

MSc AI – Fintech

Module Assignment – Part 1

Students are required to answer all questions.

Question 1

The objective of this question is to analyse the data for different instruments, based on last year's data, and provide your opinion in terms of their respective risk and return.

- (i) Download daily closing price data for S&P 500, FTSE 100 and Gold (SPDR) for the years 2014 to 2017.
- (ii) Why log returns are normally preferred from standard arithmetic returns?
- (iii) Identify the first 4 distribution moments for each index/product mentioned in part (i). For your calculations utilise daily log returns. In your answer describe the calculations/steps performed.
- (iv) Comment on the measured statistics from the perspective of risk and return. In your answer compare the results obtained.
- (v) Annualize daily return (first moment) and volatility (second moment). In your scaling process assume 250 days for the year. In your answer describe the calculations/steps performed.
- (vi) By considering the last closing price at the end of 2017, and the annualized volatility from question (v), what would be the price level of S&P 500 after 1 month, that according to normal probability, there is a 32% chance that the actual price will be above it. Show your workings.
- (vii) Download the Google and Amazon daily prices for the last 5 years (till 31/12/2017). By utilizing a regression model, perform the Beta-test against the S&P 500 index. Comment on your findings.

Question 2

Modern or mean-variance portfolio theory (MPT) is a major cornerstone of financial theory. Based on this theoretical breakthrough the Nobel Prize in Economics was awarded to its inventor, Harry Markowitz, in 1990. Using the data from Question 1, we need to investigate the right allocation across a portfolio made up of 3 investments, S&P 500, FTSE 100 and Gold (SPDR).

- (i) In question 1, you identified the individual expected return and volatility of the 3 investments separately. Calculate the expected return and volatility of the portfolio, considering equal weight for the 3 investments.
- (ii) Investigate different portfolio expected return and volatility by simulating different random weights of your investments (2000 simulations). Assume that all weights have to be >0 and that the sum of all weights should be equal to 1. Create a plot showing the expected return (y-axis) and volatility (x-axis) for different/random portfolio weights.
- (iii) Using an optimisation library (e.g. using solver in excel or an optimisation library in python), identify the two portfolios that will return (a) the highest Sharpe ratio and (b) the lowest Value at

Risk. For the Sharpe ratio, assume that the risk free rate is zero. Using the plot in question (ii), indicate the position of these two portfolios.

In your answers explain the method/steps used.

Question 3

Under the assumption of Markov property, the Binomial tree provides a method of how the future price of an instrument, can be modelled. By investigating the statistics of Google daily returns for the last 5 years (till 31/12/2017), construct a binomial tree model that projects Google stock price for the first 6 months of 2018, on a monthly basis.

(i) Present the projected probability and stock price binomial trees.

(ii) Utilizing the binomial tree from (i), what is the probability that at the end of the 6 month period the price will be greater than the starting price.

(iii) Calculate the expected stock price, on a monthly basis.

In your answers explain the method/steps used.