

NEW YORK UNIVERSITY

Leonard N. Stern School of Business

B40.3340
Advanced Futures and Options

Professor Marti G. Subrahmanyam
Fall 2009

Course Description:

This course consists of three parts. The first section of the course is a detailed examination of the pricing and hedging of option contracts, with particular emphasis on the application of these concepts to the design of derivatives instruments and trading strategies. The first part of this section is a review and re-examination of materials covered in the basic course, but with greater rigor and depth of coverage. The emphasis in the second part of this first section is on trading applications and risk management. The second section of the course is designed to provide a broad exposure to the subject of interest rate derivative products, both swaps and options. The last section of the course deals with recent innovations in the derivatives markets such as exotic options, credit derivatives and catastrophe derivatives.

In the first section of the course, the discussion of trading strategies is in the context of the management of the risk of a derivatives book. Although the principles developed in this course are relevant to the pricing and hedging of any derivative asset, their applications to the specific cases of options on stocks, stock indices, foreign exchange, futures contracts and interest rate instruments are analyzed.

The topics covered in the second part of the course include the relationship of swaps to other fixed income contracts such as futures contracts and forward rate agreements, valuation and hedging of swaps, building the yield curve, and valuation and hedging of interest rate options, with particular reference to caps, floors and swaptions, and modeling the term structure of interest rates. The application of these concepts to foreign exchange and commodity derivatives is also discussed in this section.

The third section of the course deals with non-standard option contracts such as exotic options and options on new underlying instruments such as credit, weather and insurance derivatives. Although the discussion of exotic options is fairly broad, some exotic instruments such as barrier options, Asian options and hybrid (correlation) products will be analyzed in more detail. Credit derivatives, with particular reference to credit default swaps and collateralized debt obligations will be the focus of attention in the second part of this section.

The pedagogy is a combination of lectures/discussions and PC-based problem solutions. The

course is intensive and requires a fair amount (~ 6-8 hours) of homework each week, in addition to preparation for class. The orientation of the course is the *practical* application of option concepts, rather than a discussion of option theory by itself. However, since option concepts are somewhat mathematical, a strong quantitative background, though not required, would be an advantage.

Required/Recommended Textbooks/Software:

Recommended: J.C. Hull, *Options, Futures and other Derivative Securities*, 7th edition, Prentice-Hall, 2009. (H)

Optional: S. Figlewski, W.L. Silber and M.G. Subrahmanyam (eds.), *Financial Options: From Theory to Practice*, 2nd edition, Business One-Irwin, 1992. (FSS)

S. Das and R. Sundaram, *Derivatives Markets*, manuscript, 2009.

FinancialCAD XL v 10.1 Software, Glassco-Park Inc., 2009.

The book by Hull is probably the most comprehensive derivatives textbook available today. We will use it as background, but will not follow it closely. The forthcoming book by Das and Sundaram is more intuitive. Since the book has not yet been published, I will distribute selected chapters of the manuscript.

Other Materials:

- Copies of overhead transparencies. [Available in the bookstore and in the reserve section of Bobst library .]
- Problem sets and computer exercises. [To be handed out in class. Also, available on the course website]
- Option pricing/hedging software. [Available on the course website on Blackboard.]

Instructions:

Students in the course are expected to study the readings and problem sets prior to the assigned dates and come prepared to discuss them in class. The following outline represents the topics, readings, assignments and dates for discussion. The reference dates noted are *rough* estimates for the time allotted to each subject area. Any modifications of the schedule will be announced in class.

There are several problem sets – roughly one per week throughout the course - to be worked out in groups. In many instances, students are required to use PC-based software for the solution of the problem sets. Students should work on the problem sets in groups of three. *No exceptions to this rule will be permitted without the permission of the instructor.* Solutions to the problem sets should be worked out, *printed* and handed in prior to class on the dates they are due. Hand calculators will be necessary for problem sets and examinations. *Students are urged to bring calculators to all sessions.* The lectures and reading materials assigned will, in many instances, provide an appropriate format for analysis and solution of the problem sets.

There will be two *take-home* quizzes and a final examination in the course. Grading for the course will be based approximately on the following weights:

| | |
|------------------------------|-------|
| Problem Sets and Assignments | 20% |
| Class Participation | 20% |
| Quizzes | 20% |
| Final Examination | 40% |
| | ----- |
| | 100% |

The overall grade distribution in the course will be approximately as follows:

| | |
|-----|----------------|
| A | 10-15% |
| A- | 10-15% |
| B+ | 15-25% |
| B | 15-25% |
| B | 15-25% |
| C+ | 10-15% |
| ≤ C | 0% (hopefully) |

All class sessions will be videotaped and webcast. However, viewing these recordings is meant to be a supplement and not a substitute for attending class sessions. Based on past experience, much of the learning in the course is from participating in the class discussions.

Classroom Etiquette and Related Matters:

Students registered in the course are expected to attend all sessions and be in class by 9 am. They should sit in the same place each class, as per the seating chart circulated in the first session. Students who come in late should enter from the side door of the classroom and take their places on the last row, as quietly as possible. Since class participation is assessed and forms part of the grade in the course, regular class attendance is required. In line with school policy, the use of laptop computers, cellular phones and mobile communication devices, and other electronic equipment is not

allowed during class sessions.

In order to use the class sessions more efficiently, quizzes are scheduled to be taken at home. It is to be understood that students take quizzes *without any external help from others*. Any breach of this rule will be taken seriously. Students should adhere to the MBA Honor Code and every student is obligated to report to the instructor any suspected violation of the code that he or she has observed. Further instructions are available at http://w4.stern.nyu.edu/scorp/committee.cfm?doc_id=4797.

Students with disabilities are advised to meet the instructor to make arrangements for appropriate help after consulting the Moses Center for Students with Disabilities (CSD, 998-4980).

Course Prerequisite:

Pricing of Options, Futures and Other Contingent Claims (B40.3335)

Students who have not taken the prerequisite are *required* to take the permission of the instructor before taking the course.

Office Hours:

Tuesdays, 10.30 a.m. – 12 p.m.,
Thursdays, 10.30 a.m. – 12 p.m.,
and by appointment. (Please call Ms. Hakema Zamdin at 998-0301 for an appointment.)

In addition, there will also be office hours in an internet chat-room, approximately every other week. Details will be announced in the second week of class.

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|---------|----------------|-------------|--|
| Office: | Room 9-68, KMC | Tel: X80348 | e-mail: msubrahm@stern.nyu.edu |
| Tutor: | Oliver Randall | Tel: X80329 | e-mail: orandall@stern.nyu.edu |

COURSE OUTLINE

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|---|--------------------------|
| 09/08 | I | Introduction and Review | |
| | | * Definition of the Contracts | H, Ch. 1 (review) |
| | | * Payoff Diagrams | |
| | | * Basic Option Trading Strategies | H, Ch. 10 (review) |
| | | * Reverse Engineering of Option Payoffs | |
| 09/10 | II | Introduction and Review (Contd.) | |
| | | * No-arbitrage Restrictions | H, Ch. 9 (to p. 208) |
| | | * Early Exercise of American Options | H, Ch. 9 (pp. 212-216) |
| 09/15 | III | Introduction and Review (Contd.) | |
| | | * Put-Call Parity | H, Ch. 9 (pp. 208-211) |
| | | The Binomial Model | |
| | | * Single-stage Model | H, Ch. 11 (to p. 243) |
| | | * Riskless Hedge | |
| | | * Replication | |

Problem Sets

1 and # 2

**Payoff Diagrams, Reverse Engineering and No-Arbitrage
Restrictions**

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|-----------------------------|--------------------------|
| 09/17 | IV | The Binomial Model (Contd.) | |
| | | * Risk-Neutral Probability | H, Ch. 11 (p. 243-248) |
| | | * Multiple Stages | R. Sundaram |
| | | * American Options | |
| | | * Dynamic Hedging | |

Problem Set

3

Put-Call Parity

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|-------|----|--|------------------------|
| 09/22 | V | The Binomial Model (Contd.) | |
| | | * The Limiting Case | H, Ch. 11 (p. 248-256) |
| | | * Construction of Binomial Lattices | H, Ch. 19 (to p. 426) |
| 09/24 | VI | The Black-Scholes-Merton Model | |
| | | * Intuitive Interpretation of Volatility | H, Ch.13 |
| | | * Simple Proof of the Model | |

Problem Set

4

Binomial Model

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|--|-------------------------------------|
| 09/29 | VII | The Black-Scholes-Merton Model (Contd.) | |
| | | * Alternative Proofs (Intuition) | H, Ch.13 |
| | | * Computational Issues | |
| | | * Extensions: Futures (Black) | H, Ch.16 |
| | | * Stock Indices, Dividends, Foreign Exchange | H, Ch.15 |
| 10/01 | VIII | The Black-Scholes Model (Contd.) | |
| | | * Alternative Assumptions | |
| | | * Hedge Ratio | H, Ch.17 (pp. 357-366) |
| | | * Implied Volatility | M. Brenner/ M. Subrahmanyam (1) |
| | | * Measurement of Volatility | H, Ch. 21 (skim) |
| | | * Empirical patterns of volatility: smile, mean-reversion | |
| 10/06 | IX | Valuation and Hedging of American Options | |
| | | * The Early Exercise Decision | H, Ch.11 (after p. 246) |
| | | * Binomial Method | |
| | | * Trinomial Method | H, Ch. 19 (pp. 424-426) |
| | | * Monte Carlo Method | |
| | | * Finite Difference Method | |
| | | * Geske-Johnson Approximation | R.Stapleton/ M. Subrahmanyam (1) |

| Date | Sess. No. | Subject | Chapter or Source |
|---|-------------------------------|---|------------------------------|
| 10/08 | X | Review Session | |
| 10/09 | Take-Home Quiz # 1 | | |
| 10/13 | XI | Sensitivity Analysis I (Option Values) | |
| | | * Option Delta | H, Ch.17 (to p. 369) |
| | | * Option Theta, Vega (Kappa) | |
| 10/15 | XII | Sensitivity Analysis II (Option Hedge Ratios) | |
| | | * Option Gamma | H, Ch.15 (after p. 369) |
| | | * Option Omega | Brenner/ Subrahmanyam (2) |
| Problem Set # 5 Sensitivity Analysis: Option Values and Hedge Ratios | | | |

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|---|--|
| 10/20 | XIII | Option Position Analysis | |
| | | * Position Delta | |
| | | * Position Gamma | |
| | | * Position Theta | |
| | | * Position Vega | |
| | | Value at Risk | H, Ch. 20 |
| | | * Basic Concepts | |
| | | * Measurement Issues | |
| | | * BIS Requirements | |
| 10/22 | XIV | Futures and Forward Contracts | H, Ch. 2 (review) H, Ch. 3 (skim) |
| | | * Definitions and Basics of Pricing | |
| | | * Over-the-Counter and Exchange-Traded Products | |
| | | * Forward Rate Agreements | Acharya et al. |
| 10/27 | XV | Basics of Interest Rate Swaps and FRA's | H, Ch. 7 (to p. 163) R. Stapleton/ M. Subrahmanyam (2) |
| | | * Relationship between FRA's and Swaps | |
| | | * Relationship between Swaps and Bonds | |
| | | * Spot - Forward Parity, Pricing of FRA's | |
| | | * Convexity Differences between FRA's and Futures | |
| | | * Adjusting for Convexity | H, Ch. 29 (to p. 673) |

| Date | Sess. No. | Subject | Chapter or Source |
|------|-----------|---------|-------------------|
|------|-----------|---------|-------------------|

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| <p>Problem Set</p> <p># 6</p> <p>Position Analysis</p> |
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10/29 XVI

Pricing, Valuation and Hedging of Swaps

* Valuation of Interest Rate Swaps: Principal and Forward Methods H, Ch. 7

* PVBP Analysis and Hedging of a Swap Portfolio

* Other Swaps: Currency, Equity, Commodity etc., H, Ch. 32

11/03 XVII

Building the Yield Curve

* Zero Curves versus Forward Curves

* Using Money Market Rates and Swap Rates

* Interpolation and Bootstrapping Methods

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| <p>Problem Set</p> <p># 7</p> <p>FRA's and Swaps</p> |
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| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|--|------------------------------------|
| 11/05 | XVIII | Interest Rate Option Pricing/Hedging | H, Ch. 28 (to p. 651) |
| | | * European Options on Bonds and Interest Rates | |
| | | * Option Payoffs and Strategies for Interest Rate Options | |
| | | * Classification of Interest Rate Options Products | |
| | | * No-Arbitrage Relationships: Caplets, Bond Options, Swaptions | |
| 11/10 | XIX | Interest Rate Caps and Floors | H, Ch. 28 (pp. 652-658) |
| | | * Valuation Using the Black-Scholes Model | R.Stapleton and M.Subrahmanyam (3) |
| | | * Valuation Using the Black Model | |
| | | * Valuation Using the S-S Model | |
| | | * Hedging With Forwards/Futures Contracts | |

Problem Set

8

Building the Yield Curve

| | | | |
|-------|----|---------------------------------|--------------------------|
| 11/12 | XX | Interest Rate Swaptions | H, Ch. 28 (after p. 658) |
| | | Valuation Using the Black Model | |

Problem Set

9

Interest Rate Caps/Floors

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|--|---|
| 11/17 | XXI | Forward/Spot Models of the Term Structure * Pros And Cons Of Forward Versus Spot Models * Spot Rate Models * Black-Karasinski, Hull-White models * Forward Rate Models: Ho-Lee, Heath-Jarrow-Morton, Libor Market Model (Brace-Garatek-Musiela) | H, Ch. 30 (to p. 703) H, Ch. 31 (skim) |

Problem Set

10

Interest Rate Swaptions

- Binomial Model for Pricing Derivatives
- * Building an Interest Rate Binomial Lattice
 - * Cox-Ross-Rubinstein Methodology
 - * Modeling Based on Spot Rates or Forward Rates

| | | | |
|-------|------|--|-----------------------|
| 11/19 | XXII | Exotic Options Features of exotics * Main types * Binomial model of valuation/hedging * Uses of exotic options | H, Ch. 24 (to p. 558) |
|-------|------|--|-----------------------|

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|--|--------------------------|
| | | Barrier options | H, Ch. 24 (pp. 558-561) |
| | | * Knock-out, knock-in options | |
| | | * “In-the-money” versus “out-of-the-money” knock-out options | |
| | | * Problems of valuation/hedging | |

Problem Set

11

The Ho-Lee Model

11/20

Take-Home Quiz

2

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|-------|-------|--|--------------------------|
| 11/24 | XXIII | Exotic Options (Contd.) | H, Ch. 24 (after p. 561) |
| | | Asian options | H. Ch. 24 (pp. 5651-566) |
| | | * Effect of averaging: valuation/hedging | |
| | | * General path-dependent structures | |
| | | * Problems of valuation/hedging | |

| Date | Sess. No. | Subject | Chapter or Source |
|-------------|------------------|---------------------------------|--------------------------|
| | | Hybrid (Correlation) products | H, Ch. 24 (pp. 566-567) |
| | | * Quanto options | H, Ch. 24 (pp. 576-579) |
| | | * Problems of valuation/hedging | |
| | | * Volatility/Variance Swaps | H, Ch. 24 (pp. 567-570) |
| | | * Static options replication | H, Ch. 24 (pp. 570-573) |

Problem Set

12

Barrier Options

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|-------|------|------------------------------------|-----------|
| 11/26 | | Thanksgiving break: No class | |
| 12/01 | XXIV | New Derivative Instruments: Credit | H, Ch. 22 |
| | | * Credit Derivatives: Products | |
| | | * Credit Default Swaps | |
| | | * Collateralized Debt Obligations | |

Problem Set

13

Asian Options

Date **Sess. No.** **Subject** **Chapter or Source**

12/03 XXV New Derivative Instruments: Credit (Contd.)
* Credit Derivatives: Pricing H, Ch. 23

12/08 XXVI New Derivative Instruments: Other products H, Ch. 25
* Weather and Catastrophe Derivatives
* Carbon Credit Derivatives

Case
Nexgen: Structured Collateralized Debt Obligations (CDOs)

12/09 XXVII Extra session

Review Session

12/10 XXVIII

Final Examination

DEFAULT POLICIES FOR STERN COURSES

The following are policies students should assume are in force in their Stern courses, unless their instructors explicitly establish alternate policies.

Laptops, Cell Phones, Smartphones, Recorders, & Other Electronic Devices

May not be used in class.

Attendance

Required and part of grade.

Faculty will excuse absences only in the case of documented serious illness, family emergency, religious observance, or civic obligation. If you will miss class for religious observance or civic obligation, you must inform your instructor no later than the first week of class. Recruiting activities and business trips are not acceptable reasons for absence from class.

If a student is absent from the first day of an intensive course, the instructor may request that the student be removed from the course.

Arriving Late, Leaving Early, Coming & Going

Students are expected to arrive to class on time and stay to the end of the class period.

Arriving late or leaving class early will have impact on the course grade.

Students may enter class late only if given permission by the instructor and can do so without disrupting the class.

(Note that instructors are not obliged to admit late students or readmit students who leave class or may choose to admit them only at specific times.)

Late Submission of Assignments

Late assignments will either not be accepted or will incur a grade penalty unless due to documented serious illness or family emergency. Instructors will make exceptions to this policy for reasons of religious observance or civic obligation only when the assignment cannot reasonably be completed prior to the due date and the student makes arrangements for late submission with the instructor in advance.

Note that the following policies are in force for all Stern classes:

General Behavior

Students will conduct themselves with respect and professionalism toward faculty, students, and others present in class and will follow the rules laid down by the instructor for classroom behavior. Students who fail to do so may be asked to leave the classroom. (Graduate Programs Honor Code, Undergraduate College Code of Conduct, Stern policy)

Collaboration on Graded Assignments

Students may not work together on graded assignment unless the instructor gives express permission. (Graduate Programs Honor Code, Undergraduate College Code of Conduct)

Grading

No more than 35% of students will receive grades of A or A- in MBA core courses. (Stern policy)

MBA students who do not submit Course Faculty Evaluations by the deadline will not have access to their final grades until the grade release date, which is determined by program. Faculty are requested not to release final grades to students who fail to submit evaluations and students should not ask. (Stern policy)

Endorsed by:

MBA Core Course Committee, July 9, 2007

Vice Deans, July 13, 2007

Academic Programs & Teaching Resources Committee of Faculty Council, August 1, 2007

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B40.3340
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Fall 2009

Instructions for the First Three Classes

1. Get course materials [textbook (recommended, not required), course package] from the bookstore.
2. Pick up other materials [readings, problem sets] in the first class.
3. Do Problem Sets 1 and 2.

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Some interesting websites on derivatives

As may be expected, there are several websites that offer useful information on derivatives securities and markets. Listed below are some important and useful sites that would be of interest to any student in this area.

1. www.optionmetrics.com

This website has a rich dataset and real-time data on US equity derivatives. (More detailed historical data are also available to the Stern community in a separate database.) It was put together by one of my former Ph.D. students and is used by many of the major industry players in the area of equity derivatives.

2. www.riskmetrics.com

This website is a rich source of data and research materials on derivatives and risk management. It was spun off by JP Morgan many years ago and was a pioneer in the area of tools and techniques of risk management. It continues to be a useful source of data and concepts on many aspects of risk management.

3. www.bis.org

This is the official website of the Bank for International Settlements (BIS). This organization is the “central bankers’ bank” and has been the coordinator for many of the important recent regulatory initiatives of the world’s central banks, which regulate financial institutions and markets around the world.

4. www.isda.org

This is the website of the International Swaps and Derivatives Association, the trade body for the over-the-counter derivatives market, which handles a substantial proportion of all traded derivatives. It has a wealth of information on various aspects of derivatives

markets including the details of the standard contracts for many of these products in the areas of interest rates, foreign exchange, commodities, credit etc.

5. www.cme.com
www.cbot.com

These are the official websites of the two major exchanges that trade futures and options contracts on a wide range of underlying assets from equities to interest rates to weather. They provide real-time quotations on most of the major contracts that are traded on exchanges, other than options on individual stocks.

6. www.cboe.com
www.amex.com
www.iseoptions.com

These are the official websites of the three major exchanges for equity and stock index options. They provide a plethora of information on individual option contracts, although www.optionmetrics.com consolidates all this information in a more "user-friendly" format.

7. www.riskcenter.com/

An interesting website containing links to various interesting articles, news items and reports on various aspects of derivatives contracts and markets.

8. www.risk.net/

This is the website of *Risk* magazine, the leading industry publication in the area of derivatives. This magazine has gossip about the business, recent trends in the industry and a few technical articles on concepts and models that are of interest to practitioners. A great resource for anyone involved with the derivatives industry.

9. www.moodys.com
www.standardandpoors.com
www.fitchratings.com

These are the websites of the three major credit rating agencies. They present information about the criteria for ratings as well as the ratings for several issues. The sites contain a mass of statistics about credit risk at the macro and micro levels.

10. www.dtcc.com
www.markit.com

These two websites relate to OTC derivatives. The Depository Trust and Clearing Corporation is one of the several new OTC clearing houses established in recent years. Markit is a leading data vendor, providing a ranging of pricing services for derivatives.

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Some interesting websites for derivatives quotes and risk metrics

As may be expected, there are several websites that offer useful information on the prices of derivatives securities. While real-time information from sources such as Bloomberg and Reuters would be more comprehensive, there are several websites that offer quotes on the major derivatives markets. Some important examples for the US markets are listed below:

Stock Option quotes, Greeks and implied volatilities

http://www.888options.com/quotes/default.jsp?ReferredBy=SEM_Goo_0490_A_30&gclid=CL6HztjiwY4CFRqsOAodi3bMxA

<http://www.ivolatility.com/options.j>

<http://finance.yahoo.com/q/op?s=QQQQ>

Eurodollar and Fed Funds futures quotes

http://www.cme.com/trading/dta/del/delayed_quote.html?ProductSymbol=ED&ProductFoiType=FUT&ProductVenue=G&ProductType=itr

<http://www.cbot.com/cbot/pub/page/0,3181,1525,00.html>

Swap and Libor quotes

http://b2b.thefinancials.com/us_interest_rates.asp

Seminar on Derivatives: First List of Readings

Marti G. Subrahmanyam & Rangarajan K. Sundaram
PhD Seminar in Derivatives
New York University: Fall 2008

The following is the reading list for the first 10 classes of the course. This is a tentative list; we will likely supplement these with other papers later.

Class 1. Structural Models of Credit-Risk: Theory

1. Merton, R. (1974) On the pricing of corporate debt: The risk-structure of interest rates, *Journal of Finance* 29, 449-470.
2. Black, F. and J. Cox (1976) Valuing corporate securities: Some effects of bond indenture provisions, *Journal of Finance* 31, 351-367.
3. Geske, R. (1977) The valuation of corporate liabilities as compound options, *Journal of Financial and Quantitative Analysis* 12, 541-552.
4. Cooper, I. and A. Mello (1991) The default-risk of swaps, *Journal of Finance* 46, 597-620.
5. Shimko, D., N. Tejima and D. Van Deventer (1993) The pricing of risky debt when interest rates are stochastic, *Journal of Fixed Income* 3, 58-65.
6. Zhou, C. (1996) The term-structure of credit spreads with jump-risk, *Journal of Banking and Finance* 25, 2015-2040.
7. Longstaff, F. and E. Schwartz (1995) Valuing risky debt: A new approach, *Journal of Finance* 50, 789-821.
8. Saa-Requejo, J. and P. Santa-Clara (19xx) Bond pricing with default risk, Working Paper, UCLA.
9. Kim, J., K. Ramaswamy, and S. Sundaresan (1993) Does default-risk in coupons affect the valuation of corporate bonds? A contingent-claims model, *Financial Management* 22, 117-131.
10. Collin-Dufresne, P. and R. Goldstein (2001) Do credit spreads reflect stationary leverage ratios? *Journal of Finance* 56, 1929-1957.

Class 2. Structural Models: Empirical Implementation

1. Jones, E., S. Mason and E. Rosenfeld (1984) Contingent claims analysis of corporate capital structures: An empirical investigation, *Journal of Finance* 39, 611-625.
2. Huang, J., and M. Huang (2003) How much of the corporate-treasury yield spread is due to credit risk? Results from a new calibration approach.
3. Eom, Y., J. Helwege and J. Huang (2004) Structural models of corporate bond pricing: An empirical analysis, *Review of Financial Studies* 17, 499-544.
4. Ericsson, J. and J. Reneby (2004) An empirical study of structural credit risk models using stock and bond prices, *Journal of Fixed Income* 13, 38-49.
5. Ericsson, J. and J. Reneby (2005) Estimating structural bond-pricing models, *Journal of Business* 78.
6. Ericsson, J., J. Reneby and H. Wang (2006) Can Structural Models Price Default Risk? Evidence from Bond and Credit Derivative Markets, mimeo.
7. G. Gemill (2002) Testing Merton's model for credit spreads on zero-coupon bonds, Working Paper, City University Business School, London.
8. Bharath, S.T. and T. Shumway (2006) Forecasting Default with the KMV-Merton Model, mimeo, University of Michigan.
9. T. Shumway (2001) Forecasting bankruptcy more accurately: A simple hazard model, *Journal of Business* 74, 101-124.

Class 3. Reduced-Form Models of Credit-Risk: Theory

1. Litterman, R. and T. Iben (1991) Corporate bond valuation and the term-structure of credit spreads, *Journal of Portfolio Management*, Spring, 52-64.
2. Jarrow, R., and S. Turnbull (1995) Pricing derivatives on financial securities subject to credit risk, *Journal of Finance* 50, 53-85.
3. Duffie, D. and K. Singleton (1999) Modeling Term structures of defaultable bonds, *Review of Financial Studies* 12, 687-720.
4. Madan, D. and H. Unal (1998) Pricing the risks of default, *Review of Derivatives Research* 2, 121-160.
5. Lando, D. (1998) Cox processes and credit-risky securities, *Review of Derivatives Research* 2, 99-120.
6. Schönbucher, P. (1998) Term-structure modeling of defaultable bonds, *Review of Derivatives Research* 2, 161-192.
7. Das, S. and R. Sundaram (2000) A discrete-time approach to arbitrage-free pricing of credit derivatives, *Management Science* 46(1), 46-63.

Class 4: Reduced-Form Models: Empirical Implementation

1. Duffee, G. (1998) The relationship between treasury yields and corporate bond yield spreads, *Journal of Finance* 53, 2225-2242.

2. Duffee, G. (1999) Estimating the price of default risk, *Review of Financial Studies* 12, 197-226.
3. Duffie, D., L. Pedersen, and K. Singleton (2003) Modeling sovereign yield spreads: A case-study of Russian debt, *Journal of Finance* 58.
4. Driessen, J. (2005) Is default event risk priced in corporate bonds? *Review of Financial Studies* 18, 165-195.

Class 5: Connecting the Dots

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Class 11. Correlated Default Modeling and the Subprime Crisis

1. To be listed.