PhD course in Finance

Advanced Topics in Volatility and Contagion Analysis

Instructor:	Dr. Deniz Erdemlioglu (IESEG School of Management)
Class Schedule:	Block course with 14 hours interactive sessions
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Course Period and Location:	October 2018, University of Zurich, SFI (room TBD)

Course Description and Objectives

The objective of this course is to provide students with an understanding of the recent advances on the analysis of financial volatility and contagion. The course starts with a short review of fundamentals of stochastic processes together with the distributional characteristics of asset price dynamics. From both theoretical and practical perspectives, the course then covers a wide range of topics in volatility measurement, volatility decomposition (diffusive volatility, periodic volatility, jumps), estimation methods (univariate, bivariate/multivariate) as well as cojump and contagion identification embedded in tail events. The final sessions of the course are devoted to connectedness approach and network models of contagion through the lens of macroeconomic and financial channels. The role of information signals and shifts in time-varying market conditions will be discussed in explaining volatility reaction and contagion spells.

At the end of the course, students should be able to:

- Know the major papers in the field, and how the field developed over time
- Demonstrate a rigorous knowledge on the measurement of volatility and contagion
- Extend the theoretical setup of principle tools to examine volatility and contagion dynamics
- Assess the econometric accuracy of estimation and modeling techniques through simulations
- Apply the methods learned in the class to real data and discuss the implications of findings
- Write a research paper with contributions linked to theory, implementation and empirics

Course Outline and Schedule

Outline:

PART I

1. Introduction and overview: volatility analysis
2. Volatility analysis: discrete-time approach
   (a) Stylized facts and historical volatility
   (b) Review of ARCH/GARCH-type models
   (c) Estimation, diagnostics and forecasting
   (d) Simulations and applications
3. Volatility analysis: continuous-time approach
   (a) Ito semimartingales and Lévy models for asset price dynamics
   (b) Volatility measurement and estimation
   (c) Analyzing integrated volatility using realized measures
   (d) Simulations and applications
4. Jump measurement and estimation
   (a) Analyzing daily and intra-daily realized jumps
   (b) Decomposing and estimating jump activity
   (c) Volatility jumps and self-excitation flows in tail events
   (d) Simulations and applications

PART II

1. Introduction and overview: contagion analysis
2. Financial volatility and contagion: covariation and co-jump methods
   (a) Analyzing volatility contagion using realized covariation dynamics
   (b) Analyzing tail contagion using realized co-jump dynamics
   (c) Mutual-excitation (MUTE) approach for analyzing tail contagion
   (d) Simulations and applications

3. Financial volatility and contagion: connectedness and network methods

   (a) Analyzing contagion using financial connectedness measures

   (b) Analyzing contagion using network approach

   (c) Volatility, contagion and monitoring systemic risk

   (d) Volatility, contagion and information arrivals

   (e) Simulations and applications

4. Concluding remarks

Content, Calendar and Readings:

Note: The schedule of topics is subject to minor revision. Lecture notes and material will be provided during the course period.

October 4, 2018

Overview: modeling asset price dynamics (Semimartingales and Lévy processes)

[1] Aït-Sahalia, Y. and D. Xiu (2016). Increased correlation among asset classes: Are volatility or jumps to blame, or both? *Journal of Econometrics 194*, 205–219.

[2] Aït-Sahalia, Y. and J. Jacod (2012). Analyzing the spectrum of asset returns: Jump and volatility components in high frequency data. *Journal of Economic Literature 50*, 1007–1050.

October 4-5, 2018

Volatility measurement and estimation

[3] Andersen, T. G., T. Bollerslev, and D. Dobrev (2007). No-arbitrage semi-martingale restrictions for continuous-time volatility models subject to leverage effects, jumps and i.i.d. noise: Theory and testable distributional implications. *Journal of Econometrics 138*, 125–180.

[4] Andersen, T. G., and T. Bollerslev (1998b). DM-Dollar volatility: intraday activity patterns, macroeconomic announcements and longer run dependencies. *The Journal of Finance 53*, 219–265.

[5] Barndorff-Nielsen, O., and N. Shephard (2004b). Power and bipower variation with stochastic volatility and jumps (with discussion). *Journal of Financial Econometrics 2*, 1–48.

[6] Paolella, M. S. and P. Polak (2015). COMFORT: A common market factor non-Gaussian returns model. *Journal of Econometrics 187*, 593–605.

Jump measurement and estimation

[7] Aït-Sahalia, Y. and J. Jacod (2009). Estimating the degree of activity of jumps in high frequency data. *The Annals of Statistics 37*, 2202–2244.

[8] Aït-Sahalia, Y., and J. Jacod (2009). Testing for jumps in a discretely observed process. *Annals of Statistics 37*, 184–222.

[9] Aït-Sahalia, Y., J. Jacod, and J. Li (2012). Testing for jumps in noisy high frequency data. *Journal of Econometrics 168*, 207–222.

[10] Aït-Sahalia, Y. and J. Jacod (2011). Testing whether jumps have finite or infinite activity. *Annals of Statistics 39*, 1689–1719.

[11] Andersen, T. G., T. Bollerslev, and F. X. Diebold (2007). Roughing it up: including jump components in the measurement, modeling and forecasting of return volatility. *The Review of Economics and Statistics 89*, 701–720.

[12] Barndorff-Nielsen, O., and N. Shephard (2004b). Econometrics of testing for jumps in financial economics using bipower variation. *Journal of Financial Econometrics 4*, 1–30.

[13] Bollerslev, T., V. Todorov, and S. Z. Li (2013). Jump tails, extreme dependencies and the distribution of stock returns. *Journal of Econometrics 172*, 307–324.

[14] Erdemlioglu, D., S. Laurent, and C. J. Neely (2015). Which continuous-time model is most appropriate for exchange rates? *Journal of Banking and Finance 61*, 256–268.

[15] Lee, S. S. and J. Hannig (2010). Detecting jumps from Lévy jump diffusion processes. *Journal of Financial Economics 96*, 271–290.

[16] Lee, S. S. and P. A. Mykland (2008). Jumps in financial markets: A new nonparametric test and jump dynamics. *The Review of Financial Studies 21*, 2535–2563.

[17] Todorov, V. and G. Tauchen (2011). Volatility jumps. *Journal of Business and Economic Statistics 29*, 356–371.

October 18, 2018

Contagion analysis: covariation and co-jump methods

[18] Andersen, T. G., T. Bollerslev, F. X. Diebold, and P. Labys (2003). Modeling and forecasting realized volatility. *Econometrica 71*, 579–625.

[19] Dungey, M., D. Erdemlioglu, M. Matei, and X. Yang (2017). Testing for mutually exciting jumps and financial flights in high frequency data. *Forthcoming in Journal of Econometrics.*

[20] Bandi, F. M. and R. Renò (2016). Price and volatility co-jumps. *Journal of Financial Economics 119*, 107–146.

[21] Bibinger, T. and L. Winkelmann (2015). Econometrics of co-jumps in high-frequency data with noise. *Journal of Econometrics 184*, 361–378.

[22] Jacod, J., C. Klüppelberg, and G. Müller (2017). Testing for non-correlation between price and volatility jumps. *Journal of Econometrics 197*, 284–297.

[23] Jacod, J. and V. Todorov (2009). Testing for common arrivals of jumps for discretely observed multidimensional processes. *The Annals of Statistics 37*, 1792–1838.

[24] Jacod, J. and V. Todorov (2010). Do price and volatility jump together? *The Annals of Applied Probability 20*, 1425–1469.

[25] Mancini, C. and F. Gobbi (2012). Identifying the Brownian covariation from the co-jumps given discrete observations. *Econometric Theory 28*, 249–273.

[26] Caporin, M., A. Kolokolov, and R. Renò (2017). Systemic co-jumps. *Journal of Financial Economics 126*, 563—591.

October 19, 2018

Contagion analysis: connectedness and network methods (I)

[27] Barunik, J. and T. Krehlik (2018). Measuring the frequency dynamics of financial connectedness and systemic risk. *Forthcoming in Journal of Financial Econometrics*.

[28] Diebold, F. X. and K. Yilmaz (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal 119*, 158–171.

[29] Diebold, F. X. and K. Yilmaz (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting 28*, 57–66.

[30] Diebold, F. X. and K. Yilmaz (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics 182*, 119–134.

[31] Elliott, M., B. Golub, and M. O. Jackson (2014). Financial networks and contagion. *American Economic Review 104*, 3115-3153.

[32] Härdle, W. K., W. Wang, and L. Yu (2016). TENET: Tail-Event driven NETwork risk. *Journal of Econometrics 192*, 499–513.

Contagion analysis: connectedness and network methods (II)

[33] Bardoscia, M., S. Battiston, F. Caccioli, and G. Caldarelli (2015). DebtRank: A microscopic foundation for shock propagation. *PLoS ONE 2:541*.

[34] Battiston, S., M. Puliga, R. Kaushik, P. Tasca, and G. Caldarelli (2012). DebtRank: Too central to fail? Financial networks, the FED and systemic risk. *Nature, Scientific reports 2:541*.

[35] Eisenberg, L. and T. H. Noe (2001). Systemic risk in financial systems. *Management Science 47*, 236–249.

[36] Gandy, A. and L. A. M. Veraart (2016). A Bayesian methodology for systemic risk assessment in financial networks. *Management Science 63*, 4428–4446.

[37] Glasserman, P. and H. P. Young (2016). Contagion in financial networks. *Journal of Economic Literature 54*, 779–831.

[38] Glasserman, P. and H. P. Young (2015). How likely is contagion in financial networks? *Journal of Banking and Finance 50*, 383–399.

[39] Rogers, L. C. G. and L. A. M. Veraart (2013). Failure and rescue in an interbank Network. *Management Science 59*, 882–898.

Contagion analysis: connectedness and network methods (III)

[40] Herskovic, B. (2017). Networks in production: Asset pricing implications. *Forthcoming in Journal of Finance*.

[41] Acemoglu, D., A. Ozdaglar, and A. Tahbaz-Salehi (2015). Systemic risk and stability in financial networks. *American Economic Review 105*, 564–608.

[42] Acemoglu, D., V. Carvalho, A. Ozdaglar, and A. Tahbaz-Salehi (2012). The network origins of aggregate fluctuations. *Econometrica 80*, 1977–2016.

Contagion analysis: other methods

[43] Aït-Sahalia, Y., J. Cacho-Diaz, and R. J. A. Laeven (2015). Modeling financial contagion using mutually exciting jump processes. *Journal of Financial Economics 117*, 585–606.

[44] Aït-Sahalia, Y. and T. R. Hurd (2015). Portfolio choice in markets with contagion. *Journal of Financial Econometrics 14*, 1–28.

[45] Aït-Sahalia, Y., R. J. Laeven, and L. Pelizzon (2014). Mutual excitation in Eurozone sovereign CDS. *Journal of Econometrics 183*(2), 151–167.

[46] Allen, F. and D. Gale (2000). Financial contagion. *Journal of Political Economy 108*, 1–33.

[47] Bae, K., G. A. Karolyi, and R. M. Stulz (2003). A new approach to measuring financial contagion. *The Review of Financial Studies 16*, 717–763.

VOLATILITY, CONTAGION AND INFORMATION ARRIVALS

[48] Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega (2007). Real-time price discovery in stock, bond and foreign exchange markets. *Journal of International Economics 73*, 251–277.

[49] Jiang, G. J., I. Lo, and A. Verdelhan (2011). Information shocks, liquidity shocks, jumps, and price discovery: Evidence from the U.S. Treasury market. *Journal of Financial and Quantitative Analysis 46*, 527–551.

[50] Lahaye, J., S. Laurent, and C. J. Neely (2011). Jumps, cojumps and macro announcements. *Journal of Applied Econometrics 26*, 893–921.

Course Prerequisites

- Fundamentals of Asset Pricing and Theory of Finance
- Master's level Probability theory and Statistical Inference
- Simple Regression Modeling and Time Series Analysis (e.g., ARMA, ARCH, GARCH).
- Some knowledge on Continuous-Time Finance (recommended but not mandatory)

Requirements and Rules

- Structure: All students are expected to read the articles for each class, try to have an overview understanding about the core ideas/innovations/strengths of articles and highlight the potential shortcomings or ways for further extensions. It is important to actively participate in the research discussions. It is also highly encouraged (not mandatory) to bring laptops and have R, Matlab or Oxmetrics installed. Depending on the context, the tools and methods discussed in the lectures will be implemented through real/simulated financial data and that will further help you conduct your research papers.

- Assessment: The assessment of the course consists of individual (in-class) paper presentations (about 10 minutes) and one research paper assignment that each student conducts individually (the project handout—providing the details of the assignment—will be sent one week before the course starts). The paper presentations will take place at the end of last session. The objective of paper presentations is mainly to help you get prepared for reviewing academic articles and providing critical discussions. Each individual presentation will last approximately 10 minutes (as is often the case in academic Finance conferences/seminars). To use the time efficiently and effectively, the presentation slides should be concise and well structured summarizing the main points of the article, discussing carefully the motivation, contributions and addressing the possible drawbacks/shortcomings. This assessment will help you position your own research ideas properly and link them to those existing in prior research. Pure objective and scientific stand applies, which implies that you can question and constructively criticize any published articles (including those belong to mine in the reading list).

- Exam: No exam.

- Grading: 70% assignment + 30% presentations. A supplemental handout will be sent to present the details of the research project assignments.

Course Material

The main material of the course relies on the research articles and lecture notes, and hence no textbook is required. The following textbooks are recommended.

- Diebold, F. X. and Yilmaz, K., *Financial and Macroeconomic Connectedness: A Network Approach to Measurement and Monitoring*, Oxford University Press, 2015.

- Aït-Sahalia, Y. and Jacod, J., *High Frequency Financial Econometrics*, Princeton University Press, 2014.

- Cont, R. and Tankov, P., *Financial Modeling with Jump Processes*, Chapman & Hall / CRC Press, 2014.

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