

Statistics 956
Financial and Economic Time Series

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Course Description: This graduate course introduces students to the time series methods and practices which are most relevant to the analysis of financial and economic data. The course begins with an introduction to ARIMA modeling and time series regression. It then addresses the more individual features of financial series such as time dependent volatility. After examining GARCH models in some detail, the course surveys the broader field of state space models, including non-Gaussian models and hidden Markov models.

Prerequisites: Previous graduate study of statistics at the level of Statistics 540, 541, or 550 will be useful, though not absolutely required. Familiarity with statistical computing using R or S is also useful, but the use of S and Finmetrics will be part of the class work.

Texts (Required or Recommended):

- (1) *Modeling Financial Time Series with S-Plus* by Eric Zivot and Jiahui Wang. Springer 2003.
- (2) Many recommended sources are listed on the course web site.

Grading: Grades will be based on weekly assignments (40%), and a final project (60%).

An Approximate Week-by-Week Plan:

Week 1: Introduction to Exploratory Data Analysis (EDA) of time series with S-Plus. We will also introduce several web-based data resources for financial and economic time series.

Week 2: Time Series Specification, Manipulation, and Visualization in S-Plus. (Chapters 1 and 2 of Zivot and Wang)

Week 3: Autoregressive and Moving Average Models. The Box-Jenkins paradigm and an introduction to ARMA (p,q) models including the question of model selection within the ARMA family. (Sections 3.1-3.4 Zivot and Wang)

Week 4: Discussion of the notion of model adequacy, including residual analysis, evaluation of forecast accuracy, outlier detection, model sensitivity, and portmanteau tests of model adequacy such as the Ljung-Box test.

Week 5: A richer discussion of model adequacy including the questions of long range dependence and the technology of unit root tests. We cover most of Chapter 4 of Zivot and Wang. Some details may be set aside in favor of discussing the article "Is it really long memory we see in financial returns?" by Mikosch and Starica in *Extremes and Integrated Risk Management*, P. Embrechts et al (eds.), Risk Books, 2000.

Weeks 6: Time series regression models. We will cover Zivot and Wang Chapter 6 together with additional material on the robust estimation of covariance matrices.

- Weeks 7:** Introduction to the theory and practice of GARCH models. We will deal in some detail the motivation for these models and the methods used to fit them. (Sections 7.1-7.4 of Zivot and Wang)
- Weeks 8:** Deeper discussion of GARCH models including the question of model selection within the GARCH family. We will also examine the quality of predictions from these models in comparison to simpler alternatives. (Sections 7.5-7.10 of Zivot and Wang)
- Weeks 9:** Rolling Analysis of Time Series. Forecasting versus filtering, cross validation, and the use of out-of-sample testing. (Sections 9.1-9.2 of Zivot and Wang plus additional reading from Alexander)
- Weeks 10:** Technical trading and methods of back-testing (Sections 9.3-9.5 of Zivot and Wang will be supplemented by discussion of the 1995 article of Diebold and Mariano “Comparing Predictive Accuracy,” *J. Business and Economic Statistics* **13**, 253–263)
- Weeks 11:** Vector Autoregressive Models for Multivariate Time Series (Chapter 11 of Zivot and Wang)
- Weeks 12:** Cointegration (Chapter 12 of Zivot and Wang), plus selected readings on statistical arbitrage. Discussion of the advance brief for the 2002 Bank of Sweden Prize in Honor of Alfred Nobel.
- Weeks 13:** Multivariate GARCH Modeling (Chapter 13 of Zivot and Wang). Suggestions for price-based volatility estimate. Comparison with implied volatilities.
- Weeks 14:** State Space Models and Financial Time Series (Chapter 14 of Zivot and Wang together with supplementary material on hidden Markov models and the change point problem).