Course Description: This course will introduce students to the time series methods and practices which are most relevant to the analysis of financial and economic data — especially equity returns, interest rates, and exchange rates. The course begins with an introduction to the statistical programming language S-Plus and the tools for exploratory data analysis of time series, including the sample autocorrelation and partial autocorrelation functions. It continues with the methodology of linear modelling of time series including autoregressive models, moving average models, and their generalizations.

The course then addresses the more individual features of financial series such as the challenge of coping with time dependent volatility. Empirical observations motivate the ARCH-GARCH family of models, and these become a central theme of the course. After engaging GARCH models in some detail, the course moves on to survey the broader field of state space models, including non-Gaussian models and hidden Markov models.

Prerequisites: Statistics 101–102 or Statistics 431. Familiarity with linear algebra.

Texts (Required or Recommended):


Grading: Grades will be based on weekly assignments (40%), two quizzes (worth 10% each), and a final project (40%).

An Approximate Week-by-Week Plan:

**Week 1:** Introduction to Exploratory Data Analysis (EDA) with S-Plus.
We will cover Spector, pp. 1–88, and introduce several web-based data resources for financial and economic time series.

**Week 2:** Time Series Specification, Manipulation, and Visualization in S-Plus. EDA of return series. (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, but 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 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 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).