Econometrics III: Financial Econometrics

Spring 2013
Jin-Lung Lin

Course: 1 semesters, 3 hours per lecture.
Hours: Tue. 6:10pm-9:00pm
Office Hours: Tue. 14:00-17:00, Room A406

This course focuses exclusively on financial time series analysis or financial econometrics. I am aiming at equipping the students with proper tools for advanced empirical work and lay the foundation for future theoretical research in this area.

I shall cover closely the contents of the recently published new book, **An introduction to financial time series with R** written by Ruey Tsay. After a quick review of linear time series modeling, I shall cover volatility modeling. Univariate GARCH and stochastic volatility model and multivariate volatility models. Extreme values analysis and VaR are the second main topic. High frequency financial econometrics comprises the third topic.

In additional to econometric analysis, I also emphasize computational aspects of these complicated econometric techniques. *R*, is the statistical packages used in this course.

Main textbook

- Ruey S. Tsay, **An Introduction to Analysis of Financial Data with R**, John Wiley & Sons, 2013.

Reference books:

- Ruey S. Tsay, **Analysis of Financial Time Series, 3rd** , John Wiley & Sons, 2010
- Bernhard Pfaff **Financial Risk Modelling and Portfolio Optimization with R** John Wiley & Sons, 2012
- Andersen, T.G.; Davis, R.A.; Kreib, J.-P.; Mikosch, Th. (Eds.) **Handbook of Financial Time Series**, 2009, Springer-Verlag
- John Y. Campbell, Andrew W. Lo, and A. Craig MacKinlay: **The Econometrics of Financial Markets**, 1996, Princeton University Press
- Alexander J. McNeil (Author), Rudiger Frey (Author), Paul Embrechts (Author) (2005), **Quantitative Risk Management: Concepts, Techniques, and Tools** Princeton University Press

- Stephen Taylor, **Modelling Financial Time Series**, 2nd Ed. World Scientific

Course evaluation: homework and class attendance (30%), midterm (30%), term paper (40%),

Topics

1. Financial data, their properties and R programming (1 lecture)
2. Linear models for financial time series (2 lectures)
3. Case studies of linear time series (2 lectures)
4. Asset volatility and volatility models (3 lectures)
5. Applications of volatility models (1 lecture)
6. High frequency financial data (3 lectures)
7. Value at Risk (4 lectures)

Softwares

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

1 Financial data, their properties and R programming

Tsay, chap 1

1. Asset Returns
2. Bond Yields and Prices
3. Implied Volatility
4. R Packages and Demonstrations
5. Installation of R Packages
6. The Quantmod Package

7. Some Basic R Commands
8. Examples of Financial Data
9. Distributional Properties of Returns
10. Review of Statistical Distributions and Their Moments
11. Visualization of Financial Data
12. Some Statistical Distributions
13. Normal Distribution
14. Lognormal Distribution
15. Stable Distribution
16. Scale Mixture of Normal Distributions
17. Multivariate Returns

2 Univariate ARIMA modelling

Tsay, chap2; 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
    C.Z. Wei (1992), "On predictive least squares," **The Annals of Statistics, 22**, pp 1-42.
- Estimation

  - method of moment
  - maximum likelihood method
  - nonlinear estimation

- diagnostic checking
  Box-Pierce Q-statistics Box, G.E. & D.A. Pierce (1970) ,"Distribution of residual autocorrelations in autoregressive-integrated moving average time series models," **Journal of American Statistician Association, 52**, 181-192.

3 Univariate volatility modeling

Tsay, ch. 4 R. Engle (1982),"Autoregressive conditional heteroscedasticity with estimates of the UK inflation," **Econometrica, 50**, 987-1008.
T. Bollerslev (1986), "Generalized autoregressive conditional heteroscedasticity," **Journal of Econometrics, 31**, 307-327.
R. Engle, T. Ito and W.L. Lin (1987), "Meteor showers or heat waves?"heteroscedastic intra daily volatility in the foreign market," **Econometrica, 58**, 525-542.

- ARCH
- GARCH
- GARCH-M
- metro-shower

4 Stochastic volatility models

Tsay, chaps 4,5.

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

1. Ghysels, E., Harvey, A.C., Renault, E., 1996. Stochastic volatility, in: Maddala, G., Rao, C.R., Handbook of Statistics, Vol 14. Elsevier Sciences, Amsterdam.

2. Liesenfeld, and J-F Richard, 2004, "Classical and Bayesian Analysis of Univariate and Multivariate Stochastic Volatility Models," Department of Economics, Christian-Albrecht-Universitat, Ohlshausenstr. 40-60, 24118 Kiel, Germany Department of Economics, Economics Working Paper, 2004-12.

5 Multivariate GARCH Models

TSay chaps 4,5

- Reparameterizations
- VEC, GBEKK, CCC, DCC
- Leverage effects in MGARCH models
- Estimation
- Diagnostic checking
- Applications

1. Bauwens,L., S. Laurent and J. V. K. Rombouts (2006), "Multivariate GARCH Models: A survey," **Journal of Applied Econometrics**, 21: 79V109.

2. R. Engle (2002) "Dynamic conditional correlationXa simple class of multivariate GARCH models," **Journal of Business and Economic Statistics** 20: 339V350.

3. Tse YK, Tsui AKC (2002) "A multivariate GARCH model with time-varying correlations," **Journal of Business and Economic Statistics** 20: 351V362.

6 High frequency financial data

Tsay, chap 6.

1. Nonsynchronous trading
2. Bid-ask spread of trading prices
3. Empirical characteristics of trading data

4. Model for price changes
5. Duration models
6. Realized volatility

7 Value at risk

Tsay, chap 7.

1. Risk measure and coherence
2. Calculating risk measures
3. RiskMetrics
4. An Econometric approach
5. Quantile estimation
6. Extreme value theory
7. An extreme value approach to VaR
8. Peaks over thresholds
9. The stationary loss process

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*
- *quantmod*: designed to assist the quantitative trader in the development, testing, and deployment of statistically based trading models.
- *urca*: Unit root and cointegration analysis
- *arima, forcasting*:classical time series analysis and forecasting
- *fSeries, fMultivar*: GARCH, and more

- *dse, vars*" multivariate time series analysis
- *fExtremes*: extreme value 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.