MA3071 – DLI
Financial Mathematics – Introduction

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My details

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Appointments: E-mail me to book appointments.

Blackboard Site

- Course material and course announcements will be available on Blackboard.
- Lecture slides posted on Bb before the lectures.
- Send me e-mail if I forget to upload something!
- Importance of attending classes.
- Some references are provided on Bb if you are interested in further reading, but it is not necessary to succeed in this course.

Prerequisites

- Essential prerequisites: basic probability (random variables and their distributions, mean, variance, covariance, etc.), basic calculus (derivatives and integrals, Lagrangian approach, etc.), and differential equations.
- We will not cover these in the course, and you are expected to work independently to revise them.
- Desirable skills: Programming (MATLAB, etc.), Excel
- If you have any doubts or questions about prerequisites, please get in touch with me via discussion board or email.

Assessment

- 30% Coursework
- 70% Written examination

Assessment

- *Coursework*: Consisting of 3 computer-based problem sheets, to be done individually. Hand in coursework electronically via Blackboard (one file per person). Deadlines are as follows,
  - Coursework 1: 08/Nov/2023, 16:00 (UK)/23:59 (China)
  - Coursework 2: 08/Dec/2023, 16:00 (UK)/23:59 (China)
  - Coursework 3: 20/Dec/2023, 16:00 (UK)/23:59 (China)

- *Exam*: 4 questions, 25 points each, exam date TBC.

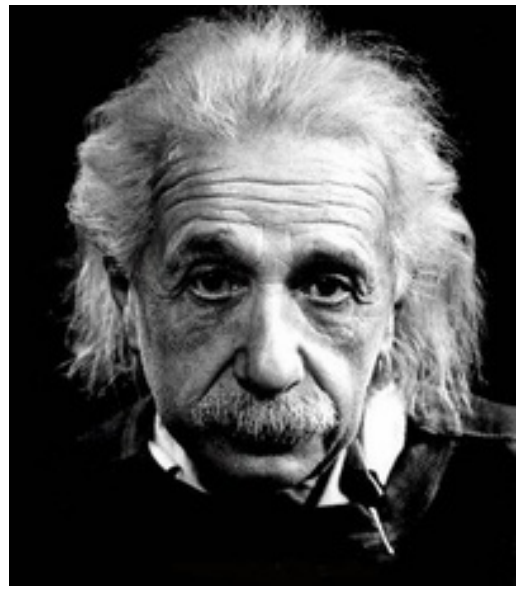
Question

- What do you think are the main topics of financial mathematics?

Answers

- There are many financial games. And in this module, we concentrate on two types of financial games.
  - Option games.
  - Portfolio optimization games.

Answers



"You have to learn the rules of the game. And then you have to play better than anyone else."

– Albert Einstein

Example: Option

- Suppose that a man wants to buy a house in a year from now. The current price is £95,000 and he believes the price will go up in a year. Therefore, he only wants to pay a guaranteed price of £100,000 even though the price may be higher than that. Are there any financial tools that would allow him to achieve this goal?

Example, cont.

- European call option contract tells you that it is possible for him to buy the house in a year from now, for a fixed price £100,000. However, to do that he needs to pay an extra fee, which is the price to buy the right.
- What is the price for him to buy the right? How much does he pay to have the current homeowner happily grant him this right?
- Obviously, the price should be fair enough for both parties to accept.

Option games

- One of the financial games is option games. Our task is to determine the option prices.

Example: Portfolio optimization

- Suppose that in a financial market, there are only two stocks (Tencent and Alibaba) available for investment. You have a lot of money and would like to invest your money in the two stocks to form a portfolio. Which of the following is a better portfolio?
  - A. 40% of money in Tencent, 60% of money in Alibaba;
  - B. 50% of money in Tencent, 50% of money in Alibaba;
  - C. 60% of money in Tencent, 40% of money in Alibaba.

Example, cont.

- We cannot answer this question intuitively.
- If both stocks have the same expected rates of return,
  - If the Tencent is more risky than the Alibaba, portfolio A would be better.
  - If the Alibaba is more risky than the Tencent, portfolio C would be better.
  - If the Tencent is as risky as the Alibaba, all the above portfolios are equivalent.
- What if both stocks are equivalently risky, but have different expected rates of return?

Example, cont.

- What about "20% of money in Tencent, 80% of money in Alibaba"?
- **Question 1**: Is there a better portfolio than all of the above?
- **Question 2**: What if both stocks have different expected rates of return and different risk levels?

Example, cont.

- Can we determine a pair of numbers (x, y) such that $x + y = 1$ and "x fraction of money in Tencent and y fraction of money in Alibaba" is the best portfolio among all feasible portfolios?

- Please note: x or y may be negative when short selling is allowed in the market.

Portfolio optimization

- Another financial game is portfolio optimization game. Our job is to identify the optimal portfolio.

Syllabus

1. Introduction to options;
2. Binomial tree models;
3. Brownian motion and stochastic differential equations;
4. Black-Scholes pricing models;
5. Monte-Carlo methods for option pricing;
6. Risk measures and Mean-variance portfolio theory;
7. Asset pricing models under equilibrium.