

Course Syllabus

Financial Derivatives 206/717

The Wharton School
University of Pennsylvania

Prof. Philipp Illeditsch

Spring 2020

Course Description and Objectives

This course covers one of the most exciting and important areas in finance: *derivatives*. Financial derivatives such as forwards, futures, swaps, and options allow a risk manager to mitigate or even eliminate unwanted risks her company is facing, thereby allowing the company to focus on its comparative advantage. For instance, a risk manager of a US based company may enter into a forward contract on the British Pound to lock in the exchange rate for future account receivables, the risk manager of an airline may enter into a futures contract on crude oil to hedge against future increases in jet fuel, or a bank may use credit default swaps to hedge the credit risk of a client. Interest rate and currency swaps give a company a lot of flexibility when choosing to finance a project with debt. For instance, a US based firm may take out a cheap USD floating rate bank loan and convert this loan into a USD fixed rate loan with an interest rate swap or a firm based in Japan may also take out this USD bank loan and uses a currency swap to convert this loan into a fixed rate loan in Yen. In both cases the firm lowers its borrowing cost without any exposure to interest rate and/or currency risk. Moreover, an active portfolio manager may use a put option on the S&P500 to protect against market downturns. If stock market returns are currently very volatile, then she may use a collar on the S&P500 instead to finance the expensive put premium. Financial derivatives allow investors to trade on future price movements with minimal upfront investments thereby making financial markets more liquid and efficient. For instance, traders in the equity index and FX futures markets can often lever up their positions more than 25 respectively 50 times (varies with the volatility of the underlying). Investor in option markets can obtain similar leverage ratios even without ever facing a margin call. This leverage baked into derivatives is often not well understood and the reason for many derivative trades that have gone terribly wrong (Lehman Brothers, Long Term Capital Management, Orange County, Barings Bank, etc). Derivatives are also often used to predict future prices or events. For instance, fed fund futures can be used to predict the future monetary policy of the fed, weather derivatives traded on the CME can be used to predict future changes in temperature, and currency options can be used to infer the likelihood of a successful exchange rate peg. Financial derivatives are sometimes in the news because they can be used to circumvent tax or accounting rules. This *regulatory arbitrage*

is possible when regulatory authorities do not treat with derivatives synthetically created assets (e.g. loans) as such and thus they receive different tax or accounting treatment. There have been important development since the financial crisis such as the switch from one-leg to two-leg pricing of interest rate and currency swaps, the move to central clearing of derivatives, and the valuation adjustments to the fair value of derivatives done by dealers to take into account funding, credit risk, and regulatory capital costs. Moreover, the upcoming switch from LIBOR to SOFR based USD floating rate loans (similar changes will occur in other countries or currencies areas) will diminish the importance of the most widely used derivatives such as the Eurodollar futures contract and the Libor swap. Instead SOFR futures and swaps will become more popular.

The main objective of this course is to help students gain the intuition and to provide the necessary skills for pricing and hedging of derivative securities, and for using them for investment, risk management, and prediction purposes. We discuss a wide range of applications and real-life cases, including the use of derivatives in asset management, the valuation of corporate securities such as stocks and corporate bonds, interest rate derivatives, credit derivatives, as well as crude oil derivatives and currency derivatives. In addition to theoretical discussions, we also emphasize practical considerations of implementing strategies using derivatives as tools, especially when no-arbitrage conditions do not hold. In order to provide a useful treatment of these topics in a world that is changing rapidly, it is necessary to stress fundamentals and to explore topics at a technical level. **Specifically, the objective of this course is to teach students how to analyze a problem/situation involving derivatives so that they also know how to deal with a different one in the future.**

Contact Information:

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Office hours: Monday 3:30pm–5pm.

Please make an appointment if you would like to meet outside of office hours.

Class times and locations

MW 12:00-1:30pm, SH-DH 209

There will be no class on the following days:

Monday, January 16 (Martin Luther King Day)

Wednesday, March 1 (Midterm Exam)

Monday-Wednesday, March 6 – 8 (Spring Break)

Teaching Assistants

There will be Teaching Assistants for the course. Their contact information and office hours will be posted on Canvas. The TA office hours will take place in the TA cubicles in the Finance Department.

Prerequisites: NONE.

The following introductory Finance and Statistics courses are recommended but not required:
FNCE 206: FNCE 100, FNCE 101, STAT 101-102
FNCE 717: FNCE 601, FNCE 602, STAT 621

Exams

There are two mandatory exams. The midterm exam is on Wednesday, March 4 in class. The final exam is scheduled by the university and I will announce the time and location on canvas as soon as it is available.

There will not be any make-up exams except as required by university policy. All regrade requests must be made in writing within one week of the day the exams are returned. Any exam submitted for regrading of a question can be subjected to a complete regrading.

Both exams are closed-book, closed-notes. For each exam you may bring a single letter-size *handwritten* formula sheet. You may write on both sides of this sheet.

Lecture notes etc.

This is a paperfree class. I will distribute all readings and lecture notes electronically via Canvas. I will always make sure to post my lecture notes on Canvas *prior* to class. If you wish to take notes directly on these lecture notes, please make sure to print out a set before class. I will *not* distribute paper copies in class. There is no bulkpack for this class. I will also use Canvas to post the problem sets and the problem set solutions.

Review sessions

There will be a review session before each of the two exams. Time and location TBA.

Problem Sets

There are six problem sets. These can be tackled in groups of up to three students. Completed assignments will be graded on the following scale, $\checkmark -$, \checkmark , $\checkmark +$. Problem sets are due at the beginning of class, on the dates shown below. No late assignments will be accepted.

Problem set solutions should be clearly written and should explain your thought process. If you submit a printout from a spreadsheet, please make sure to label it carefully. *You must submit a paper copy of your solution. I will not accept electronic copies.*

	Due date
Problem Set 1	Monday, February 3
Problem Set 2	Monday, February 17
Problem Set 3	Monday, March 2
Problem Set 4	Wednesday, March 25
Problem Set 5	Monday, April 13
Problem Set 6	Wednesday, April 29

I will post the grade for each problem set on Canvas. Please make sure you check your grade and report any errors as soon as possible and at the latest within two weeks of the problem set's due date. I will not accept any inquiries afterwards.

The solution to each problem set will be posted after your answers have been turned in (see table with deadlines). Your graded answers will be returned to a file cabinet in the Finance Department. I will not discuss the solutions to problem sets in class, but I encourage you to come the TAs' or my office hours if you have any questions.

Course requirements

Your final grade will be based on your performance on the problem sets and the two exams. I will base your overall grade on one of the two weighting schemes below; for each individual student, I will use the weighting scheme that is more favorable for him/her.

	Weighting 1	Weighting 2
Problem sets	20%	20 %
Midterm exam	40%	25 %
Final exam	40%	55 %

Books

Required textbooks:

Derivatives Markets (3rd edition), by Robert L McDonald.
Copies of the book are available at the campus bookstore.

Recommended textbooks:

There are three more books that I highly recommend.

1. *John C. Hull*, Options, Futures, and Other Derivatives (10th Edition).
2. *Sheldon Natenberg*, Option Volatility and Pricing: Advanced Trading Strategies and Techniques (2nd Edition).
3. *Kerry Back*, A Course in Derivative Securities: Introduction to Theory and Computation.

The first book is another excellent book that covers almost all the material in this class. It is slightly more technical than McDonald but also covers the material in an rigorous and intuitive way. The second book is an excellent and widely read text among option traders. It covers options products and option strategies from the perspective of a practitioner. The third text is a highly recommended textbook for students that are interested in a more advanced (and more mathematical) treatment.

A few more good books on this topic:

1. *Adam S. Iqbal*, Volatility: Practical Options Theory.
2. *Philippe Jorion*, Big Bets Gone Bad: Derivatives and Bankruptcy in Orange County. The Largest Municipal Failure in U.S. History.
3. *Rangarajan Sundaram and Sanjiv Das*, Derivatives (2nd Edition).
4. *Satyajit Das*, Traders, Guns and Money: Knowns and Unknowns in the Dazzling World of Derivatives.
5. *Roger Lowenstein*, When Genius Failed: The Rise and Fall of Long-Term Capital Management.
6. *Michael Lewis*, The Big Short: Inside the Doomsday Machine.

Exams will be based only on material covered in class and in the accompanying problem sets.

Class	Date	Topics	Reading (M)
1.	1/15	Introduction to Derivative Securities & Syllabus What is a derivative? Why are derivatives important? Who uses derivatives? Where are they traded? Evolution of this market; course outline.	Ch. 1
2.	1/22	Forward Contracts on Non-Dividend Paying Stocks Defining, pricing, using, and valuing forward contracts; cost-of-carry.	Ch. 5.1, 5.2, 5.3
3.	1/27	Forward Contracts on Dividend Paying Stocks and Stock Indices Forwards price/predict future dividends; dividend yield; transaction costs.	Ch. 5.3
4.	1/29	Equity Index Future Contracts Defining futures; trading futures on the CME group; marking-to-market; margins; leverage; pricing of S&P 500 futures	Ch. 5.4
5.	2/3	Forward and Future Contracts on Commodities Specification of commodity futures; pricing forwards/futures; storage cost; lease rate; convenience yield; spot price prediction; financialization of commodities.	Ch. 6
6.	2/5	Forward and Futures Contracts on Currencies Forward exchange rates; FX futures; CIP; UIP; the currency carry trade.	Ch. 5.6
7.	2/10	Forward and Futures Contracts on Interest Rates Forward rates; FRAs; Eurodollar futures; Treasury bond futures; hedging interest rate risk; expectation hypothesis; carry trade; CME FedWatch Tool.	Ch 5.7, 7.2, 7.4
8.	2/12	SOFR: the Future of LIBOR Repo markets; LIBOR scandal, reform, and replacement; Overnight Index Swap (OIS) Rate; Secured Overnight Financing Rate (SOFR), ESTER, SONIA, etc.	Ch. 7.5
9.	2/17	Hedging with Futures Cross-hedging with index futures; dynamic rolling futures strategies; basis risk; security/maturity mismatch; hedging debacle of Metallgesellschaft.	Ch. 5.5
10.	2/19	Introduction to Swaps: Commodity, Total-Return, and FX Swaps Defining, pricing, using, and valuing swaps; importance of OTC swap markets.	Ch. 8.1, 8.4, 8.6
11.	2/24	Interest Rate and Currency Swaps Converting a floating rate loan into a fixed rate loan; 1- and 2-leg pricing; future of the most common derivative: the LIBOR swap; SOFR swaps; OIS.	Ch. 8.2, 8.3
12.	2/26	Introduction to Options Call and put options; option terminology; margins; CBOE products.	Ch. 2.2-2.5
13.	3/2	Midterm Review Session Midterm semester review; solving previous midterm problems.	
14.	3/16	Hedging with Options and Put-Call Parity Protective puts; collars; synthetic long/short positions; conversions; reversals; box-spread.	Ch. 3.1-3.3, 9.1

Class	Date	Topics	Reading (M)
15.	3/18	The Binomial-Tree and Risk Neutral Pricing Replicating-portfolio; risk neutral/adjusted probabilities	Ch. 10.1, 11.2
16.	3/23	Derivative Pricing in the Binomial-Tree Model Dynamic replication; delta-hedging; self-financing portfolios; calibrating the binomial model; pricing calls and puts on Google.	Ch. 10.2-10.4, 11.3
17.	3/25	The Black-Scholes-Merton Model Understanding, using, and deriving the BSM-model for non-dividend paying stocks; implied volatility; math jargon of quants: Brownian motion, etc.	Ch. 12.1, 12.5
18.	3/30	The Black-Scholes-Merton Model and its Greeks Delta, Gamma, and Theta of derivatives in the BSM-model.	Ch. 12.3
19.	4/1	Delta-Hedging and Option Returns Delta-hedging; convexity vs time decay; hedging error vs transaction costs; value-at-risk; leverage; Leland, O'Brien and Rubinstein: Portfolio Insurance.	Ch 13, 26
20.	4/6	Limitations and Extensions of The Black-Scholes-Merton Model Options on dividend paying stocks, equity indices, currencies, commodities, forward contracts, and futures; negative skewness; fat tails; smile; smirk.	Ch. 12.2
21.	4/8	Stochastic Volatility Implied volatility spikes; earnings announcements; Brexit; VIX; GARCH; stochastic volatility; jumps; variance risk premium, variance swaps.	CH. 24
22.	4/13	Financial Engineering Pricing capital guarantee certificates and structured notes.	Ch. 2.6, 15
23.	4/15	American and Asian Options Early exercise; dividend-spread arbitrage; analytical and numerical solutions of Asian options; Monte-Carlo simulations	Ch. 9.3, 10.5, 11.1 Ch 14.2, 19
24.	4/20	Credit Derivatives Credit risk; reduced form model; Merton model; KMV model; credit default swaps (CDS); AIG; collateralized debt obligations (CDO); Paulson's "BigShort".	Ch. 27
25.	4/22	Interest Derivatives Caps; floors; mortgage-backed securities.	Ch. 26
26.	4/27	Regulatory Arbitrage and Valuation Adjustments (XVAs) Swaps for Greece and Italy; Mark Cuban's collared Yahoo trade; credit, debit, funding, margin, capital value adjustment (CVA, DVA, FVA, MVA, KVA).	
27.	12/9	Review Session Semester review; solving previous final exam problems.	

Classroom behavior

Laptops may be used for note-taking only. Surfing the web is very distracting for students around you. Turn your cell phone off. DO NOT LEAVE THE CLASSROOM TO TAKE A PHONE CALL!

Academic integrity

May I remind you that your work and conduct will be held accountable under the University of Pennsylvania's *Code of Academic Integrity*. Violations of this Code will be met with swift and certain punishment to the full extent of the regulation.