Continuous Time Finance
Swedish House of Finance – Stockholm School of Economics
Summer 2021

teacher: Johan Waldén

Schedule:

Mon, July 26,	10-12
Tue, July 27,	10-12, 14-16
Wed, July 28,	10-12, 14-16
Thu, July 29,	10-12, 14-16
Mon, Aug 2,	10-12, 14-16
Tue, Aug 3,	10-12, 14-16
Wed, Aug 4,	10-12, 14-16
Thu, Aug 5,	10-12

overview: The development of derivatives markets may be the single most important innovation in financial markets in the last fifty years. The celebrated Merton, Black & Scholes option pricing formula derived in the 70's has arguably been the most successful research paper in social sciences. The formula has been widely adopted by market participants, and has initiated a new field, Financial Engineering, which occupies researchers in financial institutions and universities throughout the world.

The focus of the course is on applied stochastic calculus applied to problems within finance. We will cover the theory of noarbitrage, Brownian motion, Ito integrals and calculus (Ito's lemma), change of measure (Girsanov's theorem), and links to partial differential equations (Feynman Kac's theorem, Kolmogorov equations). We apply the theory to derive many continuous time asset pricing formulas, including the celebrated Black-Scholes formulas for pricing plain-vanilla options.

required text: Tomas Björk, "Arbitrage Theory in Continuous Time", 4th edition, 2020.

optional texts: Steven Shreve, "Stochastic Calculus for Finance I: The Binomial Asset Pricing Model"

Steven Shreve, "Stochastic Calculus for Finance II: Continuous-Time Models".

Karatzas & Shreve, "Methods of Mathematical Finance".

Darrell Duffie, "Dynamic Asset Pricing Theory", 3rd edition.

attendance: Please attend all classes and do not arrive late.

grades: This is a Pass or Fail course. Grades will be based on:

Class participation	20.0 %
Assignment:	40.0 %
Final exam:	40.0 %
Total	100.0 %

final exam: There will be an open book take-home final exam, that students should solve individually. The date for the exam is yet to be determined, but it will be sometime between August 10-20.

assignment: There will be one, quite extensive, assignment that students may solve individually or in groups of two (no more!). The assignment is due on Wednesday, August 11.

ethics and etiquette:

Students are allowed to consult all the material provided in the course (slides, lecture notes, course books, etc.), but are not allowed to use any external material that resembles a "solution" to an assignment. If there is any doubt, please contact the professor. Students are also allowed to discuss course material, including assignments, with each other. However, any help must stop far short of hinting (or providing) the solution to an assignment, in form of explicit calculations, etc. **The material in the course (slides, lecture notes, assignments, solutions, etc.) is proprietary. Posting of material on the internet is strictly prohibited and will lead to legal action.**

Course Outline:

All chapters refer to Björk's textbook. This outline is tentative. Depending on the time constraints, we may not have time to cover everything on the list.

Discrete Model — Chapters 2-3

- One-period: noarbitrage, fundamental theorem of asset pricing, price systems, martingale pricing
- Binomial model
- Multi-period: dynamic portfolios, replicating portfolios, multi-period noarbitrage theory

Continuous time modeling — Chapters 4-7

- Stochastic integrals
- Relationship to differential equations
- Dynamic portfolios
- Arbitrage Pricing

The Black-Scholes model — Chapters 8-10

- Completeness, pricing, parity, the greeks

Martingale pricing — Chapters 11-13

- Stochastic Discount Factors
  discount factors, Girsanov's theorem

Multidimensional Models — Chapter 14

- Pricing, risk-neutral valuation, state space reduction, martingale approach

More derivatives — Chapter 16

- Derivatives on dividend paying stocks, barrier options, barrier options

Term structure models — Chapters 19-21

- Basic definitions and relations, short rate models, general martingale models

Change of numeraire — Chapter 15

- Application to options and interest rate models