Time Series Analysis

Spring 2008
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Course: 1 semester, 3 hours per lecture.

This course focuses exclusively on Time Series Analysis (TSA). Similar to any other field of economics, 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.

Starting with conventional univariate time analysis, including identification, estimation, diagnostic checking and forecasting of a time series model, I shall close the foundational built up with multiple time series. Unit root and cointegration econometrics makes the second part, and ARCH/GARCH the final part. I shall give an relatively thorough analysis of literatures in these area, starting with functional central limit theorem and ending up with an empirical analysis of Johansen’s maximum likelihood methods.

In addition to econometric theory, I also emphasize computational aspects of these complicated econometric techniques. \( R \), is the three statistical packages used in this course. Several lab sessions are scheduled.

Textbook

Fumio Hayashi, **Econometrics**, New Jersey: Princeton University Press, 2000

Reference Books:

Topics

First semester

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 (2 lectures)
5. Functional central limit theorem and testing unit root (2 lectures)
6. Cointegration and error correction model (3 lectures)

Softwares

R: freely available at
http://www.r-project.org
bayesm,urca

1 Introduction to stochastic processes

Spanos chap 8

- definition
- memory and heterogeneity
  - stationary
  - Martingale
  - Markov
- Brownian motion
  - derivation
  - nowhere differentiability
  - role in stochastic integral
- ARIMA processes
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
  Box-Pierce Q-statistics

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
  Lin, J and R. Tsay, 2005, "Comparisons of Forecasting Methods with Many Predictors,” manuscript.

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)
    – Dickey-Fuller (1979)
    – Granger (1981)
    – Granger and Weiss (1982)
    – Engle and Granger (1987)
    – Phillips (1987)
    – Johansen (1988)
• 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

7, VAR and Impulse Response

• VAR

• Impulse response function for stationary series
8. 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