



**CASS BUSINESS SCHOOL**

**MSC ENERGY, TRADE AND FINANCE**  
**MSC SHIPPING, TRADE AND FINANCE**

**ACADEMIC YEAR 2020-2021**

Coursework: Advanced Quantitative Methods

Lecturer: Prof Amir Alizadeh

**Notes:**

This coursework carries 50% of the overall mark for the Advance Quantitative Methods unit and should be completed **in groups of 4 students**. Students are allocated into groups and must producing the report and submit it as a group. Any attempt to copying or replicating other peoples' work will be considered as plagiarism and will result in the failure of both groups/parties.

Answers, excluding the data and computer output, should not exceed 10 to 12 pages. Therefore, answer each question briefly and precisely without omitting relevant points. Tables containing summary of the results should be included in the main text while data, estimation output, etc. should be relegated to appendices. Each group should submit three files

- 1- A typed coursework in word or pdf.
- 2- One excel file contain data and analysis.
- 3- Eviews workfiles (task 1 and 2) for econometric analysis.

The deadline for the coursework is 5pm London time Friday 2nd April 2021. There will be a 5% per day penalty for late submissions.

**Objectives:**

Having completed this coursework the students should be able to:

- Use excel and Eviews to process and analyse the data, produce tables graphs and perform regression analysis, including diagnostic tests and hypothesis testing,
- Perform forecast and evaluate the performance of different types of forecasting techniques,
- Perform simulations, analyse the outcome and make decisions based on the outcome,
- Solve linear programming problems and use them for optimisation

### Task 1

According to the CAPM, the market is the only source of risk and excess return on a security (risk premium) should only be explained by systematic risk; that is the security's sensitivity to the changes in the market, which is a well-diversified portfolio. To test this argument, collect monthly prices and dividend (or DY) for 30 stocks from any stock market over the last 5 years. Collect monthly values of the relevant stock market index and its dividend (or DY), as well as the risk free rate (e.g. 3-month US T-Bill). Finally, collect market cap, earnings, and total debt for the 30 stocks you have chosen.

- 1- Calculate monthly returns for each stock over the past 5 years for each stock and estimate the mean and standard deviation of returns for each company, as well as stock index.
- 2- To investigate the sensitivity of stock returns to market, we use CAPM and estimate the following regression for each stock

$$(r_t - r_{f,t}) = \alpha + \beta(r_{m,t} - r_{f,t}) + \varepsilon_t \quad ; \quad \varepsilon_t \sim \text{iid}(0, \sigma^2)$$

where,  $r_t$  is return on stock,  $r_{f,t}$  is risk free rate,  $r_{m,t}$  is the market return at time t.  $\alpha$  and  $\beta$  are coefficients of the regression, and  $\sigma^2$  is the variance of estimated residuals.

- 3- You should obtain 30 alphas, 30 betas, and 30 sigmas. Find the average of the estimated coefficients.
- 4- To assess the validity of CAPM, we can estimate the following regression

$$(\bar{r}_i - \bar{r}_f) = \gamma_0 + \gamma_1 \hat{\beta}_i + \gamma_2 \hat{\sigma}_i + \gamma_3 C_i + \gamma_4 EP_i + \gamma_5 DE_i + \varepsilon_i \quad ; \quad \varepsilon_i \sim \text{iid}(0, \sigma^2)$$

where  $C_i$ ,  $EP_i$ , and  $DE_i$  are market capitalization, earning to price ratio, and debt to equity ratio for stock, i.

- 5- Test the significance of each coefficient ( $\gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5$ ) and comment on your results, including the goodness of fit.

[25 Marks]

### Task 2

Download monthly prices for a commodity of your choice or shipping freight rate for a single shipping route over the past 20 years (end of the data should be Feb 2021).

- 1- Partition your sample into estimation and ex-post periods, with ex-post being 4 years. Use the observations in the estimation period to estimate 3 different models, e.g. Econometric Model, ARMA, Exponential Smoothing, etc. Perform diagnostic tests, present the final estimation outcome and the diagnostics in each case, and discuss the results.
- 2- Use appropriate technique to compute forecast values for 1 to 48 months ahead, over the ex-post period (last 4 years; i.e. March 2017 to February 2021) of the sample with the 3 models you have estimated in part 1.
- 3- Use appropriate statistics to evaluate the forecasting performance of each model and compare forecasting performance of models.
- 4- Choose the best model and prepare a short report including forecast values on how freight rates are going to behave over the next 12 months, March 2021 to February 2022 and present your forecast.

[25 Marks]

### Task 3

Collect daily returns for 15 stocks from any stock market over the last year (end of sample should be end of Feb 2021). Assuming you are going to invest £1m in these stocks, use Excel to perform the following analyses, assuming no short selling. If you are investing in non UK markets convert the amount using the current FX rate.

- 1- Measure the expected return and risk of an equally weighted portfolio of the stocks,
- 2- Measure the correlation between the stocks in your portfolio,
- 3- Measure the one-week 5% VaR of an equally weighted portfolio of stocks using the variances and correlation between stocks,
- 4- Find the optimum weight for each stock included in the portfolio in order to minimise the variance of portfolio given 3 different levels of expected returns (e.g. 5% per year, 10% per year and 15% per year; or 2%, 5% and 8% per year, etc),
- 5- Find appropriate weights to optimize risk-return of the portfolio,
- 6- Measure the one-week 5% VaR of the portfolio of stocks with minimum risk using the variances and correlation between stocks,
- 7- Find the 5% ETL of the portfolio of stocks with minimum risk using the variances and correlation between stocks,
- 8- Comment on your results in terms of risk management of this portfolio.

[25 Marks]

### Task 4

Management of a petrochemical company producing special type of polymer is trying to control its inventory costs based on the optimum production policy. The weekly cost of holding one unit of this product in inventory is \$300 (one unit is 100kg). The marketing department reckons that weekly demand is reasonably close to a lognormal distribution with an average of 120 units and standard deviation of 40 units.

If the demand exceeds the amount of product on hand, those sales are lost - i.e. there is no backlogging of demand. The production department can produce at one of the three levels: 100, 120 or 140 units per week. The cost of changing production from week to the next is \$30,000.

Management would like to evaluate the following production policy. If the current inventory is less than  $l=30$  units, then produce 140 units in the next week. If the current inventory is more than  $u=80$  units, then produce 100 units next week. Otherwise, if the current inventory is between  $u=80$  and  $l=30$  units, then produce 120 units next week. The company currently has 60 units of inventory on hand and last week's production level was 120.

- 1- Create a spreadsheet to simulate 52 weeks of operation at this manufacturer. Preset the graph of the inventory over time. What is the total cost (inventory cost plus production change cost) for the 52 weeks?

- 2- Use a simulation of 10,000 trials to estimate the average 52-week cost with values of  $u$  ranging from 50 to 100 in increments of 5. Keep  $l=30$  for all trials.
- 3- Calculate the sample mean and standard deviation of the 52-week cost under each policy. Using those results, construct 90% confidence intervals for the average 52-week cost for each value of  $u$ . Make and present a graph of the average 52-week cost versus  $u$ . What is the best level of  $u$  when  $l=30$ ?
- 4- What would be the optimum level of  $u$  and the average weekly cost if we adapt the following policy: “produce 140 if inventory level less than 30, produce 100 units if inventory level is more than 80, but keep the production level same as last week if  $30 < I < 80$ ”.
- 5- After studying the historical demand figures in more detail, the manufacturer finds that there is some degree of seasonality in the demand; in the sense that demand increases by 15% and 10% in 2<sup>nd</sup> and 3<sup>rd</sup> quarters, respectively, and declines by 10% and 15% in quarters 4 and 1, respectively. Incorporate seasonality in simulation setting and calculate the new level of  $u$  to minimize the overall cost. (Assume the first week is the first week of the year.)
- 6- What other production policies might be useful to investigate?

[25 Marks]

Good Luck!!