Course: 1 semester, 3 hours per lecture.
Lecturing time: Tuesday, 6:10pm-9:00pm
Classroom: A105.
Office hours: Tue: 2:00-5:00pm
Grading: Homework: 30%, midterm: 30%, term paper: 40%

This course focuses exclusively on Time Series Analysis (TSA) designated for graduate students majoring in economics or finance. Cointegration and financial econometrics are two main topics but with only one-semester, I need to make a quick pass on the former one so that I can devote more time on the second one. I shall start

The course starts with a lecture introducing stochastic process, time series model and statistical package R. I then spend 3 lectures covering conventional univariate time analysis, including identification, estimation, diagnostic checking and forecasting of a time series model. Unit root and cointegration econometrics makes the second part. The third and main part comprises univariate ARCH/GARCH, multivariate GARCH models and stochastic volatility models. A brief review of continuous-time econometrics concludes this course.

Similar to any other filed of economics and finance, intuition and creative ideas constitute the flesh and bone of TSA. I am aiming at equipping the students with proper tools for advanced empirical work and lay the foundation for theoretical research in TSA. In additional to econometric theory, I also emphasize computational aspects of these complicated econometric techniques. R, is the main statistical packages used in this course. Homework assignments using R will be given but there is no programming question in the midterm exam.

Textbook:


Reference Books:


**Topics**

1. Introduction to Stochastic Process, Time series and *R* (1 lecture)
2. ARIMA modelling (2 lectures)
3. Theory of Forecasting (1 lecture)
4. VAR and Impulse response analysis (1 lecture)
5. Introduction to unit root and cointegration (2 lectures)
6. Univariate GARCH (2 lectures)
7. Multivariate GARCH (2 lectures)
8. Stochastic Volatility Model (2 lectures)
9. Continuous-time time series models (3 lectures)

**1 Introduction to stochastic processes**

Spanos chap 8

- definition
- memory and heterogeneity
  - stationary
  - Martingale
2 Univariate ARIMA modelling

Granger & Newbold chap 3

- Autocorrelation, partial autocorrelation function, inverse autocorrelation function
- Wold representation theorem
- Random walk model
- General ARIMA model
- Variance stabilization transformation
- Model identification
  - using ACF & PACF
  - using AIC, BIC, & SC criterion
- Estimation
  - method of moment
  - maximum likelihood method
  - nonlinear estimation
- diagnostic checking
3 Theory of Forecasting

Granger and Newbold chap 4

- loss function
- optimal forecast when the parameters are known
- optimal forecast when the parameters are estimated
- optimal multi-step forecast
- partial least squares, principal components, ridge regression

4 Functional central limit theorem and continuous mapping theorem


- functional central limit theorem
  - for iid
  - for mixing processes
- continuous mapping theorem

5 Unit Root Econometrics

- A little history about unit root and cointegration
  - Yule (1927) periodicity of sunspot numbers
  - Box-Jenkins (1976)
• Why does unit root matter?
  – properties of I(1) vs. I(0)
  – unit root does exist in economic data

• testing unit root
  – testing unit root without intercept
  – testing unit root with intercept
  – testing unit root with autocorrelated residual
    * Augmented Dickey-Fuller Test (Fuller chap 8)
    * Phillips-Perron Test
  – testing multiple unit roots
  – near unit root

• spurious regression

• Statistical inference with integrated regressor
6 Cointegration


- definition of cointegration
- economic and statistical meaning of cointegration
- cointegration and error correction model
- estimating and testing cointegration in bivariate system
- estimating and testing cointegration in multivariate system
- empirical examples of cointegration using Taiwan data
- estimating common trend
- threshold cointegration

7 VAR and Impulse Response

- VAR
- Impulse response function for stationary series
- Impulse response function for nonstationary processes
- Impulse response function and causality
- Lutkepohk (1991), chap.3


8 ARCH, ARCH-M, GARCH


• ARCH

• GARCH

• GARCH-M

• metro-shower

9 Multivariate GARCH Models

• Reparameterizations

• VEC, GBEKK, CCC, DCC

• Leverage effects in MGARCH models

• Estimation

• Diagnostic checking

• Applications


10 **Stochastic volatility models**

• SV vs. GARCH
• Estimating SV model
• SV and option pricing
• SVpack in OX


11 **Continuous-time econometrics**

• Some continuous-time stochastic processes
  
  – Wiener processes
  – Generalized Wiener processes
  – Ito processes

• Ito’s lemma
• Distribution of stock prices and log returns
• Black-Scholes differential equations
• An extension of Ito lemma
• Stochastic integral
• Jump-diffusion models
• estimation of continuous-time models

• Tsay(2005), chap 6.

Softwares

R: freely available at
http://www.r-project.org
Task view: Empirical finance
http://cran.r-project.org/src/contrib/Views/Finance.html

• R packages

• urca: Unit root and cointegration analysis

• arima, forecasting: classical time series analysis and forecasting

• fSeries, fMultivar: GARCH, and more

• dse, vars” multivariate time series analysis

The Rmetrics bundle comprised of the fArma, fAsianOptions, fAssets, fBasics, fBonds, fCalendar, fCopulae, fEcofin, fExoticOptions, fExtremes, fGarch, fImport, fMultivar, fNonlinear, fOptions, fPortfolio, fRegression, fSeries, fTrading, fUnitRoots and fUtilities packages contains a very large number of relevant functions for different aspect of empirical and computational finance.