NEW ECONOMIC SCHOOL
Master of Arts in Economics

Financial Econometrics
Module 6, 2017–2018

Professor: Stanislav Khrapov
New Economic School
skhrapov@nes.ru

Course information

Course Website: my.nes.ru
Instructor's Office Hours: write me an email
Class Time: TBA
Room Number: TBA
TA: TBA

Course description

This course is designed for students interested in quantitative finance and related fields. The aim is to teach students how to accurately price derivative financial instruments and estimate underlying models. The goal is that students become familiar with the current issues in empirical asset pricing, the methodologies used, the classic papers as well as the recent contributions, and be able to analyze and evaluate new research effectively. Finally, students are expected to acquire the skills to conduct and present original empirical research in finance.

Course requirements, grading, and attendance policies

Course prerequisites include Advanced Time Series Econometrics and Derivatives.
The grading of student's performance is based on homeworks (60%) and final exam (40%):

- Three individual homework assignments with strict deadlines. Late submissions have zero weight. Free exchange of ideas is allowed and welcome, but free-riding is not (see Academic Integrity Policy).
- Final exam. Closed book exam will contain questions loosely based on a published paper in financial econometrics handed out in advance.

The format of the make-up exam is identical to the final exam.

Course materials

Required textbooks and materials

- **[CLM]** Campbell J. Y., Lo A. W. and MacKinlay C. A. (1997): *The Econometrics of Financial Markets*. Princeton University Press.
- **[SIN]** Singleton K. J. (2006): *Empirical Dynamic Asset Pricing: Model Specification and Econometric Assessment*. Princeton University Press.
- **[TS]** Tsay R. S. (2010): *Analysis of Financial Time Series*. Wiley.
- **[CN]** Cochrane J. (2005): *Asset Pricing*. Princeton University Press.
- **[GJ]** Gourieroux C. and Jasiak J. (2001): *Financial Econometrics, Problems, Models and Methods*. Princeton University Press.

Additional materials

- Duffie, D. (2010). *Dynamic Asset Pricing Theory*. Princeton University Press, 3rd edition.
- Johannes, M. S. & Polson, N. G. (2010). MCMC Methods for Continuous-Time Financial Econometrics. In Y. Ait-sahalia & L. P. Hansen (Eds.), *Handbook of Financial Econometrics: Applications*, volume 2 chap- ter 13, (pp. 1–72). Elsevier B.V.
- Piazzesi, M. (2010). Affine Term Structure Models. In Y. Ait-sahalia & L. P. Hansen (Eds.), *Handbook of Financial Econometrics: Tools and Techniques*, volume 1 chapter 12, (pp. 691–766). Elsevier B.V.

Course contents

1. Volatility measurement and forecasting
   (a) RiskMetrics
   (b) GARCH
   (c) Realized Volatility
   (d) Stochastic Volatility
2. Risk management
   (a) Value-at-Risk, Expected Shortfall
   (b) Covariance risk, time-varying betas
   (c) Asset allocation
3. Continuous time models of interest rates, stock prices, and volatility
   (a) Geometric Brownian Motion
   (b) Vasicek model
   (c) Cox-Ingersoll-Ross model
   (d) Heston Stochastic Volatility model

4. Derivatives
    (a) Bonds: term structure of interest rates
    (b) Options: implied volatility, smile, smirk and surface
    (c) No arbitrage and risk-neutral pricing
    (d) Pricing via simulation
    (e) Calibration
5. Estimation methods
    (a) Simulated Maximum Likelihood
    (b) Simulated Method of Moments
    (c) Markov Chain Monte Carlo

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.

Sample tasks for course evaluation

Final exam 2012

This exam is based on the following paper:

- Christoffersen, P., Jacobs, K., & Heston, S. L. (2011). A GARCH Option Model with Variance-Dependent Pricing Kernel. *University of Toronto, working paper*.

Please, answer the following questions:

1. What is the main difficulty the authors try to overcome by avoiding estimation of continuous time model? What are the approaches to estimate the continuous time model without filtering unobserved spot variables? Do not give a list of ten approaches. Choose one and motivate your choice.
2. Propose a modification of the model which can potentially match the persistence of volatility not just qualitatively as in the paper, but also quantitatively. Choose one model for continuous time and one for discrete time.
3. What is the role of parameter ρ in the model? What is the effect of non-zero parameter on option prices? How does the implied volatility smile look like if this parameter is set to zero?
4. What are the risk factors in the SV-type continuous-time model (1)-(3)?
5. What are the risk factors in the GARCH-type discrete time model (5), (9), and (10)?
6. In terms of the SV-type continuous-time model (1)-(3) find the instantaneous equity and volatility risk premia. How the two are related?

7. How would you estimate these?

8. In terms of the GARCH-type discrete time model (5), (9), and (10) derive the expected equity premium and expected volatility premium over one period (day). How the two are related? How would you estimate these?

9. Prove or disprove that the model in (1)-(3) belongs to the class of Affine class of models.

10. How does volatility persistence parameter κ in (1) relate to the autocorrelation of GARCH volatility in (5)? Does the relationship change if we change the horizon to something other than one period (day)?

11. What is the lazy alternative to option pricing formula (16) that does not require derivation of conditional generator and computing Fourier inverse?

12. Outline the procedure based on GMM to estimate the model parameters of GARCH-type discrete time model (5), (9), and (10). Write moment conditions, choose instruments, and what kind of data would you use. If the data includes option prices how would you incorporate this information into estimation procedure?