Economics 613: Seminar in Applied Econometrics
(Continuous-Time Models)

Spring 2017

Contact Details

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Class Time and Location

Lecture: Wednesday 13:10 - 16:10, NJ Hall 105.

Course Overview

The main purpose is to introduce students to the recent development of continuous-time modeling techniques in economics (macroeconomics and contract theory), finance (asset pricing and theoretical corporate finance), and econometrics (high frequency analysis). Students will learn how to employ the mathematical tools of stochastic optimization and stochastic control to solve various economic problems, and get to know the frontiers in high frequency econometrics.

Evaluation: homework and term project.

Course Outline

Part I. Mathematical Preliminaries

- Deterministic optimization/control revisited
  - Pontryagin's maximum principle (MP): Hamiltonian systems (first-order)
  - Bellman's dynamic programming (DP): HJB equations (first-order)
  - Mathematical relationship and economic interpretation (shadow price)
- Stochastic process and stochastic calculus
  - Brownian motion and Itô process
  - Quadratic (co-)variation and Itô formula
- Stochastic optimization/control
  - Pontryagin's maximum principle (MP): Hamiltonian systems (first-order and second-order)
  - Bellman's dynamic programming (DP): HJB equations (first-order and second-order)
  - Mathematical relationship and economic interpretation (shadow price and relative risk aversion)

Reference:

Yong, Jiongming and Xunyu Zhou (1999), *Stochastic Controls: Hamiltonian Systems and HJB Equations*, Springer.

Part II. Continuous-Time Macroeconomics

- Neoclassical growth model in continuous-time
- New Keynesian model in continuous-time
- Heterogenous agenet model in continuous-time

References:

Achdou, Yves, Jiequn Han, Jean-Michel Lasry, Pierre-Louis Lions and Benjamin Moll (2015), Heterogeneous Agent Models in Continuous Time. Working paper.

Brunnermeier, Markus K. and Yuliy Sannikov (2016), Macro, Money and Finance: A Continuous-Time Approach. Working paper.

Brunnermeier, Markus K. and Yuliy Sannikov (2014), A Macroeconomic Model with a Financial Sector. *American Economic Review*, 104(2), 379-421.

Merton (1975), An Asymptotic Theory of Growth Under Uncertainty, *Review of Economic Studies*, 42(3), 375-393.

Gabaix, Xavier, Jean-Michel Lasry, Pierre-Louis Lions and Benjamin Moll (2016), The Dynamics of Inequality, *Econometrica*, Vol. 84(6), 2071-2111.

Part III. Contract-theory in Continuous-Time

- First best (risk-sharing)
- Second best (moral hazard)
- Third best (adverse selection)
- Dynamic corporate financing

References:

Cvitanic, Jakša and Jianfeng Zhang (2013), *Contract Theory in Continuous-Time Models*, Springer.

DeMarzo, Peter and Yuliy Sannikov (2006), Optimal Security Design and Dynamic Capital Structure in a Continuous-Time Agency Model, *The Journal of Finance*, 61(6), 2681-2724.

Sannikov, Yuliy (2008), A Continuous-Time Version of the Principal-Agent Problem, *Review of Economic Studies*, 75(3), 957-984.

Part IV. Option pricing

- Equivalent martingale measure
- Risk premium

References:

Shreve, Steven (2004), *Stochastic Calculus for Finance II*, Springer.

Bollerslev, Tim and Viktor Todorov, Tails, Fears and Risk Premia, *The Journal of Finance*, 66, 2165-2211.

Andersen, Torben G., Nicola Fusari and Viktor Todorov (2015), The Risk Premia Embedded in Index Options, *Journal of Financial Economics*, 117, 558-584.

Andersen, Torben G., Nicola Fusari and Viktor Todorov (2016), The Pricing of Short-Term Market Risk: Evidence from Weekly Options, *accepted for publication in The Journal of Finance*.

Part V. Continuous-Time Econometrics

- Volatility and jumps
  - Integrated volatility and spot volatility
  - Jumps and co-jumps
  - Jump excitation
- Continuous-time regression
- Factor model in continuous-time

References:

Jacod, Jean and Phillip Protter, (2011), *Discretization of Processes*, Springer.

Aït-Sahalia, Yacine and Jean Jacod (2014), *High Frequency Financial Econometrics*, Princeton University Press.

Jacod, Jean (2009), Statistics and High Frequency Data, Lecture notes.

Aït-Sahalia, Yacine and Jean Jacod (2009), Testing for Jumps in a Discretely Observed Process, *Annals of Statistics*, 37, 184-222.

Aït-Sahalia, Yacine and Jean Jacod (2010), Is Brownian Motion Necessary to Model High Frequency Data?, *Annals of Statistics*, 38, 3093-3128.

Aït-Sahalia, Yacine and Jean Jacod (2010), Testing Whether Jumps Have Finite or Infinite Activity, *Annals of Statistics*, 39, 1689-1719.

Aït-Sahalia, Yacine and Jean Jacod (2010), Analyzing the Spectrum of Asset Returns: Jump and Volatility Components in High Frequency Data, *Journal of Economic Literature*, 50, 1007-1050.

Jacod, Jean and Todorov, Viktor (2009). Testing for common arrivals of jumps for discretely observed multidimensional process. The Annals of Statistics, 37, 1792-1838.

Jacod, Jean and Todorov, Viktor (2010). Do price and volatility jump together? Annals of Applied Probability, 20(4), 1425-1469.

Li, Jia, Viktor Todorov and George Tauchen (2016), Jump Regressions, *accepted for publication in Econometrica*.

Li, Jia, Viktor Todorov and George Tauchen (2016), Adaptive Estimation of Continuous-time Regression Models using High-Frequency Data, Working paper.

Aït-Sahalia, Yacine and Dacheng Xiu (2016), Principal Component Analysis of High Frequency Data, Working paper.