

FNCE90011 Derivative Securities

FINAL EXAM - Semester 2, 2020

Instructions: *Please read carefully!*

The exam consists of two parts:

1. A series of 12 multiple-choice questions (30 marks in total), to be completed online via the LMS Quiz.
2. A series of 7 short-answer questions (70 marks in total). This part of the exam can be accessed as a separate LMS Assignment.

Please complete **both** parts and answer **each** question in **each** part.

Instructions for the Short Essay Part

1. Please answer **all** questions in this document.
2. You may submit typed or handwritten answers.
3. In your write-up, please indicate clearly which question and sub-question the answer refers to.
4. Please include your worked solution, not just the final answer.
5. Answers to all questions combined should be submitted as a single document, uploaded to the LMS.
 - a. If you are unsure, please refer to the Gradescope getting started guide: <https://lms.unimelb.edu.au/students/student-guides/gradescope>
 - b. You may upload multiple versions if you would like to update your answers. Only the last received version will be used for grading. Please always update a full set of answers; i.e., if you would like to change the answer to only a single question, please ensure to upload the answers to all other questions as well.
6. An additional 30 minutes is available at the end of the exam to upload the document. The multiple-choice questions will not be available during that time so make sure you submit the quiz on time!

General instructions for the exam

The following instructions are also included in the LMS Multiple-Choice Quiz.

1. You may not communicate with other people for the duration of the exam. The only exception is contacting the subject coordinator or LMS support staff if you face technical difficulties.
2. Subject to the restrictions outlined above, you may consult any textbook or internet resource to answer your question. In the case of any inconsistency between external sources and the content of the lecture slides and textbook, the content of the lecture slides and textbook should be relied on.
3. Be smart about what resources you use. If you are going to try and look up the answer to every question you will not have sufficient time to complete the exam.
4. If you are well-prepared you have to trust your own expertise in answering the questions. If you have time left at the end you may use external sources to double-check answers to some questions you were not sure about.
5. You may use a calculator or computer program to perform any required calculations.

6. Take your time to read the question carefully. Sometimes you may not need to calculate to find the correct answer.
7. We will be available on the LMS exam chat during the exam.

Best of luck!

Bruce & Thijs

Part A: Multiple choice questions

Please refer to the LMS quiz for the multiple-choice questions and submit your answers there.

The quiz will be available for the duration of the exam, but once you submit, you cannot view or edit your answers anymore.

Part B: Short essay questions

Question B.1 [5 marks; 10 minutes]

The continuously compounded risk-free rate is 12% per annum and interest rates are constant. Shares in *Uni Corp* are listed and actively traded. The shares are currently trading at \$65. You own a four-month American-style over-the-counter call option on a share of *Uni Corp* with an exercise price of \$50. There is no liquid secondary market in which these options can be sold. *Uni Corp* will not pay any dividends during the next four months.

After a careful analysis of the industry and the firm you are convinced that *Uni Corp* is considerably overvalued and is likely to soon decrease in price. Your new colleague suggests that since you cannot easily sell the option, you should realize \$15 now by exercising the option and then immediately selling the share.

Explain clearly and completely why your colleague is wrong. Show that if you do not exercise immediately you can lock-in a current payoff of at least \$16.96053 irrespective of what subsequently happens to *Uni Corp's* share price.

Your answer to this question should be no more than a half page.

Question B.2 [2 + 3 + 3 + 3 = 11 marks; 15 minutes]

Shares in *Winnie Corp* are currently trading at \$10. The company is about to pay a dividend of \$2 a share and the share price will then decline to \$8. Over the subsequent quarter, the share price will either rise by 35% or decline by 25%. Note that the share price will go up or down only once over the coming quarter. The continuously compounded risk-free rate is 8% per annum. Consider a three-month European put option on a share of *Winnie Corp* with an exercise price of \$10.50.

- (a) What are the two possible values of a *Winnie Corp* share at the end of the quarter?
- (b) What positions in *Winnie Corp* stock and bonds will replicate the payoff to this put and what is the cost of the replicating portfolio?
- (c) Check your valuation using the risk-neutral pricing technique.
- (d) What would be the price of the put if it were an American-style option?

Question B.3 [4 + 4 + 4 = 12 marks; 15 minutes]

I work for a financial institution. I have the following portfolio of over-the-counter options on platinum. Each contract is for 1 ounce of platinum.

	Current position (# contracts)	Delta	Gamma	Vega
Call A	Long 1,000	0.50	1.7	1.8
Call B	Short 500	0.80	1.1	0.2
Put C	Long 2,000	-0.40	1.3	0.7
Put D	Short 800	-0.70	0.9	2.2

- (a) What are the delta and gamma of my portfolio?
- (b) My friend is a market maker who has completed a number of trades in options on platinum today. At the end of the trading day, her portfolio has a delta of 300 and a gamma of 5000. She wants to delta-gamma hedge her portfolio against overnight price risk, using a position in spot platinum and put D from the table above. What position in the spot asset and put D should she take to gamma and delta hedge her portfolio?
- (c) You see a new call option on platinum. Its maturity is 3 months and strike price is \$36. The current spot price of the underlying asset is \$37 per ounce and the volatility is 25% per annum. The continuously-compounded risk-free rate is 1% per annum. What are the delta and gamma of the call option, assuming the Black-Scholes-Merton assumptions are satisfied?

Question B.4 [5 marks; 5 minutes]

Use the formula for a Cash-or-Nothing European call option in the Black-Scholes model and an appropriate version of put-call parity to derive the formula for a Cash-or-Nothing European put option.

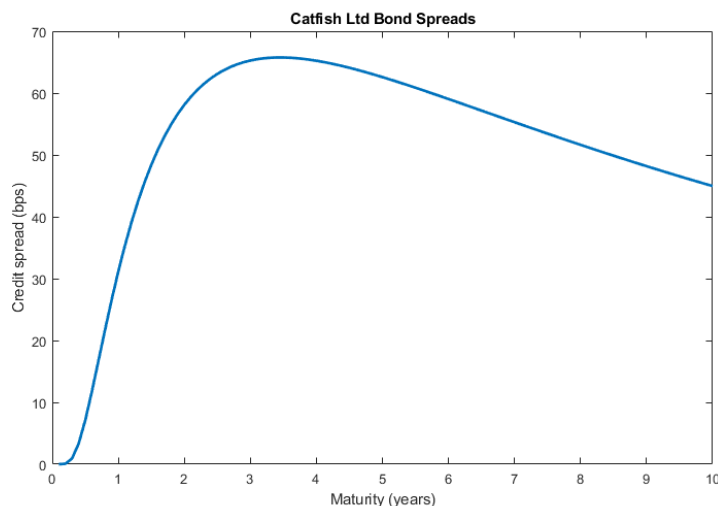
Hint: write down the payoff table for both the put and the call.

Question B.5 [4 + 4 + 6 = 14 marks; 20 minutes]

The value of the assets owned by *Catfish Ltd* follows a lognormal distribution. The current firm value is \$100. The firm is about to issue a zero-coupon bond with a face value of \$60. The volatility of the firm's assets is 30% annualized, and the continuously-compounded risk-free rate equals 10% per annum.

- (a) If the bond has a maturity of 1 year, what are the current prices of the Catfish bond and of a default-free bond with the same characteristics?
- (b) If the value of the assets of Catfish would increase by \$0.5 over the next second, by how much would the value of the bond change approximately?

The treasurer of Catfish Ltd is considering his options (no pun intended) and examines a range of different maturities for the bond. His assistant has created the following graph showing the credit spread for a zero-coupon bond as a function of its maturity.



- (c) The treasurer asks you for advice to understand the graph. In your response, address the following questions:
 - What drives the increase in credit spread as the maturity increases with short maturities?
 - What drives the decrease in credit spreads as the maturity keeps on rising?

Question B.6 [4 + 4 = 8 marks; 15 minutes]

In their paper, Goncalves-Pinto et al. (2019) use the option-implied stock price derived from put-call parity to analyse stock return predictability identified by option prices.

They argue that when transaction costs are considered, put-call parity for European options becomes a set of inequalities:

$$S_{ASK} \geq c_{BID} + Ke^{-rT} - p_{ASK} \quad (1)$$

$$-c_{ASK} - Ke^{-rT} + p_{BID} \geq S_{BID} \quad (2)$$

- (a) Suppose that (1) is not satisfied. How would you arbitrage this? Include a cash flow table in your answer.
- (b) Suppose that the option-implied value is above the price at which the stock is currently trading. On average, this stock will earn a positive return in the near future. What are the two potential explanations that the literature has put forward for this phenomenon?

Question B.7 [4 + 3 + 2 + 2 + 4 = 15 marks; 20 minutes]

Consider a gas swap contract calling for the exchange of 1m^3 of gas at the end of each year for a period of 3 years. The discount factors for maturities of 1, 2 and 3 years are 0.98, 0.92 and 0.88, respectively. Gas storage is costly; the proportional storage costs equal 3% per year with annual compounding. There is no convenience yield on gas. The current spot price equals \$2 per m^3 .

- (a) What is the swap rate for this 3-year swap?
- (b) A swap is a financially engineered contract that combines a position in forwards with a position in bonds. What are the borrowing and lending transactions implicit in the 3-yr swap of a)? *(if you could not answer question a), you may assume the swap rate equals \$2.25 per m^3)*
- (c) Based on the data in b), which party in the swap is more exposed to credit risk over the life of the swap, the long (i.e., purchasing the gas) or short (i.e., selling the gas)? Why?
- (d) What condition (contango or backwardation) should the forward curve satisfy such that the long party will effectively borrow money in the early part of the swap contract?
- (e) A callable interest rate swap gives the party that pays the fixed rate the right to cancel the swap contract without additional payments or penalties any time before the maturity of the contract. Like other swap contracts, the callable swap will be constructed so that it has zero value initially. Comparing a callable swap to an otherwise identical plain vanilla swap, for which contract will the swap rate be higher? Why?

END OF EXAM QUESTIONS