Econometrics III: Financial Time Series

Spring 2011
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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.

After a quick review of stochastic process and time series modeling, I shall start the econometric analysis with volatility modeling. Univariate GARCH and stochastic volatility comes first, followed by multivariate volatility models. Extreme values analysis and VaR are the second main topic. High frequency financial econometrics comprises the third and credit risk modeling the fourth. If time permits, I shall cover the event study methodology as it is very useful.

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, **Analysis of Financial Time Series, 3rd** , John Wiley & Sons, 2010

Reference books:

- 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
- Philipp J. Schönbucher (2003) *Credit derivatives Pricing mMdels:Models, Pricing and Implementation*, John Wiley 2003

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

Topics

1. Introduction and review of programming in *R* (1 lecture)
2. Review of stochastic process, random walks Brownian Motion, functional central limit theorem, and stochastic integration (1 lecture)
3. ARIMA modeling and *R* (2 lecture)
4. Univariate volatility modeling (3 lectures)
5. Multivariate volatility modeling (3 lectures)
6. Review of stochastic integral and Ito's lemma (1 lecture)
7. Credit risk models (6 lectures)

Softwares

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

1 Review of stochastic processes

lecture note

- 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
    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. 3 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

- 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

- 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 Mmodels: 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 Review of stochastic integral and Ito's lemma

Tsay, chap 6.

- Wiener process
- stochastic integral
- jump-diffusion model
- option pricing
- estimation of continuous-time models

7 Credit risk modeling

- Introduction of credit risk: credit-risky instruments, defaults, ratings
- Merton's model of the default of a firm
- Credit risk models
  - Poisson random variables: Poisson mixture portfolio model: Credit Risk+
  - Binomial random variables: Binomial mixture portfolio model:
    CreditMetricsTM (Equity is the driver)
    KMVXR - Model (Asset Value is the driver)
  - Ratings-based model: CPV - credit portfolio view
  - Dynamic intensity process
- Common industry models (KMV, CreditMetrics, CreditRisk+)
- Modelling dependence between defaults with factor models
- Calculating the portfolio credit loss distribution

- Large portfolio behaviour of the credit loss distribution
- Calibration and statistical inference for credit risk models
- Credit derivatives pricing models

1. Crouhy, M D.G., D. Galab, and R. Mark (2000), "A comparative analysis of current credit risk models," **Journal of Banking and Finance** 24 59-117.
2. McNeil, Frey, and Embrechts chaps 8,9.

Campbell, Lo, and MacKinlay: chap 4.

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, forcasting*:classical time series analysis and forecasting
- *fSeries, fMultivar*: GARCH, and more
- *dse, vars*" multivariate time series analysis
- *fExtremes*: exteeme 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.