UNIVERSITY OF PENNSYLVANIA
The Wharton School

FNCE 922:
CONTINUOUS-TIME FINANCIAL ECONOMICS

Prof. Domenico Cuoco Spring 2018

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Course Description:

This course is an introduction to the theory of continuous-time financial economics, offering a review not only of the core results relating to dynamic asset pricing and consumption/portfolio choice in continuous time, but also of the main mathematical and statistical tools on which the theory is built. Upon completion of the course, students should have sufficient familiarity with these tools to be able to formulate and analyze continuous-time financial models.

The articles listed in the course outline include many of the classical papers in the field. You are strongly encouraged to read as many of them as possible.

Prerequisites:

The prerequisite for this course is FNCE 911 (or familiarity with C.-f. Huang and R. Litzenberger, *Foundations for Financial Economics*, North-Holland, 1988). Some graduate-level knowledge of analysis and statistics is helpful but not required.

Text and References:

The required textbook is:

D. Duffie, *Dynamic Asset Pricing Theory*, Princeton University Press, 2001.

The following books are also recommended:

K. Back, *Asset Pricing and Portfolio Choice Theory*, Oxford University Press, 2010.

I. Karatzas and S.E. Shreve, *Methods of Mathematical Finance*, Springer, 2010.

The recommended mathematical references are:

H.L. Royden, *Real Analysis*, Macmillan, 1988.

N. Dunford and J.T. Schwartz, *Linear Operators. Part I: General Theory*, Wiley, 1988.

The recommended statistical references are:

J.M. Steele, *Stochastic Calculus and Financial Applications*, Springer, 2010.

I. Karatzas and S.E. Shreve, *Brownian Motion and Stochastic Calculus*, Springer, 1991.

P. Protter, *Stochastic Integration and Differential Equations*, Springer, 2010.

Course Outline and Suggested Readings:

1. Background Material from Mathematics and Statistics

Lecture notes.

2. Arbitrage and Martingales

Lecture notes.

Textbook, Chapter 6.

J.M. Harrison and D. Kreps (1979), "Martingales and Arbitrage in Multiperiod Securities Markets", *Journal of Economic Theory* **20**, 381–408.

∗ S. Clark (1993), "The Valuation Problem in Arbitrage Price Theory", *Journal of Mathematical Economics* **22**, 463–478.

∗ K. Back and S. Pliska (1991), "On the Fundamental Theorem of Asset Pricing with an Infinite State Space", *Journal of Mathematical Economics* **20**, 1–18.

P.H. Dybvig and C.-f. Huang (1988), "Nonnegative Wealth, Absence of Arbitrage, and Feasible Consumption Plans", *Review of Financial Studies* **1**, 377–401.

3. Complete Markets: Hedging and Pricing Contingent Claims

Lecture notes.

Textbook, Chapters 5 and 8.

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

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

∗ I. Karatzas (1988), "On the Pricing of American Options", *Applied Mathematics and Optimization* **17**, 37–60.

∗ D. Duffie and R. Stanton (1992), "Pricing Continuously Resettled Contingent Claims", *Journal of Economic Dynamics and Control* **16**, 561–573.

∗An asterisk denotes material that can be skipped on a first reading.

4. Complete Markets: Optimal Consumption and Portfolio Choice

Textbook, Chapter 9.

R. Merton (1971), "Optimum Consumption and Portfolio Rules in a Continuous Time Model", *Journal of Economic Theory* **3**, 373–413.

J. Cox and C.-f. Huang (1989), "Optimal Consumption and Portfolio Choices when Asset Prices Follow a Diffusion Process", *Journal of Economic Theory* **49**, 33–83.

∗ J. Cox and C.-f. Huang (1991), "A Variational Problem Arising in Financial Economics", *Journal of Mathematical Economics* **20**, 465–487.

∗ I. Karatzas, J.P. Lehoczky and S.E. Shreve (1987), "Optimal Portfolio and Consumption Decisions for a 'Small Investor' on a Finite Horizon", *SIAM Journal on Control and Optimization* **25**, 1557–1586.

5. Incomplete Markets

H. He and N.D. Pearson (1991), "Consumption and Portfolio Choices with Incomplete Markets and Short-Sale Constraints: The Infinite-Dimensional Case", *Journal of Economic Theory* **54** 259–305.

∗ I. Karatzas, J.P. Lehoczky, S.E. Shreve and G.-L. Xu (1991), "Martingale and Duality Methods for Utility Maximization in an Incomplete Market", *SIAM Journal on Control and Optimization* **29**, 702–730.

6. Portfolio Constraints

J. Cvitanić and I. Karatzas (1992), "Convex Duality in Constrained Portfolio Optimization", *Annals of Applied Probability* **2**, 767-818.

∗ H. He and H. Pagés (1993), "Labor Income, Borrowing Constraints, and Equilibrium Asset Prices", *Economic Theory* **3**, 663–696.

D. Cuoco (1997), "Optimal Consumption and Equilibrium Prices with Portfolio Constraints and Stochastic Income", *Journal of Economic Theory* **72**, 33–73.

∗ J. Cvitanić and I. Karatzas (1993), "Hedging Contingent Claims with Constrained Portfolios", *Annals of Applied Probability* **3**, 652–681.

M. Broadie, J. Cvitanić and H.M. Soner (1998), "Optimal Replication of Contingent Claims under Portfolio Constraints", *Review of Financial Studies* **11**, 59–79.

∗ I. Bardhan (1995), "Synthetic Replication of American Contingent Claims when Portfolios are Constrained", *Stochastic Processes and their Applications* **57**, 149–165.

7. Dynamic Equilibrium with Complete Markets

Textbook, Chapter 10, Sections A–H and J.

∗ R. Merton (1973), "An Intertemporal Capital Asset Pricing Model, *Econometrica* **41**, 867–888.

* D. Breeden (1979), "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities", *Journal of Financial Economics* **7**, 265–296.

I. Karatzas, J.P. Lehoczky and S.E. Shreve (1990), "Existence and Uniqueness of Multi-Agent Equilibrium in a Stochastic, Dynamic Consumption/Investment Model", *Mathematics of Operations Research* **15**, 80–128.

8. Dynamic Equilibrium with Portfolio Constraints

S. Basak and D. Cuoco (1998), "An Equilibrium Model with Restricted Stock Market Participation", *Review of Financial Studies* **11**, 309–341.

* J. Detemple and A. Serrat (2003), "Dynamic Equilibrium with Liquidity Constraints", *Review of Financial Studies* **16**, 597–629.

9. Models of the Term Structure

Textbook, Chapter 7 and Chapter 10, Section I.

J. Cox, J. Ingersoll and S. Ross (1985), "An Intertemporal General Equilibrium Model of Asset Prices", *Econometrica* **53**, 363–384.

J. Cox, J. Ingersoll, and S. Ross (1985), "A Theory of the Term Structure of Interest Rates", *Econometrica* **53**, 385–408.

D. Heath, R. Jarrow and A. Morton (1992), "Bond Pricing and the Term Structure of Interest Rates: A New Methodology for Contingent Claims Valuation", *Econometrica* **60**, 77–105.

10. Alternative Preferences

* D. Duffie and L.G. Epstein (1992), "Stochastic Differential Utility", *Econometrica* **60**, 353–394.

D. Duffie and L.G. Epstein (1992), "Asset Pricing with Stochastic Differential Utility", *Review of Financial Studies* **5**, 411–436.

* L.G. Epstein and M. Schneider (2003), "Recursive Multiple Priors", *Journal of Economic Theory* **113**, 1–31.

L.G. Epstein and M. Schneider (2008), "Ambiguity, Information Quality, and Asset Pricing", *Journal of Finance* **63**, 197–228.