Quantitative Analysis of Financial Time Series

Course Syllabus

Fall 2017

Instructor: Dr. Zhonghao Fu

Teaching Assistant:

Office hours:

Class schedule:

Course Description: Quantitative Analysis of Financial Time Series is a course designed for the first/second year Master students of the EMA Program at the School of Economics, Fudan University. This intermediate course of time series analysis focuses on the economic intuition and theoretical justification behind the econometric modeling of financial time series process. It starts with the basic concepts in time series analysis and the stylized facts of financial times series data and then covers the univariate and multivariate time series with topics including ARIMA models, volatility models, VAR models, factor models, forecasting time series, model selection, unit root, and structural changes. This course emphasizes the application of time series models in financial data. Empirical examples related to testing the efficient market hypothesis, CAPM, predicting excess equity return, derivative pricing, financial contagion, risk management, and exchange rate prediction will be covered.

Prerequisites: Advanced calculus and a first-year graduate course in probability and statistics. Some background in undergraduate time series analysis is useful but not essential. The course is self-contained.

Credit Hours: 3

Textbooks:

- Tsay R S. Analysis of financial time series. John Wiley & Sons, 2005;
- Ruppert D. Statistics and data analysis for financial engineering. New York: Springer, 2011;
- Hamilton J D. Time series analysis. Princeton: Princeton university press, 1994;
- Brockwell P J, Davis R A. Introduction to time series and forecasting. springer, 2016;
- Hong Y. Lecture notes on nonlinear time series, 2012.

Gradings: Student grade in this courses will be based on:

- Homeworks (10%);
- Midterm exam(30%);
- Final exam (60%).

Tentative Course Outline:
The weekly coverage might change as it depends on the progress of the class.

- **Time series process and its main characteristics (Week 1)**:
  Basic concepts of time series process (stationarity, ergodicity and memory); Main characteristics (means, autocovariation and autocorrelation functions);

- **Introduction to financial time series (Week 2)**:
  Basic returns data characteristics, asymmetry and fat tails; Connections between econometric modeling and economic intuitions in financial time series data;

- **Modeling univariate conditional mean dynamics (Week 3)**:
  Autocorrelation, spectral density, ARIMA models, unit root process, locally stationary process, parameter instability;

- **Modeling univariate conditional mean dynamics (Week 4)**:
  Stylized features of nonlinear time series; Nonlinear phenomena in economics and finance; Nonlinear measures of serial dependence;

- **Modeling univariate conditional mean dynamics (Week 5)**:
  Nonlinear autoregressive models (threshold autoregressive model, smooth transition autoregressive model, Markov Chain regime switching autoregressive model, and random coefficient autoregressive model);

- **Modeling univariate conditional mean dynamics (Week 6)**:
  Estimation of conditional mean models (conditional least squares method, quasi-maximum likelihood method, and Generalized Method of Moments (GMM) estimation);

- **Modeling univariate conditional mean dynamics (Week 7)**:
  Diagnostic checking for conditional mean models (linearity testing, bi-spectral tests, Keenan's test, Tsay's test, White's neural network test, generalized spectral derivative test, and specification testing for nonlinear time series models);

- **Modeling multivariate conditional mean dynamics (Week 8)**:
  Vector autoregression model and co-integration (Time series co-integration, co-integration regression, testing of co-integration, vector autoregression, error correction model);

- **Factor models (Week 9)**:
  Principal Component Analysis (PCA); Single-factor models (CAPM); Multi-factor models (Fama-French three-factor model);

- **Modeling conditional variance dynamics (Week 10)**:
  Stylized facts of volatility clustering in financial returns; Generalized modeling strategy; Engle's AutoRegressive Conditional Heteroskedasticity (ARCH) model;

- **Modeling conditional variance dynamics (Week 11)**:
  Linear ARCH models (GARCH(p; q), IGARCH, RiskMetrics, and long memory volatility model);

- **Modeling conditional variance dynamics (Week 12)**:
  Nonlinear ARCH models (EGARCH(p; q), Threshold GARCH(p; q), and Markov Regime-Switching GARCH Model);

- **Modeling conditional variance dynamics (Week 13)**:
  Estimation and diagnostic checking for conditional variance models (Engle's LM Test, McLeod and Li's Portmanteau Test, One-sided ARCH Test, and Generalized spectral derivative test);

- **Forecasting financial time series (Week 14)**:
  Forecasting time series, model selection, forecast evaluation;

- **Unit root and structural changes (Week 15)**:
  Nonstationarity problem in financial time series process (stylized facts, economic intuitions, modeling, and testing).