

Digital Finance Group Coursework 2024-2025

Module name: Digital Finance

Module code: COMP0164

Academic year: 2024-25

Term 1, 2 or 3: Term 1

Nature of assessment: Group Coursework

Section Content

- A. Core Information
- B. Coursework Brief and Requirements
- C. Assessment of This Coursework
- D. Group Instructions

Section A: Core Information

Feature	Description
This assessment is marked out of	100 marks
% weighting of this assessment within the total module mark	70%
Academic misconduct (including plagiarism)	Academic Misconduct is any action or attempted action that may result in a student obtaining an unfair academic advantage. Refer to Academic Manual Section 9: Student Academic Misconduct Procedure - 9.2 Definitions.
Submission date & time	16:00 (UK time) on 12 December 2024
Penalty for late submission	Standard UCL penalties apply. Students should refer to the UCL Academic Manual . If you encounter problems, issues, challenges which fall under the scope of Extenuating Circumstances, please apply to the Computer Science Department.
Submitting your assignment	The assignment MUST be submitted to the module submission link located within this module's Moodle 'Submissions' tab by the specified deadline. Submissions should be as both a pdf of your work and the Jupyter Notebook of your work. For questions 1-4 you should comment your python code and show your formulas and working steps in markdown. For questions (case studies) 5-6 in particular, if you prefer, you may submit an additional PDF with the reports for the case studies, originally created in Word or LaTeX. However, you are welcome to continue using markdown, as with the other questions.
Anonymity of identity	Normally, all assignments are anonymous unless the nature of the assessment e.g. video, presentation, group work, is such that anonymity is not possible.

Section B: Coursework Brief and Requirements

This assignment will require you to apply what you have learnt in the lectures, tutorials and covered in the reading materials to answer six questions.

You should submit your answers as both a Jupyter Notebook written in python of your code and markdown, as well as an exact pdf copy.

For each question where a numerical answer is required, you should show the python code that you used to compute the answer and the relevant formulas and working steps to solve the problem. If you do not include each of these in your answers, you will only gain partial marks. The final answer for each question should be printed out below the cell it was obtained in.

[10 marks] are available for the structure, clarity, language, mathematical notion and overall presentation of your coursework.

Question 1: Corporate Finance [15 marks]

In this question, you are asked to evaluate business and investment ideas.

You are tasked with evaluating an investment project proposed by a company called Boogle. During the latest earnings report, Boogle's CFO announced an investment of \$150 million for a new business expansion project. The project is planned to be financed with an \$100 million public offering of a 10-year debt and the remainder with an equity offering. You have collected the information necessary to evaluate this project in Exhibits 1 and 2.

Exhibit 1: Relevant Information for Analysis

Equity risk premium	4.53%
Risk-free rate of interest	3.9%
Market value of Boogle's debt	\$1.0 billion
Market value of Boogle's equity	\$2.6 billion
Boogle's equity beta	1.4
Boogle's before-tax cost of debt	9.2%
Corporate tax rate	37.5%

Exhibit 2: Estimated Project Financials

	Year 1	Year 2	Year 3
Revenue	98.7	110.3	112.6
Operating Costs	32	36	38
Depreciation	16	16	16

- Calculate the after-tax weighted average cost of capital of Boogle prior to its new project investment. **[3 marks]**
- Find Boogle's after-tax asset beta prior to the new project. **[2 marks]**
- Assuming the new project has the same asset beta as the Boogle company in b.), find the the project equity beta. **[2 marks]**
- The formula for project after-tax free cash flow at time t is

$$FCF = (\text{Revenue} - \text{Operating Costs} - \text{Depreciation}) \times (1 - \text{Tax Rate}) + \text{Depreciation}.$$

Define a Python function to calculate the project FCFs and demonstrate that the after-tax free cash flow generated for the next three years are \$47.7 million, \$52.4 million, and \$52.6 million respectively. **[2 marks]**

e.) Find the project NPV and IRR with the next three years after-tax free cash flow given in d.).**[3 marks]**

Assume the following is a dividend-paying stock.

Stock:

Atat Steel is in the steel manufacturing sector with a required rate of return of 7.35%. You estimate that if the economy is booming, the company's current annual dividend of \$0.8 per share will grow 10.5% a year for the next four years and then stabilize at a 3.5% growth rate a year indefinitely. However, if the economy falls into a recession, then Atat Steel will not likely experience the elevated 10.5% short-run growth and instead will grow by 3.5% indefinitely.

f.) Use the discount dividend method and find the current value of Atat Steel stock under both economic conditions. **[3 marks]**

Question 2: Bonds and Fixed Income [16 marks]

In this question, you are given background information on some bonds and you tasked with calculating crucial data about them.

Exhibit 3: Current Par Rates and Spot Rates

Maturity	Par Rate (Annual)	Spot Rate (Annual)
1 year	2.50%	2.50%
2 years	3.02%	3.00%
3 years	3.53%	3.50%
4 years	3.98%	4.00%
5 years	4.42%	?

Exhibit 4: Information for Selected Bonds

Bond Name	Maturity	Coupon (Annual)	Type of Bond
Bond A (Face value \$1,000)	3 years	6.78%	Option-free
Bond B	3 years	4.30%	Callable at par on start of year 1 and tear 2
Bond C	3 years	4.30%	Putable at par on start of year 1 and year 2

Exhibit 5: Binomial Interest Rate Tree, based on an estimated interest rate volatility of 10%, where 'u' represents an up move and 'd' represents a down move.

Year 0	Year 1	Year 2
2.3400% (r)	3.5930% (ru node)	4.6540% (ruu node)
	2.9417% (rd node)	3.8043% (rud node)
		3.1254% (rdd node)

- a.) Based on Exhibit 3, find the five-year spot rate. **[2 marks]**
- 3 b.) Assuming the law of one price, use Exhibit 3 to calculate the compounded forward rate (annually compounded) of a one-year loan starting in three years. **[1 mark]**
- 3 c.) Given spot rates for one-, two-, and three-year zero bonds, how many forward rates can be calculated? Please list the compounded forward rates (annually compounded) that can be calculated and briefly explain your answer. **[3 marks]**

d.) Find the yield to maturity for Bond A. **[4 marks]**

e.) Based on Exhibit 5, assume an equal probability of interest rate going up and down at each node. Calculate the value of Bond B and Bond C with the binomial tree model. **[3 marks]**

f.) All else being equal, explain the effect of a fall in interest rates on Bond B and Bond C. **[2 marks]**

g.) All else being equal, which bond is most likely to increase in value if interest rate volatility is 15% rather than 10%? Briefly explain your answer. (Hint: consider the value of options) **[1 mark]**

Question 3: Forward and Futures Contracts [12 marks]

In this question you will be working with futures and forward contracts

Consider a stock that is trading at \$100 today. The stock does not generate income/pay dividends. The stock is traded in a well-functioning market with no transaction costs and no restrictions on short sales. Both borrowing and lending can be done in unlimited amounts at the 2% risk-free rate.

- a.) What is the difference between forward contracts and futures contracts (Answers should be no longer than 200 words) **[4 marks]**
- b.) Consider a futures contract on the stock with a maturity of one year. Suppose that the futures price is currently at \$97. Are the futures fairly priced? Describe an arbitrage strategy that would allow you to make a riskless profit. **[2 marks]**
- c.) Same as question b) but suppose that the futures price is currently at \$103. Describe your arbitrage strategy. **[2 marks]**
- d.) Consider a stock with the market value of \$76 that pays 5% dividend yield over the next year. Given the risk-free rate of return is 3%, and the initial forward price is \$73, what is the present value of the forward contract with one year maturity? **[2 marks]**
- e.) Consider the same conditions as in part d.), but with the dividend of \$3, what is the present value of the forward contract? **[2 marks]**

Question 4: Options [16 Marks]

In this question, you will be working with options.

Suppose that you hold a long position on a European call option that has an underlying asset price of \$45.34, strike price of \$44, risk-free rate of 1.5%, 20% annualized volatility, and a half-a-year left to maturity. The underlying asset does not have any investment yield.

- a.) Value this call option. **[1 mark]**
- b.) Based on the Black-Scholes-Merton model, describe a portfolio that replicates the call option's payoff. **[1 mark]**
- c.) Define a function to price the option with the binomial tree method. The function should take the number of steps (n) as one of the inputs. You should NOT use list comprehension in the function. **[3 marks]**
- d.) By setting $n = 10, 50$ and 100 , compare and comment on the results under the two methods. **[2 marks]**

When buying two calls with the exercises price of x_1 and x_3 and selling two calls with the exercise price of x_2 , where

$$x_2 = \frac{x_1 + x_3}{2},$$

with the same maturity for the same stock, we call it a butterfly. Consider the following call options for the stock that trades at \$57.03:

Option Name	Strike Price	Call Premium (Price)
Call Option 1	50	10
Call Option 2	55	7
Call Option 3	60	5

- e.) Create a graphical representation of the butterfly strategy's payoff. **[2 marks]**
- g.) Why might an investor enter into such a strategy? **[2 marks]**
- g.) Use binomial model (set some arbitrary high number of iterations) to price the european butterfly option from part e.), assuming it has 1 year to maturity, the risk-free rate is 1.5% and the annualized volatility of the underlying stock is 15%. **[5 marks]**

Question 5: Case Study [14 marks]

Using the data sources and tools introduced in Workshop 3, along with any relevant material from the lectures, analyze the current state and future outlook of a selected country/economy from a macroeconomic and financial perspective. As a primary suggestion, groups may consider analyzing the United States economy, as most available free data sources focus on this country. However, groups are welcome to choose any country/economy they wish to analyze. Groups **MUST** include figures and/or tables from various data sources, as well as research reports or studies that justify and support the analysis conducted. The report should be approximately 600/700 words, excluding the bibliography, captions for tables and figures, and any numbers included in tables.

Question 6: Case Study [17 marks]

Using the data sources and tools introduced in Workshop 3, along with any relevant material from the lectures, analyze the current state and future outlook of a selected publicly traded company (stock) included in a major stock market index, such as the S&P 500 or Russell 2000, among others. The company may be located in a different country than the one chosen in Question 5. As a primary suggestion, groups may consider analyzing a company from the “Magnificent 7”: Apple, Microsoft, Alphabet (Google), Amazon, Nvidia, Tesla, or Meta (Facebook). You should include, at least, a brief introduction to the company (i.e., a description of its main business) and a fundamental analysis.

Groups MUST include figures and/or tables from a variety of data sources, as well as research reports or studies that justify and support the analysis conducted. The report should be approximately 600/700 words, excluding the bibliography, captions for tables and figures, and any numbers included in tables.

You are not limited to analyzing an “excellent” publicly company/stock; you may also consider a poorly performing company whose stock price may decline, making a short position potentially profitable.

Each group, working as financial analysts, must provide a final conclusion based on their analysis by assigning a rating to the company. The rating scale is as follows:

- (5) Strong Sell
- (4) Sell
- (3) Neutral
- (2) Buy
- (1) Strong Buy

Note that calculating a (target) price for the company is not required; simply provide a recommendation based on thorough research and analysis.

Section C: Assessment of This Coursework

Within each section of this coursework, you may be assessed on the following aspects, as applicable and appropriate to this particular assessment, and should thus consider these aspects when fulfilling the requirements of each section:

- The accuracy of any calculations;
- The strengths and quality of your overall analysis and evaluation;
- Appropriate use of relevant theoretical models, concepts and frameworks;
- The rationale and evidence that you provide in support of your arguments;
- The credibility and viability of the evidenced conclusions/recommendations/plans of action you put forward;
- Structure and coherence of your considerations and reports;
- Appropriate and relevant use of, as and where relevant and appropriate, real world examples, academic materials and referenced sources. Any references should use either the Harvard OR Vancouver referencing system (see [References, Citations and Avoiding Plagiarism](#));
- Academic judgement regarding the blend of scope, thrust and communication of ideas, contentions, evidence, knowledge, arguments, conclusions;
- Each part has requirements with allocated marks, maximum word count limits/page limits and where applicable, templates that are required to be used.

You are advised to refer to the [UCL Assessment Criteria Guidelines](#).

Section D: Group Instructions

You should create your own groups in Moodle (minimum 4; maximum 5). Each group member should contribute to the coursework equally. Only one person from each group needs to submit the various parts of the assignment.