

# **FIN9007 Derivatives 2022**

## ***Group Project Guideline***

Work in a group of four students, write a report based on the following requirements. The report should be **No more** than 15 pages (including figures and tables, excluding title page, references, and appendix). 1.5 line spacing. 12-point font size. Reasonable margin.

### **Requirements for the Code:**

- a. R is used as the coding software. R studio is used as the IDE in this module.
- b. Code should be added in the appendix of the report.
- c. Code should contain no bug. Anyone can rerun your code.

### **Requirements for figures and tables:**

Figure or tables must appear in the body of the text (often at the top of a page) possibly near where they are referenced in the text. Underneath the figure or table, there should be a sequential number and a caption with a brief description of what it is about. Use of a different font or font size or boldface/italics is recommended to distinguish the caption from the main text.

### **Sample Data:**

- a. 2010-2020 daily close S&P 500 index level
- b. 2010-2020 daily close SDPR ETF
- c.
  - 1. S&P 500 E-mini futures daily settlement price on 20200110
  - 2. S&P 500 E-mini futures (Delivery Date 20200619) daily settlement price from 20190315 to 20200619
- d.
  - 1. Daily SPX option price on 20200110
  - 2. Daily SPX option price (Expiry Date 20200619) from 20180620 to 20200618
- e.
  - 1. Daily SPY option price on 20200110
  - 2. Daily SPY option price (Expiry Date 20200619) from 20180620 to 20200618

## **Assignments:**

1.1 Present and comment on the summary statistics of S&P 500 index, SDPR ETF, S&P 500 E-mini futures, SPX options, and SPY options. (5%)

1.2 Present and comment on the relationship between S&P 500 index and SDPR ETF. (5%)

1.3 Use time series of S&P 500 futures prices, present and comment the relationship between S&P 500 futures and S&P 500 index level. (5%)

2.1 Estimate the put-call parity implied underlying asset price. Compare the put-call parity implied underlying asset price with the S&P 500 index level and S&P 500 futures price. Calculate put-call parity implied interest rate and dividend yield. Does put-call parity implied underlying asset price always move in the same direction as the S&P 500 index level? (15%)

2.2 Compare option price bounds and the market option prices. Does option prices within the theoretical bounds? Is there an arbitrage opportunity? (5%)

3.1 Use binomial tree model, calculate both SPX and SPY option prices. Are option prices calculated from the binomial tree model consistent with market option prices? (10%)

4.1 Choose a trading date, use Wiener process, Generalized Wiener process (Brownian motion), and Geometric Brownian motion (GBM), to simulate future S&P 500 index level, and plot the distribution at expiry. Comment whether those stochastic processes well describe the index movement. (5%)

5.1 Use the Black-Scholes formula to calculate SPX option prices. Are option prices calculated from the Black-Scholes formula consistent with market option prices? (5%)

5.2 Use GBM and Monte Carlo simulation to calculate SPX option prices. Compare computed option prices and market option prices. (10%)

6. Based on the Black-Scholes formula and binomial tree model, calculate implied volatility of SPX and SPY options. Plot and comment option implied volatility curves. What is the relationship between option implied volatility, conditional expected volatility, and realised volatility? (10%)

7.1 Estimate and comment on S&P 500 index historical volatility. Use GARCH and EWMA model to estimate S&P 500 conditional volatility. (5%)

7.2 Compare GARCH and EWMA models in forecasting S&P 500 conditional volatility. (5%)

8.1 Choose an ATM SPX option contract. Use the Greek letters to comment on the option price changes over time. Do the Greek letters explain the changes in option prices? And why? (10%)

8.2 Use SPY ETF or SPX futures to create a synthetic option (ATM, at least 30 days time to maturity, choose the start date and option specs by yourself). Compare the performance of the synthetic option and the exchange traded option. (5%)