

**MTH6113 Assessment 2 – Deadline April 12<sup>th</sup> at 5PM.**

**Please submit two files on QMPlus – one excel and one pdf with the explanations for question 1 and solutions for question 2 and question 3.**

1. Using the same stocks from Assessment 1, plot their returns and their prices. For each stock use their empirical means and standard deviations to simulate their corresponding lognormal models. Explain your results. What are the drawbacks of the lognormal model for stock prices, based on your data.

[50 marks]

Excel – 30 marks

Explanations - 20 marks

Based on the diagram for the actual returns we observe:

- Volatility clustering: we can observe periods of large volatility and low volatility; 5 marks. Possible no-autocorrelation (not always and not easy to identify from the diagram only) – no marks deduction for not mentioning this.
- Heavy tails – spikes in the returns, 5 marks
- The lognormal model does not capture these features, 5 marks.
- Extra 5 marks, for identifying some of the spikes with real events (e.g. earnings announcements/ CEO departures, positive/negative news, etc); histograms for empirical data and lognormal model for comparison.

Note that some students stated the opposite in their answers: the features of empirical observations, for the lognormal model as they did not realise that the diagrams had different scales.

2. In a market in which the Arbitrage Pricing Theory (APT) model holds, the expected return is given by

$$E[R_i] = \lambda_0 + \beta_{i,1}\lambda_1 + \beta_{i,2}\lambda_2 + \dots + \beta_{i,n}\lambda_n$$

- a) Assume that risk-free rate in this economy is 0.02. Consider a two-factor model,  $n = 2$  and two well diversified portfolios  $P_1$  and  $P_2$  with the following features:

	$P_1$	$P_2$
Expected returns: $E(R_i)$	0.18	0.05
Sensitivity to factor 1: $\beta_{i,1}$	0.2	0.1
Sensitivity to factor 2: $\beta_{i,2}$	0.7	0.3

Find the risk premiums for each factor.

[15 marks]

Answer:

First  $E[R_i] = \lambda_0 = 0.02$

$$0.18 = 0.02 + 0.2\lambda_1 + 0.7\lambda_2$$

$$0.08 = 0.02 + 0.1\lambda_1 + 0.3\lambda_2$$

$$0.16 = 0.2\lambda_1 + 0.7\lambda_2$$

$$0.06 = 0.2\lambda_1 + 0.6\lambda_2$$

$$\lambda_1 = \frac{\lambda_2 = 1}{0.06 - 0.6} = -2.7$$

- b) Assume there is another well diversified security  $P_3$  in this economy with factor sensitivities,  $\beta_{3,1} = 0.2$ , and  $\beta_{3,2} = 0.7$ . The expected return of this security is  $E(R_3) = 0.25$ . State whether the APT is satisfied. If yes, explain why, if not propose an arbitrage strategy.

[15 marks]

Answer:

$P_3$  has the same exposure to the factors as  $P_1$  but has a higher return than what the APT says.

This means that the new portfolio  $P_3$  is underpriced by the market.

An arbitrage strategy is a costless strategy that generates profits in all states of the world.

In this case an arbitrage strategy is to buy  $P_3$  and short sell  $P_1$ .

- 3 As a result of the COVID-19 crisis there was a global move to home working, and increased reliance on video conference facilities such as those offered by Zoom Video Communications. At the same time there was a sudden increase in trading volumes for Zoom Technology shares. The latter is a company that sells electronic technology for mobile phones. It was soon established that this was a clear case of mistaken identity. Please propose and explain a test for establishing whether the markets are efficient in this case.

[20 marks]

Students should discuss all 3 forms of market efficiency – and correctly identify that this example captures how fast the new information coming on the market is incorporated into the stock prices – in particular speed of adjustment. Hence, we will be testing semi-strong form efficiency (2 points for definition of each form efficiency = 6 points+ 2 points identifying correctly that we are looking into semi-strong efficiency) = total 8 points.

One possible test would be to test whether the **short ratio** (short interest) for Zoom Technology rapidly increases over a short period in time – this means that investors realise their mistake fast and dump the stock back on the market. Other measures could be looking at the **volume of trades**, etc. 6 points.

In terms of looking at **returns** – we should see a sharp decrease in the returns of Zoom Technology over a short period of time once the mistake is identified - for the markets to be semi-strong efficient. 6 points.

Different answers would be considered (e.g. event studies).

If students look only at statistical tests for testing weak form efficiency they will receive only 4 marks.