THE WHARTON SCHOOL

Prof. Winston Dou   **FNCE2170**

Spring 2023

Course Syllabus
Financial Derivatives

Course Description

This course delves into one of the most exciting yet foundational areas in finance: derivative securities. In the modern financial architecture, derivatives stand out as some of the most intricate and exotic securities traded by institutional specialists. Yet, simultaneously, some of them remain basic securities frequently traded by retail investors, as exemplified by instruments like the S&P 500 Index Options. More than just trading vehicles, the core concepts of financial derivatives act as cornerstones to fathom a wider spectrum of financial issues, from complex risk management and strategic corporate decisions to the intricate dynamics of venture capital investment stages.

The global derivatives market is burgeoning at an unprecedented pace, boasting a notional value surpassing $600 trillion. Now, more than ever, it is crucial to grasp both the strategic potentials presented by these instruments and the associated risks.

The main objective of this course is to help students gain the intuition and skills on (1) pricing and hedging of derivative securities, and (2) using them for investment and risk management. In terms of methodologies, we apply the non-arbitrage principle and the law of one price to dynamic models through three different approaches: the binomial tree model, the Black-Scholes-Merton option pricing model, and the simulation-based risk neutral pricing approach.

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 with embedded options, 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.

The breakout of the novel coronavirus (COVID-19) as a pandemic has caused global stock markets to plummet and led to a global economic recession. It further highlights the importance of advanced derivatives trading techniques for hedging the left-tail disaster risk. Meanwhile, the emergence of the pandemic has seen countries around the world take measures to try to stop its spread, including the imposition of travel restrictions, distancing restrictions, business cessation orders, and national lockdowns. The impact of these measures on businesses and the financial markets is causing concern among market participants about the ability of their counterparties to meet their payment and delivery obligations under derivatives transactions.

Pre-requisites

There are no formal prerequisites for this course. However, basic knowledge to linear algebra, calculus, statistics, and probability is expected. The introductory finance courses can also be helpful. Thus, if any, the following courses are recommended but not required: FNCE 100, FNCE 101, STAT 101-102.

Course Materials

Lecture Notes & Readings:

They will be posted on CANVAS (https://canvas.upenn.edu/) before each class. I will also post additional reading materials on CANVAS, including research papers and newspaper articles, which can provide useful background knowledge or add depth to the materials covered in lectures. I will not distribute hardcopies of lecture notes in classes.

Readings and practice problems will be regularly assigned from textbook (M). Neither Book (M) nor book (H) is cheap, but they have become standard references among wall-street practitioners, and thus they can be valuable long-term investments.

Required Textbook:

(M) McDonald, *Derivatives Markets*, 3rd ed., Pearson 2012.

Recommended Textbook:

(H) Hull, *Options, Futures and Other Derivatives*, 10th ed., Pearson Prentice Hall 2011.

Some Optional Materials:

(D) Das, *Traders, Guns & Money*, 3rd ed. Financial Times/Prentice Hall 2006.
(V) Veronesi, *Fixed Income Securities: Valuation, Risk, and Risk Management*, Wiley 2010.

Course Requirements

Lecture Participation:
TR 1:45 -- 3:14 p.m. JMHH F90. In person.

Assignments:

There are six group problem sets. These problem sets should be finished in groups of 2-4 students with group discussions. However, you are required to write down your own solutions and submit individual copy of solutions separately. Only electronic submission is acceptable through the provided link.

Please put down the names of your teammates clearly at the beginning of each submission. You must submit by the deadline.

Each problem set is graded up to 10 points for timely submission, correctness of your derivations and solutions, and clarity of your explanations. If you really wish to submit a spreadsheet, please make label entries clearly and explain them carefully.

Please do not be late for your problem set solution submission; otherwise, at least 4 points out of 10 have to be deducted, and no submission is acceptable 24 hours after the corresponding deadline. The following are the strict deadlines for all problem sets (tentatively):

- Problem set 1: September 14th
- Problem set 2: September 28th
- Problem set 3: October 19th
- Problem set 4: November 9th
- Problem set 5: November 21st
- Problem set 6: December 7th

Students must submit their solutions of the problem sets through the links on the CANVAS. The title of the pdf or word file must have the following format:

FIRSTNAME_LASTNAME_PENNID_HWk

where k = 1, 2, 3, 4, 5, 6 for the problem set k.

The graded solutions will be returned via CANVAS. I will post the solution for each problem set on CANVAS. Please find me if you feel there are any potential grading errors within two weeks of the problem set's due date. It's unfair to consider any inquiries afterwards.

Exams:

There are two exams: midterm and final.

The midterm exam takes place on Thursday, **October 26th, in class**. All students have to take the exam in the session they are registered for. The exam is a closed-book and closed-notes one. However, students can bring in an 8.5"-by-11" (A4-letter) cheat sheet. Students are not allowed to use cell phones, touchpads, or laptops during the exam.

The final exam takes place on **TBA**. The exam is also a closed-book and closed-notes one. Students can also bring in an 8.5"-by-11" (A4-letter) cheat sheet. No cell phones, touchpads, or laptops are allowed during the exam.

Re-grading must be applied to all questions, if requested. No re-grading inquiries will be considered a week after solutions and grades are returned.

Students who are unable to take the exam during the given time periods must petition their dean's office for a makeup exam.

Both exams are based only on materials covered in lectures and problem sets.

Final Grades:

The final grade is based on the performance on participation, problem sets, and exams. It is a weighted average of each performance evaluations with a full score of 100. The more favorable weighting scheme is picked for each student between the following two:

	Weighting 1	Weighting 2
Participation	10%	10%
Assignments	20%	20%
Midterm	30%	10%
Final	40%	60%

Office Hours and Review Sessions

Office Hours: Mondays 5:00 – 6:30 p.m. or by appointment
TA Office Hours: Wednesdays 4:00 – 5:30 p.m.
Review Sessions: TBA

Contact Information

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Academic Integrity & Generative AI Guidelines

University of Pennsylvania's Code of Academic Integrity.

A copy can be found at

http://provost.upenn.edu/policies/pennbook/2013/02/13/code-of-academic-integrity

Moderate Use of Generative AI Permitted for Homework Only:

You may use generative AI programs (e.g., tools like ChatGPT) to help generate ideas and brainstorm in the process of studying and working on the problem sets. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity. You may not submit any work generated by an AI program as your own. If you

include material generated by an AI program, it should be cited like any other reference material (with due consideration for the quality of the reference, which may be poor). Any plagiarism or other form of cheating will be dealt with severely under relevant Penn policies.

Generative AI NOT Permitted for Exams:

You are NOT allowed to use generative AI (e.g, tools like ChatGPT) for your in-class exams. Using such tools in this course will be considered a violation of Penn's Code of Academic Integrity and I will report suspected use to the Center for Community Standards and Accountability. Please contact me if you have questions about this policy.

Classroom Policy

- Zero participation score if late for classes more than twice.
- Please do not surf the web.
- Please do mute your cell phone in lectures.
- Please do not leave the classroom to take a phone call.
- Please do not chat around during lectures.

Mark Your Calendar

- **Tuesday, August 29th, First Class**

- Thursday, October 26th, Midterm Exam

- Thursday, December 7th, Last Class

- TBD, Final Exam

Course Schedule (Tentative)

Class	Date	Topic	Reading (M)
1	08/29	Introduction to Derivative Securities & Syllabus	Ch. 1
2	08/31	Forward Contracts on Financial Assets and Indices	Ch. 5, 7
3	09/05	Future Contracts on Financial Assets and Indices	Ch. 5, 7
4	09/07	Forward Contracts on Commodities	Ch. 6

5	09/12	Future Contracts on Commodities	Ch. 6
6	**09/14**	Forward and Futures Contracts on Currency	Ch. 5.6, 5.7
7	09/19	Forward and Futures Contracts on Interest Rates	Ch. 7
8	09/21	Swaps: Total Return Swaps, Commodity Swaps, Variance Swaps	Ch. 8.1, 8.4, 8.5, 8.6
9	09/26	Currency Swaps and Interest Rate Swaps: Applications *Examples: Greece currency swaps and interest rate swaps with Goldman Sachs*	Ch. 8.2, 8.3
10	**09/28**	Other Popular Swaps	Ch. 8
11	10/03	Introduction to Options *Examples: short sales constraints and synthetic stocks, Collar strategies, and Barring/Leeson*	Ch. 9
12	10/05	Option Trading Strategies	Ch. 9
13	10/10	Binomial Trees and Risk Neutral Pricing	Ch. 10.1
14	10/17	Binomial Trees: Two-Period Model	Ch. 10.2, 10.3
15	**10/19**	Binomial Trees: Multi-Period Model *Examples: option prices around FDA approvals, implied binomial*	Ch. 10.2, 10.3
16	10/24	The Black-Scholes-Merton Formula	Ch. 12
17	**10/26**	**Midterm Exam (in class)**	
18	10/31	Options' Greeks and Dynamic Replications *Examples: replicating the S&P 500 index option, portfolio*	Ch. 12.3, 13
19	11/02	Delta-Gamma Hedging and Option Returns	Ch. 12.3, 13
20	11/07	Limitations and Extensions of The Black-Scholes-Merton Model	Ch. 20.8, 21.5
21	**11/09**	American Options	Ch. 9.3, 10.4, 11.1
22	11/14	Exotic Options: Examples	Ch. 14
23	11/16	Pricing with Monte Carlo Simulations: A Simple Study	Ch. 19
24	**11/21**	Introduction to Credit Derivatives *Examples: KMV Model, credit default swaps, collateralize debt obligations, copula, Amherst, AIG, Paulson's "Big Short"*	Ch. 27

25	11/28	Default and Credit Risk	Ch. 16, 17
26	11/30	Theory v.s. Reality: Failures of Non-Arbitrage Conditions *Examples: TIPs arbitrage, Chinese warrants, convertible arbitrage, covered interest rate parity*	
27	12/05	Monte Carlo Methods	
28	**12/07**	Artificial Intelligence in Algorithm Trading + Wrap up	