Economics 871
Time Series Analysis

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Office Hours
TBD

Prerequisites
1. Economics 770 (Introduction to Econometric Theory)
2. Economics 771 (Econometrics)
3. Graduate level probability theory and mathematical statistics (usually obtained through 1 and 2).

Objectives
This course is concerned with modeling information over time from an economic perspective. We approach the topic with an eye toward understanding methods: model construction, and conventions and challenges with inference. Theory details are kept brief in order to allow for a broad array of topics useful for economists and those interested in finance, as well as other social scientists.

Economic information over time exhibits stylized characteristics: 1. *persistence*: values today are weakly-to-highly dependent on values in the near-to-distant past (e.g. output, investment, equity returns); 2. *nonlinearity*: the relationship between economic variables over time is often nonlinear based on forecasting principles and/or economic rational (e.g. exchange rates); 3. *heterogeneity* and *non-stationarity*: attributes of economic events evolve or suddenly change over time (e.g. output; shock to investment trend); 4. *conditional heteroscedasticity*: volatility in macroeconomic and financial variates cluster (e.g. equity returns); 5. *leptokurtosis*: many economic time series have too many large values to be modeled by a Gaussian distribution, and many suggest extremely heavy distribution tails (infinite fourth or even second moment: asset returns).

All of these properties imply conventional models for iid data may not be appropriate. We begin by learning the how to estimate a serial correlation coefficient and test for the white noise hypothesis. We then study linear and nonlinear parametric time series models, including Autoregressive Moving Averages:ARMA, Vector Autoregression: VAR, Generalized Autoregressive Score: GAS; Generalized Autoregressive Conditional Heteroscedasticity: GARCH; and Stochastic Volatility. We also cover classic topics of non-stationarity (trend, unit root), and spurious regressions and cointegration. Along the way, we encounter multiple scenarios in which large sample asymptotic theory may not be appropriate due to small sample dynamics, or may be non-standard (i.e. not Gaussian, or chi-squared). We therefore learn various bootstrap techniques for handling inference.

Evaluation
There will be one midterm exam (30%), a final exam (40%), and an assortment of assignments based on econometric theory and computer applications (30%). While students may consult with each other, each must turn in his or her own work.

Reading and Textbooks

Required Reading

Time Series Analysis by J. D. Hamilton, 1994, Princeton University Press.

Lecture Notes

1. Notes are available on the Sakai site. These follow most of pour course topics, and have a heavier theory (asymptotic theory) content.
2. There are also notes available online: e.g. Eric Zivot's are here.
3. Online textbooks include, e.g., Cochrane's and Diebold's.

Suggested Textbook Reading

Time Series: Theory and Methods, by P. J. Brockwell and R. Davis (1991), Springer Verlag.
Introduction to Multiple Time Series Analysis by Helmut Lutkepohl (1991), Springer Verlag.
Forecasting by M.P. Clements and D.F. Hendry (2000), Cambridge Univ. Press.
Analysis of Financial Time Series by R. Tsay (2002), Wiley.
ARCH Models and Financial Applications by C. Gourieroux (1997), Springer.
The Econometric Modeling of Financial Time Series by T.C. Mills (1996), Cambridge.
Stochastic Limit Theory, by James Davidson (1994), Cambridge University Press.
Asymptotic Theory for Econometricians by Halbert White (1999), Academic Press.
Asymptotic Theory of Statistic Inference for Time Series by M. Taniguchi and Y. Kakizawa (2000).
Financial Modeling under Non-Gaussian Distributions by E. Jondeau, S-H.Poon, M. Rockinger (2006).

Topics (*these many change during the course of the semester*)	**Readings in Hamilton**
1. Autocorrelation function: properties, estimation, white noise test, bootstrap.	**Chap. 3, 7**
2. Stationary ARMA: representation, spectrum, QML estimation, Forecasting; specification testing and the bootstrap	**Chap. 1-5, 7, 14**
3. Spectral analysis (time and frequency domain decompositions)	**Chap. 6**
4. Kalman Filter - State Space representations, ARMA, Unobserved Components	**Chap. 13**
5. Non-Stationarity: Trend, Unit Roots	**Chap. 15-17, 19**
6. Random volatility models: GAS, GARCH, Stochastic Volatility	**Chap. 21**
7. Vector Autoregressions, spurious regressions, cointegration.	**Chap. 11**