GARCH.

Week 7: This week concerns models with one time events. This is sometimes called intervention analysis. The basic idea is to use dummy variables to capture unique events. The coefficients on the dummy variables model the unique event so that the other terms in the model can capture the model's basic features.