

January Examination Period 2022-23

ECN382 Portfolio Management

Duration: 2 hours

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UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR**

Answer ALL questions

You are permitted to bring 20 x A4 pages of notes into your examination (i.e. 10 double-sided pieces of paper). These can be typed or handwritten and can include graphs and images. They can include material from any source.

Your notes must be stapled together and include your student ID number and the module code on the first page. You must submit your notes at the end of the examination with your answer booklet.

Calculators are permitted in this examination. Please state on your answer book the name and type of machine used. Complete all rough workings in the answer book and cross through any work that is not to be assessed.

Possession of unauthorised material at any time when under examination conditions is an assessment offence and can lead to expulsion from QMUL. Check now to ensure you do not have more than 20 pages of notes. You should also not have mobile phones, smartwatches or unauthorised electronic devices on your person. If you do, raise your hand and give them to an invigilator immediately.

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EXAM PAPERS MUST NOT BE REMOVED FROM THE EXAM ROOM

Examiner: Dr Debapriya Paul

Question 1 [25 marks]

- a) Table 1 below shows mean excess returns (returns in excess of the risk-free rate), standard deviations, Sharpe ratios, and CAPM alphas for value strategies. The table is from the paper “Value and Momentum Everywhere” by Asness, Moskowitz and Pedersen (2013), discussed in the lectures. The results are reported as annualised numbers.

<u>Table 1</u>				
	Value Portfolios			
	P1	P2	P3	P3 – P1
Mean	9.5%	10.6%	13.2%	3.7%
(<i>t</i> -stat)	(3.31)	(4.33)	(5.19)	(1.83)
Stdev	17.9%	15.4%	15.9%	12.8%
Sharpe	0.53	0.69	0.83	0.29
Alpha	–1.7%	0.8%	3.6%	5.3%
(<i>t</i> -stat)	(–1.59)	(1.02)	(3.17)	(2.66)

Describe the construction of a value strategy and interpret the results reported in the table.

[8 marks]

- b) Table 2 shows the results of momentum strategies, from the same paper.

<u>Table 2</u>				
	Momentum Portfolios			
	P1	P2	P3	P3 – P1
Mean	8.8%	9.7%	14.2%	5.4%
(<i>t</i> -stat)	(2.96)	(4.14)	(4.82)	(2.08)
Stdev	18.6%	14.8%	18.5%	16.4%
Sharpe	0.47	0.66	0.77	0.33
Alpha	–2.3%	0.2%	3.7%	6.0%
(<i>t</i> -stat)	(–1.68)	(0.29)	(2.34)	(2.30)

Describe the construction of a momentum strategy and interpret the results reported in the table.

[8 marks]

- c) Table 3, taken from the same paper, shows the effect of combining value and momentum strategies with equal weights.

<u>Table 3</u>	
50/50 Combination	
P3 – P1	
Mean	4.6%
(<i>t</i> -stat)	(3.98)
Stdev	7.2%
Sharpe	0.63
Alpha	5.7%
(<i>t</i> -stat)	(5.05)

Discuss these results, making sure to draw relevant comparisons to the results in Tables 1 and 2.

[9 marks]

Turn Over

Question 2 [25 marks]

The following information applies to parts 2a to 2c only. Assume that asset returns in an economy depend on the realisation of two zero-mean risk factors, denoted by $\tilde{I}_1$ and $\tilde{I}_2$. Three well-diversified portfolios, denoted by A, B and C, are available whose returns are given by the following expressions:

$$R_A = 0.06 + 2\tilde{I}_1 + 4\tilde{I}_2$$

$$R_B = 0.04 - \tilde{I}_1 + 3\tilde{I}_2$$

$$R_C = 0.08 + 3\tilde{I}_1 + 3\tilde{I}_2$$

- a) Use assets A, B, and C to construct factor-replicating portfolios for Factor 1, Factor 2 and for the risk-free asset in this economy. Show your calculations. [9 marks]
- b) Write the APT pricing equation in this economy. [4 marks]
- c) A fourth asset, denoted by D, is introduced in this economy. Its returns are given by

$$R_D = 0.09 + 4\tilde{I}_1 + 2\tilde{I}_2$$

Are there any arbitrage opportunities in the economy? Explain. If such arbitrage opportunities exist, specify exactly how you would implement the arbitrage, assuming that only assets A, B, C and D can be traded (i.e., you cannot trade the portfolios you constructed in part 2(a) directly). [7 marks]

- d) Assume that the CAPM holds, in which case, the return on any asset i can be written as:

$$R_i = r_f + \beta_i(R_m - r_f) + \varepsilon_i$$

where r_f is the risk-free rate, R_m is the return on the market portfolio, and ε_i is the idiosyncratic return, with $\mathbb{E}[\varepsilon_i] = 0$. Assume that the risk-free rate is constant, and that the idiosyncratic return is uncorrelated with both the market return and the idiosyncratic return of any other asset. There are N risky assets in the economy. Denote by μ_m and σ_m^2 the expected excess return and the variance of the excess return of the market portfolio.

If P is an efficient frontier portfolio with CAPM beta equal to β_P , explain why P has the least idiosyncratic risk among all portfolios with CAPM beta equal to β_P (Hint: you may find it useful to write expressions for the expected return and variance of a portfolio in this economy).

[5 marks]

Question 3 [25 marks]

You want to use the Black-Litterman model to decide on your investment allocation across US equity sectors, for which the current market capitalisation (in US\$ trillion) is shown in Table 4 below.

Table 4	
Sector	Market Cap
Communication Services	3.79
Consumer Discretionary	6.18
Consumer Staples	4.16
Energy	3.79
Financials	7.42
Health Care	7.41
Industrials	4.81
Information Technology	11.27
Materials	2.10
Real Estate	1.31
Utilities	1.54
Total	53.78

You also have historical data for the returns of the sector indices.

- Denote the (known) variance-covariance matrix of sector excess returns as Σ , and the risk-aversion parameter of a representative agent (i.e. you) as λ . Show how you can derive the market-implied expected excess returns (denoted by the vector Π) for these sectors. Determine your equilibrium sector weights if you agree with these expected excess returns. **[5 marks]**
- Suppose excess returns for all sectors have the same variance and are uncorrelated (this statement is only true for part 3(b) and does not apply to the other parts of this question). That is, Σ has the same diagonal terms, and all the off-diagonal terms are zero. Is the expected excess return of the Energy sector higher or lower than that of the Financials sector? Explain. **[5 marks]**
- Now, suppose you have uncertainty regarding the market-implied estimate of these sector expected excess returns, so that your beliefs for expected excess returns (denoted by the vector μ) are captured by the following specification:

$$\mu = \Pi + \epsilon_M$$

where the vector ϵ_M is normally distributed with mean 0 and variance-covariance matrix $\tau\Sigma$. How does the introduction of these prior beliefs affect your optimal portfolio weights in these sector indices and the risk-free asset? Show your calculation and explain the intuition. Suppose τ is increased, how would your investment in the risk-free asset change? Explain. **[5 marks]**

Turn Over

d) You have developed two views regarding the future expected excess returns of these sectors. They are:

- the Energy sector will outperform the Real Estate sector by 1.2% over the next investment period; and
- the Information Technology sector will underperform the market-value-weighted average of Industrials, Utilities and Consumer Staples by 0.8%.

Specify these views in terms of the view matrices P and Q discussed in the lectures. **[5 marks]**

e) You recognise that there is uncertainty regarding whether your views will prove correct, so that if

$$P\mu = Q + \epsilon_V,$$

you believe that ϵ_V is normally distributed with mean 0 and variance-covariance matrix Ω . Carefully explain how to combine these views with your prior beliefs about μ to update your estimates for expected returns and variance of the returns of these eleven sectors, providing explicit expressions for them. Describe qualitatively how you would expect the resulting optimal weights for each sector to differ from those from part 3(c). **[5 marks]**

Question 4 [25 marks]

XYZ, a pension fund, has a liability of \$100 million due in 5 years. The fund's only asset is \$70 million held in cash. Two bonds, A and B, are currently trading in the market. Bond A is a 3-year, 7.5% coupon bond with a face value of \$100; coupons are paid annually. Bond B is a perpetuity with an initial cash flow of \$5 in one year's time, with cash flows growing thereafter at 2% per year. Throughout this question, assume the term structure of interest rates is flat at 10%.

(a) Calculate Bond A's Macaulay Duration. **[6 marks]**

(b) The Macaulay Duration of a growing perpetuity with initial cash flow C_1 (at time 1), cash flow growth rate g , and discount rate r is given by:

$$D_{Mac} = \frac{1 + r}{r - g}$$

Using this expression, calculate the Modified Duration of Bond B. **[3 marks]**

(c) To manage its interest rate risk exposure, XYZ proposes creating a portfolio of bonds A and B such that the following two conditions are met:

- The current values of the bond portfolio and the company's liability are the same.
- The change in the value of the bond portfolio in response to a small, parallel shift in the term structure matches the change in the value of the company's liability.

How many units of Bond A and B must the company purchase today? **[10 marks]**

(d) Explain why the immunisation strategy in (c) is not static and outline some of the practical limitations faced by the bond portfolio manager in implementing such a strategy. **[6 marks]**

End of Paper

End of Examination/ Debapriya Paul