

5. FINANCIAL ENGINEERING

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Course description:

The objective of this course is to provide the participants with the necessary skills to value and hedge a wide variety of derivatives contracts; and to enable them to profitably design and structure such contracts. The course presents a systematic, unified approach to the pricing of derivatives and adopts cutting-edge methods throughout. Continuous-time mathematics is developed and employed as the main tool of analysis. In developing the theory, the course will cover stochastic calculus, the valuation of securities via martingale methods and valuation via partial differential equations, as well as the necessary numerical methods.

Course text:

Hull, John, "Options Futures and Other Derivative Securities", 6th Edition, Prentice-Hall, 2006.

Course assignments and assessments:

The course grade will be based on:

- Two assignments dealing with the valuation of derivatives and associated strategies (30% of grade)
- A final exam (70% of grade)
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Detailed Outline

Week 1

INTRODUCTION TO DERIVATIVES MARKETS

Definitions and historical development

Characteristics of forwards, futures and options

Payoff diagrams

Types of traders

Readings (☼ = optional):

Hull, Chapter 1

☼ Miller "Financial Innovations: The past twenty years and the next", *Financial Innovations and Market Volatility*, Blackwell 1991.

Week 2

FUTURES BASICS (MARKETS AND HEDGING ISSUES)

The operation of futures markets

Hedging with futures

Hedge ratio

Rolling hedges

19/3/2012

Readings:

Hull, Chapters 2, 3

☀Mello, A., "Maturity structure of a hedge matters: lessons from Metallgesellschaft debacle", Bank of America, *Journal of Applied Corporate Finance*.

Week 3

FORWARD AND FUTURES PRICES

Stock index futures

Forwards and futures on currencies

Futures on commodities

Cost of carry

Delivery options

Readings:

Hull, Chapter 5, Appendices 3A, 3B

☀French, K., "A Comparison of Futures and Forward Prices", *Journal of Financial Economists*, November 1983, 311-42

Week 4

INTEREST RATE FUTURES

Preliminaries on interest rate futures

Treasury bond, treasury note and treasury bill futures

Duration and duration based hedging

Readings:

Hull, Chapter 6

☀Veit, W., and W. Reiff, "Commercial banks and interest rate futures: a hedging survey", *Journal of Futures Markets* 3, (1983), 283-293.

☀Carleton, W., and I. Cooper, "Estimation and uses of the term structure of interest rates", *The Journal of Finance*, Vol. XXXI, No 4, September 1976, 1067-1083.

Week 5

SWAPS

Interest rate swaps

Currency and other swaps

Valuation

Credit risk

Examples

Readings:

Hull, Chapter 7

☼ Falloon, W., "Swaps on the side", *Risk*, Vol. 9, No 1, January 1996.

☼ Smith, C., C. Smithson, and L. Wakeman, "The Evolving Market for Swaps", *Midland Corporate Finance Journal* 3, Winter 1986, 20-32.

☼ Hull, J., "Assessing Credit Risk in a Financial Institution's Off-balance Sheet Commitments", December 1989, 489-502.

Week 6

OPTION BASICS (MARKETS, PRICES, TRADING STRATEGIES)

Description of options and markets

Properties of option prices, limits

Basic trading strategies involving options

Readings:

Hull, Chapters 8, 9, 10

☼ "Understanding stock options", *The Options Clearing Corporation*, 1994.

☼ "Fact and Fantasy in the use of options", Black, F., *Financial Analysts Journal*, July-August 1975.

Week 7

BLACK-SCHOLES OPTION PRICING

Asset price random walks

Markov and Wiener processes, geometric Brownian motion

Ito's lemma

Derivation of the Black-Scholes differential equation

The Black-Scholes model

Risk neutral valuation

Readings:

Hull, Chapters 12, 13, ☼ Appendices 12A, 13A, 13B, 13C

☼ Black, F., Scholes, M., "The pricing of Options and corporate liabilities", *Journal of Political Economy*, Vol. 81, May-June 1973, 637-653.

☼ Nisbet, M., "Put-call parity theory and an empirical test of the efficiency of the London Traded Options Market", *Journal of Banking and Finance*, 16, 381-403, 1992.

☼ Smithson, C., "Wonderful life", *Risk*, Vol. 4, No 9, October 1991.

Week 8

OPTIONS ON INDICES, CURRENCIES, FUTURES CONTRACTS

Options on stock indices, currencies, futures contracts

Exchange traded bond options

Interest rate caps

Readings:

Hull, Chapters 14, (emphasise contract descriptions; skim evaluation)

☀Rindell, K., and Sandas, P., "An empirical examination of the pricing of European bond options", *Journal of Banking and Finance*, 15, 521-533, 1991.

☀Leong, K., "Model choice", *Risk*, Vol. 5, No 11, December 1992.

Week 9

DERIVATIVES AND ASSET MANAGEMENT (THE GREEK LETTERS)

Naked and covered positions

Stop-loss and delta hedging strategies

The Greeks: theta, gamma, rho

Portfolio insurance

Readings:

Hull, Chapter 15, ☀Appendix 15A

☀Genotte, G., and Leland, H., "Market Liquidity, Hedging, and Crashes", *American Economic Review*, December 1990.

☀Culp, C., and M. Miller, "Metallgesellschaft and the economics of synthetic storage", *Bank of America, Journal of Applied Corporate Finance*.

Week 10

MODELING AND FORECASTING VOLATILITY

Volatility changes, ARCH models

Stochastic volatility models, High frequency empirical evidence

Implied volatility

Option valuation when volatility is stochastic

Readings:

Hull, Chapters 19

☀Mayhew, S. "Implied volatility", *Financial Analysts Journal*, July-August 1995.

☀Engle, R., and Mezrich, J., "Grappling with Garch", *Risk*, Vol. 8, No 9, September

1995.

☀Nandi, S., "How important is the correlation between returns and volatility in a stochastic volatility model? Empirical evidence from pricing and hedging in the S&P 500 index options market", *Journal of Banking and Finance*, 22, 589-610, 1998.

Week 11

NUMERICAL PROCEDURES

The Binomial asset pricing model

Monte Carlo simulation

Variance reduction

Finite difference methods

Readings:

Hull, Chapters 11, 17

☀Hull, J., and White, A., "Valuing derivative securities using the explicit finite difference method", *Journal of Financial and Quantitative Analysis*, Vol. 25, No 1, March 1990.

Week 12

VOLATILITY SMILES AND ALTERNATIVES TO BLACK-SCHOLES

The volatility term structure

Volatility matrices

Alternative models for stock pricing

Pricing models involving jumps

Readings:

Hull, Chapter 16, 24

☀Bates, B., "The Crash of '87: was it expected? The evidence from options markets", *Journal of Finance*, Vol. XLVI, No 3, July 1991.

☀Bakshi, G., Cao, C., and Chen Z., "Empirical Performance of alternative option pricing models", *The Journal of Finance*, Vol. LII, No 5, December 1997.

Week 13

EXAM