

University of Utah
David Eccles School of Business

Finance 6240
Derivatives and Risk Management
Fall 2016
Tuesday/Thursday 9:10-10:30, SFE 3170
office hours by appointment

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Course Overview The International Swaps and Derivatives Association found that “over 90% of the world’s 500 largest companies use derivatives to help manage their risk.” Options began trading on US exchanges in 1973. In 2015, the largest options exchange in the U.S., CBOE, traded about 1.1 billion option contracts (each contract typically written on 100 shares). The dollar volume of these transactions exceeded \$500 billion. In 2015, the CME, the largest futures exchange, had (round turn) volume of over 3.5 billion contracts. The notional value of contracts traded on the CME was \$1,167 trillion. As a point of reference, the US GDP for 2015 was about \$17.9 trillion.

This class will explore a wide variety of “derivative” securities, including options, futures, swaps, and CDOs. We will examine what these products are, where they are available, and examine how they are used. One of the most important uses of many of these products is in financial risk management. We will discuss managing interest rate risk, currency risk, and credit risk as examples of risk management strategies.

You will have the opportunity to investigate some of the theories and pricing models discussed in class first-hand through portions of problem sets. You will need access to security prices (possibly including stocks, options, and treasury notes, bonds, bills, and strips) to complete those assignments.

Course Materials The recommended text for this course is *An Introduction to Derivatives & Risk Management*, tenth edition by Don M. Chance and Robert Brooks (Thomson South-Western, 2015). You may use an earlier edition of the text, although you may have to adjust the reading assignments. If you want a more technical treatment of the material, I will hand out some other choices on the first day of class. You may wish to subscribe to the *Wall Street Journal* or some other newspaper. Other materials will be handed out in class.

Grades The course grade will be determined by your performance on four items: two midterm exams, a final exam, and several problem sets.

problem sets	25%
midterm 1	25
midterm 2	25
final exam	25

The final exam will take place during the regularly scheduled time determined by the university.

If you are interested in devoting time to a particular topic, let me know and we will try and work it into the schedule.

Expectations for individual work: Students who cheat on an exam will receive an E for the course. You may discuss homework assignments with your classmates, but I expect each student to do his or her own assignment. If you turn in a homework assignment that is not fully your own work, you will receive a zero on the assignment for the first offense and an E in the course for a second offense. The dean's office and the university have the right to impose harsher sanctions.

Exam policy: Failure to adhere to the exam policy may result in a failing grade. I take cheating seriously. If you cheat on an exam, you will receive an E in the course.

1. You must take the exam at the scheduled time unless you are ill. If you are sick, please notify me by email or leave a message on my voicemail (801.585.3212) before 9:10 a.m. the day of the midterm or before the start of the scheduled final exam. When you return, please provide a note from a healthcare professional.
2. You must take the final exam at the time scheduled by the university. If you choose to leave campus before the scheduled exam, you will receive a zero for the exam.
3. You will be permitted to bring notes to each exam. You may not use any materials other than your notes, materials for writing your exam, and your calculator during the exam.
4. Calculators must be used in a non-transmitting mode. Turn off access to the internet, mail, or any external source. Cell phones may not be used during the exam and must be placed out of view. Turn off your phone during the exam.
5. You must show your work to receive credit.
6. You may not look at another student's exam or notes, and you must not share your work or notes with another student during the exam. If you believe someone else is copying your work, ask the instructor to be reseated.

ADA Policy: The University of Utah David Eccles School of Business seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, <http://disability.utah.edu>, 160 Olpin Union Building, (801) 581-5020 (V/TDD) to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notice to the Center for Disability Services.

David Eccles School of Business Statement of Professional and Ethical Conduct: Because of the importance of professional and ethical behavior in business, and its emphasis in our program, professional or academic misconduct is not tolerated in the David Eccles School of Business. Students are expected to adhere to the standards of behavior outlined in the University of Utah Code of Student Rights and Responsibilities (Policy 6-400). Students engaging in behavioral misconduct could be subject to suspension or dismissal from the University. Students involved in any form of academic misconduct, including but not limited to cheating on tests, plagiarism and

collusion may, at the instructor's discretion, receive a failing grade in the course, examination, or academic assignment. In addition to or instead of this sanction, the instructor may refer the case to the Student Behavior Committee for hearing. If the instructor chooses not to do so, the Associate Dean for Academic Affairs, after appropriate investigation, may do so along with a recommendation to dismiss the student from the Business School. If, after hearing the evidence, the Committee determines that the student in question is guilty of the misconduct charged, the Committee may impose sanctions in addition to those taken by the professor. If the academic dishonesty is not proven, the instructor must rescind any sanctions imposed and will be required to evaluate the student's performance with the assumption that there has been no misconduct. The School will treat the student likewise. If a student suspects another student of academic misconduct, he/she should refer the incident to the instructor, the appropriate department, the Associate Dean for Academic Affairs, or the Student Behavior Committee, administered by the Associate Dean of Students, 270 Union.

Class Schedule and Reading Assignments
Finance 6240 Fall 2016

Class Topic	Readings (Chance and Brooks)
I. <u>Introduction to risk and hedging, arbitrage, and continuous compounding</u> Aug 23	Chapters 1 and 2; Preliminaries handout
II. <u>Introduction to options</u> Aug 25 What is an option? Aug 30 Arbitrage bounds, determinants Sep 1 of option prices, and payoff diagrams	Chapters 3, 6, and 7
III. <u>Option pricing</u> Sep 6 Binomial option pricing Sep 8 Sep 13 Sep 15 Sep 20 Black-Scholes option pricing	Chapter 4 Chapter 5
Sep 29: Midterm Examination 1	
IV. <u>Forwards and futures</u> Sep 22 Cost of carry and valuing forwards Sep 27 Futures and marking to market Oct 4 Hedging with futures	Chapter 8 Chapter 10
V. <u>Options <i>on</i> futures and options <i>in</i> futures</u> Oct 6 Oct 18	Chapter 9
VI. <u>Swaps</u> Oct 20 Oct 25 Oct 27 Nov 1	Chapter 11
Nov 10: Midterm Examination 2	
VII. <u>Option applications: Real options, corporate securities, and implied volatility</u> Nov 3 Implied volatility Nov 8 Corporate securities Nov 15 Real options	Chapter 5; handout Class notes Chapter 5; class notes
VIII. <u>Value at Risk (VaR)</u> Nov 17 Nov 22	Parts of chapter 14
IX. <u>Credit risk, collateralized securities or other topics (depending on class interest)</u> Nov 29	Parts of chapter 14;

Dec 1
Dec 6

class notes

Semester wrap-up and review: December 8

No class on October 11 and 13, November 24

**Final exam: as scheduled by the University:
Wednesday, December 14, 8 – 10 a.m.**

Assignment sheet – Finance 6240
Fall 2016

Assignments are due in class on the date indicated. Assignments will be accepted with a late penalty **prior to** the next class meeting unless otherwise noted.

Homework 1 (due in class September 6)

Find three violations of the no-arbitrage conditions on stock options using either closing prices or most recent trade prices from Yahoo Finance (<http://finance.yahoo.com>). One violation should be an immediate exercise for either puts or calls, one should be of the “more alive than dead,” type, and one should be for any violation you choose. For each violation, specify the underlying stock, the strike price, the expiration date, and whether you are looking at a call or put. If you are investing in a T-bill, list the calendar date of your investment, the maturity date of the T-bill, and the discount rate.

Each of your positions should involve trading a “round lot,” that is, should be for 100 shares or for options on 100 shares. For each violation, identify the violation, and record each of the transactions necessary to produce an arbitrage profit. Show the profit your position will produce in all states of the world either now or at the option’s expiration, as appropriate.

For your more alive-than-dead position, choose an option that expires after September 22. Sometime between when you complete the first part of homework 1 and September 22, close out your more-alive position. When you close your position, record the amount of your profit. Explore the likely profits from different strategies and choose the strategy you think is best. Explain why you made that choice. Please turn in this part of the assignment no later than September 22.

Use T-Bill rates to find the price of risk-free borrowing and lending. Buy bills at the asked price and sell them (or sell them short) at the bid price. The T-Bill bid-asked spread will be the only transaction cost you must consider in your trades. Assume that all of the reported prices are correct and are available contemporaneously.

Homework 2 (due in class September 20)

Part A. Use this information to answer questions 1 through 5 below.

A stock's end-of-year price is **uniformly** distributed from a low price of \$50 to a high price of \$150. Investors are risk neutral. The 1-year interest rate is 10 percent (discretely compounded).

1. What should be the current market price of the stock?
2. Assume the stock has a call option with an exercise price of \$125 and 1 year to expiration.
 - a. What is the probability that the call will be exercised?
 - b. What is the equilibrium call price?

3. Assume the stock has a put option with an exercise price of \$50 and 1 year to expiration.
 - a. What is the probability that the put will be exercised?
 - b. What is the equilibrium put price?

4. Suppose the stock price distribution changes so that it is uniformly distributed from a low of \$40 to a high of \$140--that is, the distribution shifts downward relative to the distribution in questions 1-3.
 - a. What should be the current price of the stock now?
 - b. Find the price of the call in question 2 now.
 - c. Find the price of the put in question 3 now.

5. Suppose the stock price distribution changes so that it is uniformly distributed from a low of \$40 to a high of \$160--that is, the distribution spreads relative to the distribution in questions 1-3.
 - a. What should be the current price of the stock now?
 - b. Find the price of the call in question 2 now.
 - c. Find the price of the put in question 3 now.

Part B. Use the following information to answer questions 1-3.

Current stock price	\$100
Stock price in 1 year	\$120 or \$90
Risk-free rate	10 percent, annually
Strike price of option	\$110

1.
 - a. Find u , d , and q for the stock.

 - b. Draw the picture for the stock price dynamics for two years. Include the stock price at each point in time.

 - c. Draw the picture for the call price dynamics for two years. Include the option values only at the maturity date.

 - d. Find the call option value for each of the possible outcomes at the end of the first years and at the present by computing the present value of the expected payoffs at each point in your tree.

2. Assume you plan to write a call with one year (not two years) to expiration.
 - a. Find the number of shares of stock (Δ) and the amount of risk free borrowing (B) necessary to completely hedge your position. Use these values to compute the equilibrium value of the call directly.

- b. Construct a table for your hedged position which shows the cash flows at the current period and at maturity.
3. Repeat parts c and d of problem 1 for an American put with two years to expiration.

Homework 3 (due in class September 22)

Assume the following information for a non-dividend paying stock and a call option written on the stock. Show your work.

Exercise price	\$40
Current stock price	\$30
σ^2	0.25
Time to expiration	0.25 years
Risk-free rate	0.05

- a. Use the Black-Scholes model to determine the value of the call option.
- b. Change the time to expiration to 0.5 years and compute the call value again.
- c. Change σ^2 to 0.36 (assuming that $T = 0.25$) and compute the call value.

Homework 4 (due in class October 6)

You want to construct a forward contract on a particular stock. The stock pays no dividends. The current price of the stock is \$50 per share. The forward contract expires in 3 months. The risk-free rate is 4% annually. Assume the contract is for 1,000 shares.

- a. What should be forward price for the contract?
- b. Assume the forward price of the contract is \$50,000 and that you have no transaction costs or other market frictions. Form a portfolio that requires no investment today and will guarantee you profits at the forward's expiration date. Specify all of your transactions and cash flows at all relevant dates.
- c. Now assume that you established a long position in one contract at the fair price you determined in part a. One month later, the stock is selling for \$55 per share. The risk-free rate hasn't changed. You wish to close out your position. What will you receive or pay when you close out your position?

Homework 5 (due in class October 25)

You wish to take a short position in one wheat forward contract. The contract specifies that the short may deliver either 5,000 bushels of soft wheat or 5,000 bushels of hard wheat. Use the following information to calculate the forward price you would be willing to pay for one contract on 5,000 bushels.

Spot price of hard wheat	\$6.00/bushel
Spot price of soft wheat	\$5.80/bushel
Time to expiration	3 months (.25 years)
Risk-free rate	.04 (continuously compounded annual rate)
Present value of storage and insurance costs	\$0.30/bushel
Standard deviation of difference in returns between hard and soft wheat	0.20 (annually)

Homework 6 (due in class November 3)

1. Consider two firms, L and H. They are each offered the following terms for borrowing \$50 million dollars for three years.

<u>Firm</u>	<u>Fixed</u>	<u>Floating</u>
L	6.5 %	LIBOR + 0.75 %
H	7.875	LIBOR + 1.375

- a. Find the quality spread differential if the firms agree to enter into a swap.
- b. Design a swap to take advantage of the quality spread between the two firms' borrowing opportunities. Assume the spread differential is evenly divided between the two firms.
2. Two companies, AAA and BBB, are offered the following rates for borrowing. Both companies want to borrow \$10 million for one year beginning December 1, 2014, and make quarterly interest payments beginning March 1, 2015.

	<u>Fixed</u>	<u>Floating</u>
AAA	10.8 %	LIBOR + 0.25%
BBB	12.0	LIBOR + 0.75

- a. What is the quality spread differential (your answer should be a number)?
- b. Design a swap to divide the gains evenly between the two firms.
- c. Based on your answer to b, complete the following table for the swap for AAA.

Date	3-month LIBOR	days from last pmt date	AAA receives	AAA pays	Net to AAA
Dec 1, 2014	10%	–			
Mar 1, 2015	11%	90			

Jun 1, 2015	12%	92			
Sep 1, 2015	11%	92			
Dec 1, 2015	10%	91			

3. Determine the actual quarterly **net** payment for the floating payer in a floating- for fixed-rate interest rate swap over the life of the swap. The notional principal is \$20 million. The fixed-rate payer pays 11 percent. The floating-rate payer pays LIBOR, with the rate determined on the first day of the interest period. Interest payments are based on the exact number of days, which are 92, 182, 273, and 365 from the start of the contract. The current 3-month LIBOR rate at the time the contract was negotiated was 11.5. The 3-month LIBOR rates that actually resulted during the swap were 10.5 (92 days later), 10.2 (182 days later), and 9.6 (273 days later).
4. Consider two multi-national companies, A and B. A, a Swiss company, wants to borrow in dollars and B, an American company, wants to borrow in Swiss Francs (CHF). They are offered the following rates from their bankers.

	<u>US \$</u>	<u>CHF</u>
A	9.875 %	7.5%
B	10	8.5

- The principal amount they are seeking is the same. What if they do a swap? Both go to a dealer who takes 0.25%, and divides the remaining differential, 20% to company A and 80% to company B. Specify the terms of the swap to A, B, and to the intermediary.
5. A large swap dealer would like to price a \$25 million fixed-for-floating rate swap. The swap will be for two years and will require semi-annual payments. The term structure of LIBOR is 12 percent for ½ year, 12.25 percent for one year, 12.75 percent for 1½ years, and 13.02 percent for two years. Find the fixed rate, assuming that Reciprocate wishes the initial value of the swap to be zero. [For simplicity, use round fractions of a year, rather than actual days.]
6. Barter, Inc. is currently engaged in a three-year swap with \$10 million notional principal. Payments are made every half year. Barter pays a fixed rate of 12 percent and receives a floating rate of LIBOR. The swap is now halfway through the second year and Barter has just made its payment. Determine the value of the swap to Barter. Be sure to include a sign (is the value positive or negative?) The appropriate discount rate for Barter is LIBOR. Current LIBOR rates are 9.75 percent (½ year), 9.875 percent (1 year), and 10 percent (1½ year). [Assume the swap is figured in round fractions of a year, rather than in days.]

Homework 7 (due November 22)

1. Consider the following information for a stock on a non-dividend paying stock with several

calls.

Stock price: \$26.34
Risk-free rate: 0.03 (annually)
Time to call expiration: 0.4 years

<u>Strike price</u>	<u>call price</u>
18	8.56
20	6.60
25	2.75
30	0.87

- Find the implied volatility for each call.
- Draw a graph with strike price on the horizontal axis and implied volatility on the vertical axis.

2. Your firm has decided to invest in a two-year project. The project will produce no cash flows until the end of the project. You have determined that the net present value of the project is \$100 million, but the risk is high: you estimate that the standard deviation of the project value is 0.80 (annualized).

An investor has offered to assume the project one year from now for \$80 million if you decide at that time to give up your interest. How much would you pay the investor to take on this risk?

Homework 8 (due in class December 1)

Review the material on value-at-risk handed out in class. Your assignment is to use the Monte Carlo method to evaluate the value-at-risk of a simple portfolio consisting of an investment in an S&P index fund and a 20-year US Treasury bond.

You have \$10,000 to invest in the two securities. You are restricted to investing in round lots of \$1,000 (e.g., you could invest \$2,000 in the S&P and \$8,000 in T-bonds, or \$5,000 in each, etc.). Pick your portfolio weights.

In conducting your Monte Carlo simulation, assume the following.

- S&P daily returns are normally distributed with daily mean $.11/250$ and daily standard deviation of $.2/\sqrt{250}$. Assume the S&P has no serial correlation.
- The Treasury bond is a 20-year bond with coupon of 5 percent, payable semi-annually.
- The current annualized interest rate (effective annual yield) is 5.0625 percent. Interest rates evolve daily according to the following formula: $r_t = .0104 + .8r_{t-1} + .0003\varepsilon_t$, where ε_t has a standard normal distribution. Further, assume that the term structure is always flat.

- Random changes in the S&P and in interest rates are uncorrelated.

Generate 200 simulated values of the change in your portfolio's value. Use the simulated changes to estimate the 1-day VAR of your portfolio for a 95% level of confidence. Please turn in the first page of your simulated results (include a table like the one attached) and the first page of your sorted values.

Sample Homework 7 Table

trial t	r_t	B_t	$\Delta B = B_t - B_{t-1}$	S_t	$\Delta S = S_t - S_0$	$\Delta V = \Delta B + \Delta S$
0	.050625		-		-	-