EC 794: Financial Econometrics

Spring 2022

Course Overview

This course is designed for Ph.D. students working in the areas of econometrics, finance, and quantitative macroeconomics. We will discuss econometric methods for testing asset pricing theories and understanding financial markets, with an emphasis on the interplay between finance theory and econometric analysis. We cover topics related to the cross-section and time-series properties of asset returns, nonparametric volatility measurement, arbitrage- and consumption-based asset pricing models (estimation, inference, and model evaluation), methods for estimating continuous-time models, volatility risk premium, term structure models, state-price density estimation, network models, and systemic risk. The goal is twofold. The first is to familiarize students with appropriate econometric methods. The second is to expose them to new research ideas, thus facilitating the development of their thesis in related areas.

Requirements

There are four homework assignments, a 45-minute presentation, and a research paper. There is no final exam. The problem sets account for 20% of the final grade, the presentation 20%, the class participation 20%, and the paper 40%. Students earn class participation points by joining discussions and answering questions. Students are strongly encouraged to arrange two meetings (in February and March, respectively) to discuss the paper's progress.

Material

I will distribute a set of PowerPoint lecture notes that are based primarily on the first three books below and various research articles:

1. Campbell, J.Y. (2017), Financial Decisions and Markets. Princeton University Press.
2. Aït-Sahalia, Y. and L.P. Hansen (2010, eds), Handbook of Financial Econometrics, North-Holland. (Available on Elsevier.)
3. Campbell, J.Y., Lo, A.W. and C. Mackinlay (1997), The Econometrics of Financial Markets. Princeton University Press.
4. Aït-Sahalia, Y. and J. Jacod (2013), High-frequency Financial Econometrics, Princeton University Press.
5. Singleton, K.J. (2006), Empirical Dynamic Asset Pricing: Model Specification and Econometric Assessment. Princeton University Press.
6. Taylor, S.J. (2005), Asset Price Dynamics, Volatility, and Prediction. Princeton University Press.
7. Tsay, R.S. (2002), Analysis of Financial Time Series. Wiley.

Academic Conduct

Students should know and understand the GRS Academic Conduct Code. Any suspected academic misconduct would be reported to the Dean's Office.

COURSE OUTLINE

Part 1: Time Series and Cross Sectional Properties of Asset Returns

1 Time series properties of asset returns (I)

We study the time-series properties of aggregate stock returns at monthly and lower frequencies. We relate these properties to the efficient market hypothesis. Topics include the efficient market hypothesis and robust inference for predictive regressions.

References

[1] Campbell, J.Y and M. Yogo (2006)*: "Efficient Tests of Stock Return Predictability." *Journal of Financial Economics,* 81, 27-60.

[2] Fama, E.F. (1970)*: "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance,* 25, 383-417.

[3] Fama, E.F. (1991): "Efficient Capital Markets: II." *Journal of Finance,* 46, 1575–1617.

[4] Fama, E.F. and K.R. French. (1988): "Dividend Yields and Expected Stock Returns." *Journal of Financial Economics*, 22, 3–25.

[5] Lewellen, J. (2004)*: "Predicting Returns with Financial Ratios." *Journal of Financial Economics,* 74, 209–235.

[6] *Handbook of Financial Econometrics* (Chapter 11).

2 Time series properties of asset returns (II)

We examine the statistical properties of high-frequency asset returns, covering the bid-ask spread, intra-day seasonality in volatility, and their implications for volatility modeling.

References

[1] Andersen, T. and T. Bollerslev (1997)*: "Intraday Periodicity and Volatility Persistence in Financial Markets." *Journal of Empirical Finance*, 4, 115-158.

[2] Engle, R. (2000)*: "The Econometrics of Ultra High Frequency Data." *Econometrica*, 1-22.

[3] Glosten, L.R. (1987): "Components of the Bid-Ask Spread and the Statistical Properties of Transaction Prices." *Journal of Finance*, 42, 1293-1307.

[4] Roll, R. (1984): "A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market." *Journal of Finance*, Vol. 39, No. 4, pp. 1127-1139.

[5] *Handbook of Financial Econometrics* (Chapter 7).

3 Cross-sectional properties of asset returns

We examine cross-sectional properties of asset returns through the lenses of the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). Topics include valid inference for the two-stage regression, testing portfolio efficiency, principal component analysis, and factor models of large dimensions.

Capital Asset Pricing Model (CAPM)

References

[1] Black, F., M. Jensen, and M. Scholes (1972): "The Capital Asset Pricing Model: Some Empirical Tests." In: Jensen, M. (Ed.), *Studies in the Theory of Capital Markets*. Praeger, New York, NY, pp. 79–121.

[2] Fama, E. and J. MacBeth (1973): "Risk, Return and Equilibrium: Empirical Tests." *Journal of Political Economy* 81, 607–636.

[3] Lintner, J. (1965): "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." *Review of Economics and Statistics,* 47, 13-37.

[4] Markowitz, H.M. (1959). Portfolio Selection: Efficient Diversification of Investments. John Wiley & Sons, New Jersey.

[5] Sharpe, W.F. (1964): "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *Journal of Finance*, Vol.19, pp.425-442.

Multi-factor pricing models

References

[1] Ang, A. and D. Kristensen (2012): "Testing Conditional Factor Models." *Journal of Financial Economics*, 106, 132-156.

[2] Carhart, M. (1997): "On Persistence in Mutual Fund Performance." *Journal of Finance,* 52, 57–82.

[3] Fama, E.F. and K.R. French (1993): "Common Risk Factors in the Returns on Bonds and Stocks." *Journal of Financial Economics*, 33, 3-53.

[4] Fama, E. and K.R. French (2015): "A Five-factor Asset Pricing Model." *Journal of Financial Economics*, 116, 1-22.

[5] Fama, E. F. and K.R. French (2020): "Comparing Cross-section and Time-series Factor Models." *Review of Financial Studies*, 33,1891-1926.

[6] Gagliardini, P., E. Ossola, and O. Scaillet (2016): "Time-varying Risk Premium in Large Cross-sectional Equity Data Sets." *Econometrica*, 84, 985-1046.

[7] Gibbons, M. R., S. Ross, and J. Shanken (1989)*: "A Test of the Efficiency of a Given Portfolio." *Econometrica*, 57, 1121-52.

[8] Lewellen, J., S. Nagel, and J. Shanken, J. (2010): "A Skeptical Appraisal of Asset Pricing Tests." *Journal of Financial economics*, 96, 175-194.

[9] Ross, S. (1976): "The Arbitrage Theory of Capital Asset Pricing." *Journal of Economic Theory* 13, 341–360.

[10] Shanken, J. (1992)*: "On the Estimation of Beta-pricing Models." *Review of Financial Studies*, 5, pp. 1-33.

[11] *Handbook of Financial Econometrics*, Chapter 14.

Large dimensional factor models and PCA

References

[1] Ando, T and J. Bai (2020)*: "Quantile Co-Movement in Financial Markets: A Panel Quantile Model With Unobserved Heterogeneity." *Journal of the American Statistical Association*, 115, 266-279.

[2] Bai, J. and S. Ng. (2008)*: "Large Dimensional Factor Analysis." *Foundations and Trends in Econometrics*, Vol. 3, No. 2, 89–163.

4 Volatility in time and space

We examine volatility from both a time series and a cross section perspective. We focus on basic models and concepts, setting the stage for further analysis. Topics include volatility concepts such as realized volatility and implied volatility, GARCH models, stochastic volatility models, and the GEOVOL model of Engle and Campos-Martins (2020).

References

[1] Clark, P. (1973). "A Subordinated Stochastic Process Model With Finite Variance for Speculative Prices," Econometrica 41, 135-155.

[2] Engle, R.F. (1982). "Autoregressive conditional heteroskedasticity with estimates of the variance of U.K. inflation," Econometrica 50:987-1008.

[3] Engle, R.F. and S. Campos-Martins (2020). "Measuring and Hedging geopolitical Risk," working paper.

[4] Herskovic, B., B. Kelly, H. Lustig, and S. Van Nieuwerburgh. (2016) "The common factor in idiosyncratic volatility: Quantitative asset pricing implications," Journal of Financial Economics, 2016, 119, 249–283.

Part 2. Econometric Analysis of the Stochastic Discount Factor (SDF)

5 SDF: specification analysis

We examine the SDF from a nonparametric perspective through the Hansen-Jagannathan bound. We study the Hansen-Jagannathan distance as a measure for model misspecification. We investigate the time series properties of a SDF proxy that are consistent with a time-varying riskfree rate and a time-varying equity premium. Some discussions are devoted to the equity premium puzzle from a nonparametric view point.

References

[1] Hansen, L.P, J. Heaton, and G.J. Luttmer (1995): "Econometric Evaluation of Asset Pricing Models." *Review of Financial Studies*, 8, 237-274.

[2] Hansen, L. P. and R. Jagannathan (1991)*: "Implications of Security Market Data for Models of Dynamic Economies." *Journal of Political Economy*, 99, 225-262.

[3] —- (1997)*: "Assessing Specification Errors in Stochastic Discount factor Models." *Journal of Finance*, 52, 557-590.

[4] Mehra, R and E.C. Prescott (1985): "The Equity Premium: A Puzzle." *Journal of Monetary Economics* 15, 145–161.

6 SDF: estimation and inference

We present methods for estimating the SDF and, more generally, for estimating models implied by moment conditions. Topics include the GMM, simulated method of moments, and indirect inference.

References

[1] Duffie, D. and K.J. Singleton (1993)*: "Simulated Moments Estimation of Markov Models of Asset Prices." *Econometrica*, Vol. 61, 1993, 929-952.

[2] Gouriéroux, C, A. Monfort, and E. Renault (1993): "Indirect Inference." *Journal of Applied Econometrics*, 8, S85-118.

[3] Hansen, L. (1982)*: "Large Sample Properties of Generalized Method of Moments Estimators." *Econometrica*, 50, 1029-1054.

[4] Hansen, L.P. and K.J. Singleton (1982): "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models." *Econometrica*, 50, 1269-1286.

[5] Hansen, L.P. and K.J. Singleton (1983): "Stochastic Consumption, Risk Aversion and the Temporal Behavior of Asset Returns." Journal of Political Economy, 91, 249–265.

[6] Hall, R. E. (1988): "Intertemporal Substitution in Consumption," *Journal of Political Economy*, 96, 339–357.

[7] Nagel, S. and K.J. Singleton (2011): "Estimation and Evaluation of Conditional Asset Pricing Models." *The Journal of Finance*, 66, 873–909

[8] Smith, A.A. (1993): "Estimating Nonlinear Time Series Models using Simulated Vector Autoregressions." *Journal of Applied Econometrics*, 8, S63-S84.

[9] *Handbook of Financial Econometrics*, Chapter 8.

Part 3. Continuous-time Models

7 Continuous-time models and option pricing

WE review option pricing models with and without stochastic volatility from an econometrician's perspective. Topics include the Black-Scholes formula, option pricing under stochastic volatility. We also outline the challenges associated with estimating continuous-time models with latent processes.

References

[1] Black, F., and M. Scholes (1973): "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 81, 637–654.

[2] Merton R. C. (1973): "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science*, 4, 141–183.

[3] Cox, J., and S. Ross (1976): "The Valuation of Options for Alternative Stochastic Processes," *Journal of Financial Economics* 3, 145-166.

[4] Hull, J. C., White, A. D. (1987): "The Pricing of Options on Assets with Stochastic Volatilities." *Journal of Finance*. 42, 281-300.

[5] Heston, S. L. (1993). "A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options." *Review of Financial Studies*. 6, 327-343.

[6] Campbell, et.al. (1997), Chapter 9.

[7] Taylor (2005), Chapters 13-14.

8 Estimating continuous-time models

We present and compare different approaches to estimating continuous-time models using discrete-time data. Topics include simulated MLE, the simulated method of moments, analytical approximations to the transition density, MCMC.

References

[1] Aït-Sahalia, Y. (2001). "Maximum Likelihood Estimation of Discretely Sampled Diffusions: a Closed Form Approximation Approach." *Econometrica* 70, 223-62.

[2] Aït-Sahalia, Y., (2007): "Estimating Continuous-Time Models Using Discretely Sampled Data", Advances in Economics and Econometrics, Theory and Applications, Ninth World Congress, edited by R. Blundell, P. Torsten and W. K. Newey, Econometric Society Monographs, Cambridge University Press.

[3] Elerian, O., Chib, S. and N. Shephard. (2001): "Likelihood inference for discretely observed non-linear diffusions", *Econometrica*, 69, 2001, 959–993.

[4] Hansen, L. P., Scheinkman, J. A. (1995): "Back to The future: Generating Moment Implications for Continuous-time Markov Processes". *Econometrica* 63, 767- 804.

[5] Chapter 13 in *Handbook of Financial Econometrics*.

Part 4. Volatility Dynamics

9 Volatility: nonparametric measurement using high frequency data

We discuss recent developments in measuring the volatility using high-frequency data. Topics include: realized volatility, the effect of microstructure noise on the measurement, realized kernel, jumps, and Bi-power variation.

References

[1] Andersen, T.G., Bollerslev, T., Diebold, F.X and P. Labys (2001): "The Distribution of Realized Exchange Rate Volatility," *Journal of the American Statistical Association* 96, 42-55.

[2] Barndorff-Nielsen, O. E. and N. Shephard (2002). "Econometric Analysis of Realized Volatility and its Use in Estimating Stochastic Volatility Models." *Journal of the Royal Statistical Society*, Series B, 64, 253-280.

[3] Andersen, T.G., Bollerslev, T., Diebold, F.X and P. Labys (2003): "Modeling and Forecasting Realized Volatility". *Econometrica*, 71. pp. 579 - 625.

[4] Barndorff-Nielsen, O. E., Hansen, P.R., Lunde, A. and N. Shephard (2008): "Designing Realized Kernels to Measure the ex post Variation of Equity Prices in the Presence of Noise." *Econometrica*, 76, pp. 1481-1536.

[5] Barndorff-Nielsen., O. E. and N. Shephard. (2004): "Econometric Analysis of Realized Covariation: High Frequency based Covariance, Regression and Correlation in Financial Economics." *Econometrica*, 72, 885–925.

[6] Taylor (2005), Chapter 12;

[7] Tsay (2002), Chapter 5.

[8] Chapter 2 in *Handbook of Financial Econometrics*.

10 Implied volatility and the volatility risk premium

We consider estimating the volatility process under the risk-neutral measure. Topics include model-free implied volatility, the volatility risk premium, and the information content of the volatility premium.

References

[1] Britten-Jones,M. and A. Neuberger. (2000). "Option Prices, Implied Price Processes, and Stochastic Volatility." *Journal of Finance*, 55, pp. 839 - 866.

[2] Carr, P., Wu, L.R. (2009): "Variance Risk Premiums", *Review of Financial Studies*, 22, 1311-1341.

[3] Jiang, G. J. and Y.S. Tian. (2005): "The Model-Free Implied Volatility and Its Information Content." *Review of Financial Studies*, 18, pp. 1305-1342.

[4] Bollerslev, T., G.Tauchen and H. Zhou (2009): "Expected Stock Returns and Variance Risk Premia," *Review of Financial Studies*, 22, 4463-4492.

Part 5. Topics

11 Term structure models

We consider the estimation of (affine) term structure models.

References

[1] Duffie, D., J. Pan and K. Singleton (2000): "Transform Analysis and Asset Pricing for Affine Jump-Diffusions." *Econometrica* 68, 1343-76.

[2] Wu, J.C. and F.D, Xia (2016): "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound," *Journal of Money, Credit, and Banking*, 48, 253-291.

12 State-price density (SPD) estimation

We discuss some parametric and nonparametric methods for estimating the SPD.

References

[1] Jarrow, R. and Rudd, A. (1982). Approximate Option Valuation for Arbitrary Stochastic Processes, *Journal of Financial Economics*, 10:347-369.

[2] Longstaff, F. A. (1995). Option Pricing and the Martingale Restriction, *Review of Financial Studies*, 8, 1091-1124.

[3] Shimko, D. (1993). Bounds of probability. *Risk*, 6(4), 33–37.

[4] Rubinstein, M. (1994) Implied binomial trees, *Journal of Finance*, 49, 771-818.

[5] Jackwerth, J. C. and M. Rubinstein (1996). Recovering Probability Distributions from Option Prices, *Journal of Finance* 51, 1611-1631.

[6] Ait-Sahalia, Y. and A. Lo (1998): "Nonparametric Estimation of State-Price Densities Implicit in Financial Asset Processes", *Journal of Finance*, vol LIII, 499-547.

[7] Ait-Sahalia, Y. and J. Duarte (2003): "Nonparametric Option Pricing under Shape Restrictions," *Journal of Econometrics,* 116, 9 – 47.

[8] Chapter 9 in the *Handbook of Financial Econometrics.*

13 Systemic risk measures and network models

References

[1] Adrian, T. and M. K. Brunnermeier* (2016): "CoVaR." *American Economic Review*, 106, 1705-41.

[2] Baruník, J. and T. Křehlík (2018): "Measuring the Frequency Dynamics of Financial Connectedness and Systemic Risk. " *Journal of Financial Econometrics*, 16, 271–296.

[3] Bisias, D., M. Flood, A.W. Lo, and S. Valavanis (2012): "A Survey of Systemic Risk Analytics." *Annual Review of Financial Economics,* 4, 255-296.

[4] Brownlees C.T and R.F. Engle (2017): "SRISK: a Conditional Capital Shortfall Index for Systemic Risk Measurement." *Review of Financial Studies*, 30, 48–79.

[5] 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.

[6] Engle, R. (2018): "Systemic Risk 10 Years Later. " *Annual Review of Financial Economics*, 10, 125-152.

[7] Giglio, G., B. Kelly, and S. Pruitt (2016): "Systemic Risk and the Macroeconomy: An Empirical Evaluation." *Journal of Financial Economics*, 119, 457-471.

[8] Hansen., L.P. (2014). "Challenges in Identifying and Measuring Systemic Risk." in *Risk Topography: Systemic Risk and Macro Modeling,* edited by M. Brunnermeier and A. Krishnamurthy. University of Chicago Press.

14 Structural change

We discuss methods for testing and estimating multiple structural changes in linear models, as well as forecasting models allowing for regime changes.

References

[1] Bai, J. and P. Perron (1998): "Estimating and Testing Linear Models with Multiple Structural Changes." *Econometrica*, 66, 47-78.

[2] Pesaran, M.H., D. Pettenuzzo, and A. Timmermann (2006): "Forecasting Time Series Subject to Multiple Structural Breaks," *The Review of Economic Studies*, 73, 1057–1084.

15 Model uncertainty

References

[1] Pastor, L. and R.F. Stambaugh (2012): "Are Stocks Really Less Volatile in the Long Run?" *Journal of Finance*, 67, 431–478.

[2] Draper, D. (1995). "Assessment and Propagation of Model Uncertainty." *Journal of the Royal Statistical Society*. Series B, Vol. 57, No. 1, pp. 45-97.

[3] Buraschi, A. and A. Jiltsov (2006). "Model Uncertainty and Option Markets with Heterogeneous Beliefs." *Journal of Finance*. 61, pp. 2841 - 2897.

[4] Drechsler., I. (2013). "Uncertainty, Time-Varying Fear, and Asset Prices." *Journal of Finance*, 68, 1843-1889.

[5] Johannes, M., L.A. Lochstoer, and Y. Mou (2016): "Learning about Consumption Dynamics." *The Journal of Finance*, 71, 551-600.