THE INSTITUTE OF ACTUARIES OF AUSTRALIA

INVESTMENT MANAGEMENT **2001 EXAMINATIONS**
PAPER TWO

SOLUTIONS

The purpose of this document is to assist candidates in their preparation for future examinations. It is emphasised, however, that the solutions herein are not necessarily the only solutions or the best solutions, especially for those questions testing judgement. They should be regarded as illustrative only. However, a candidate who covered all the points in the specimen solution in the examination would have scored a very comfortable pass. This document should be used in conjunction with the 2001 Examiner's Report which is on the IAAust web site.

QUESTION 1 (9 Marks)

You are an asset consultant, with multiple superannuation fund clients under advice.

a) You have previously advised a client to invest 100% with Manager C based on Manager C's claim to limit its' tracking error to 6% and the client's desire to invest in a "relatively low risk manager". He is furious that the latest figures he has seen (which are reproduced above) show that the manager has the third highest tracking error and it is in excess of 6% p.a.

Draft your reply using information included in Table A below. (4 marks)

Table A. Performance Survey

	3 Months to 31/03/01		*1 YR TO 31/03/01*		*3 YRS TO 31/03/01*	
Manager/Fund	***Standard Deviation***	***Tracking Error***	***Standard Deviation***	***Tracking Error***	***Standard Deviation***	***Tracking Error***
	(%pa)	***(%pa)***	***(%pa)***	***(%pa)***	***(%pa)***	***(%pa)***
Manager A	*17.4*	*15.5*	*12.2*	*8.3*	*15.6*	*11.9*
Manager B	*14.4*	*12.0*	*10.5*	*11.1*	*14.0*	*10.3*
Manager C	*10.6*	*8.4*	*9.8*	*6.3*	*11.1*	*5.0*
Manager D	*14.2*	*5.4*	*11.1*	*3.6*	*12.8*	*5.2*
Manager E	*12.7*	*5.0*	*13.6*	*3.8*	*12.9*	*3.9*
Manager F	*12.7*	*5.0*	*11.0*	*2.8*	*12.8*	*4.8*
Manager G	*11.6*	*4.4*	*11.4*	*3.7*	*11.8*	*5.1*
Manager H	*10.9*	*4.4*	*9.7*	*3.2*	*10.7*	*3.9*
Manager I	*12.0*	*4.4*	*10.4*	*2.9*	*11.3*	*2.8*
Manager J	*11.8*	*4.1*	*13.5*	*2.8*	*12.2*	*3.7*
Manager K	*12.9*	*3.8*	*11.6*	*3.3*	*11.8*	*3.3*
Manager M	*13.4*	*3.4*	*12.9*	*2.8*	*12.5*	*3.2*
Manager N	*11.9*	*3.0*	*10.4*	*2.5*	*11.3*	*3.0*
Manager O	*12.8*	*2.7*	*11.7*	*2.3*	*12.2*	*2.5*
Manager Q	*10.0*	*2.5*	*10.5*	*2.8*	*10.3*	*2.5*
Manager R	*12.1*	*2.5*	*12.2*	*2.4*	*11.9*	*2.3*
Manager T	*12.3*	*2.3*	*10.8*	*2.7*	*11.8*	*2.6*
Manager U	*11.9*	*1.9*	*10.9*	*3.5*	*11.3*	*3.0*
Manager V	*12.2*	*1.8*	*11.8*	*2.5*	*12.0*	*2.4*

NB: All calculations have been based on monthly return figures

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Model Solution:

Part a:

- 3 mths is too short a time to measure tracking error – not statistically significant
- Even 1 year isn't really long enough
- Tracking error isn't the same as risk
- Standard deviation over the year is actually the second lowest
- Standard deviation has decreased as tracking error has increased – maybe they avoided volatile stocks which outperformed

(One mark per point, max 4 marks)

b) You have decided to move 50% of the client's money to another manager, with the aim of minimising the tracking error of the combined portfolio. What additional statistic would you require to do this? (2 marks)

Model Solution:

Part b:

- You need the covariance matrix (1 mark) of the excess (1 mark) returns.

c) What impact do you think this would have on the information ratio of the combined portfolio (going forwards), and why? (3 marks)

Model Solution:

Part c:

- The tracking error should decrease – due to the diversification, and also if a lower tracking error manager is chosen
- The value added may decrease slightly if low tracking error means less value added, or you may assume it is unchanged if value added is not proportional to tracking error.
- If value added is unchanged and tracking error decreases, information ratio clearly increases.
- Information ratio is likely to increase anyway, as diversification benefit should be bigger than loss of value added.

(One mark per point, Max 3 marks)

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QUESTION 2 **(9 Marks)**

A large super fund is planning to split its international equity exposure between four managers. Three alternative ways of doing this have been proposed:

1. ***Four global managers with different styles, namely one large cap growth, one large cap value, one small cap growth, and one tactical asset allocation specialist***
2. ***Four regional managers covering North America, Europe, Japan and Emerging markets***
3. ***Four sector specialists, namely Technology/ Capital goods, Consumer goods/Pharmaceuticals, Resources and Financials***

Discuss the merits of each alternative, focusing in each case on the potential for the total portfolio to outperform its global index benchmark (Salomon Brothers Broad Market Index ($A)).

Model Solution

The assumption behind each approach is that a manager should focus on one method of adding value. The question then is which is likely to be most effective.

1. The large cap managers will be complementary, and assuming a reasonable degree of market efficiency (ie if stock selection doesn't add much) will not add a great deal of value on average. The small cap manager can add considerable value, and so can the TAA manager but in both cases at the cost of a lot of risk.
   (*1 mark per point, max 3*)

2. These managers are exploiting local expertise. Competition would indicate that there is not much scope for added value in North America, or to a lesser extent in Europe. More opportunity exists in the other two, but they only account for around 20% of the total. Around 50% would be in the US where expectation of added value is lowest. (*1 mark per point, max 3*)

3. These managers are industry specialists who focus on cross-border anomalies. It is possible to argue that cross-border research is less intensive than local country research, and so there is greater scope for exploiting pockets of inefficiency this way. The risk issue is whether the four sectors (as defined) add up to total market coverage. The benchmarks for each manager would need to be carefully defined and monitored. (*1 mark per point, max 3*)

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QUESTION 3 **(10 Marks)**

a) ***You are an actuary with clients who are superannuation trustees. One of your trustee clients has asked you to help find a buyer for a large parcel of shares in a life insurance company to which their fund has become entitled through a recent demutualisation. You would receive a commission of 0.5%. Explain with reasons what circumstances would need to apply to you to be able to advise on this:***

i. ***under Corporation Law***
ii. ***under the Institute of Actuaries Professional Standards and Guidance Notes***

(5 marks)

Model Solution

Part a

(i) You would need property authority under a dealers licence (1 mark). This is advice on securities (1 Mark) where a commission is payable (1 mark)

(ii) GN151 provides under the section 2.3, a requirement for experience, information resources and property authority where advice is provided on specific investments (1 mark). This would reinforce the requirement under part (i). It also implies requirement to have information to analyse the stock and the relevance of it to the client portfolio (1 mark).

[5 Marks in total]

b) ***Assuming you are able to advise clients on the share offering referred to in Part a), explain how you would identify other clients whose investment arrangements might indicate an interest in purchase of these shares and the allocations they might be able to make to them.***

(3 marks)

Model Solution

Part b

Other clients would need to have investment portfolios which included shares. This would be a primary indication from their existing investments that their investment objectives were appropriate to invest in shares. (1 mark)

If you did not have details of clients' current investments you would need to consider their investment objectives and time horizon of investment to see whether an allocation to shares is appropriate (1 mark).

You would also need to consider whether the client had an understanding of the shares as an asset class and how they might ensure that diversification across asset class and across different securities within each asset class was appropriate. If they didn't have this understanding from recent advice you would need to cover these issues at the same time as making the offer of shares (1 mark).

[3 Marks in total]

c) You are another actuary who has been contacted by the actuary in Part a) to see if any of your clients may be interested in purchase of the shares. What circumstances need to apply for you to be exempted from adviser and dealer licensing under ASIC Policy Statement 120 if you refer one of your clients to the other actuary?

(2 marks)

Model Solution

Part c

You must do nothing more than merely introducing your client to the other actuary (1 mark) who you have checked is appropriately licenced to give the advice (1 mark).

[2 Marks in total]

QUESTION 4 **(16 Marks)**

An Australian superannuation fund has $2 billion in assets. Members' benefits are determined each year as: opening balance, plus contributions less expenses, plus interest at the rate earned on the Fund's assets.

The Trustee of the Fund has made a decision to move from the current strategy (which has 15% of assets invested internationally) to a new strategy with 50% of assets invested internationally, as follows:

	Current	***New***
Australian Shares	*45%*	*25%*
International Shares	*15%*	*25%*
Australian Listed Property	*10%*	*5%*
International Listed Property	*-*	*5%*
Hedge Fund	*-*	*10%*
Total "Growth" Assets	***70%***	***70%***
Australian Fixed Interest	*25%*	*15%*
International Fixed Interest	*-*	*10%*
Australian Cash	*5%*	*5%*
Total "Income" Assets	*30%*	*30%*

The international listed property exposure is to be gained by investing exclusively in US Real Estate Investment Trusts. The Hedge Fund exposure is to be gained by investing in a single hedge fund managed in the US.

a) ***The Fund's Trustee Board has approached you to provide advice concerning the level of currency hedging that is appropriate in the long term. They have told you that they are concerned about the timing of the change, given that at the time of the change the Australian Dollar has recently traded at US51c. In particular they are concerned about underperforming their "peer group" of funds if the Australian dollar strengthens. This "peer group" typically invest 20%-25% of assets internationally, the majority of which is unhedged.***

The Trustee Board have asked you to write to them outlining what level of currency hedging is appropriate overall and in particular which of the asset classes outlined above should be hedged back into Australian dollars.

Draft the letter to the Trustee; if necessary indicate any further analysis that you would wish to perform or extra information that you would require. (11 marks)

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Model Solution

Part a

Form & clarity of letter (given that it is addressed to Trustees, who are not necessarily investment professionals) (0.5 marks)

General:

- Some exposure to other currencies introduces diversification benefits, therefore it makes sense not to hedge all overseas currency exposure. (1 mark)
- There are additional management and transaction costs involved in hedging. (1 mark)
- Strategic asset allocation is a long term decision, and therefore the current level of the Australian dollar should not be given undue weight in the decision making process. (1 mark)
- This is an accumulation fund so members are bearing the investment risk. Furthermore as there is no smoothing of returns from year to year this is fully reflected in the investment earning rate credited to members each year. They are "used to" currency exposure of 15%, and so some currency hedging is probably appropriate, as a foreign currency exposure of 50% is likely to be too high for the membership. (1.5 marks)
- Rather than considering each asset class separately, an alternative is to consider what proportion of total assets the Trustee wants to be exposed to currency risk, and then appoint a currency overlay manager to implement this. (1. mark)
- Students could suggest that the Trustee makes the transition to the new strategy over a period (eg. 12 months) to minimise the "market timing" risk associated with an immediate move. (1 mark)

Competitor Positioning and Regret

- We are told that the average competitor fund invests 20-25% of assets internationally, most of which is unhedged. Therefore "business risk" would be minimised by hedging 25-30% of the foreign currency exposure present in the new strategy. Whilst this may not be "optimal" from a purest point of view, given the extreme difficulty in finding an optimal hedge ratio and the Trustee's particular concern in this area it may be a reasonable solution.
  (1 mark)

- The concept of "regret" arises here where the Trustee makes a decision to hedge a certain proportion of assets, and it later becomes apparent that the Fund would have performed better had the Trustee adopted an alternative strategy (such as completely unhedged). It has been postulated that regret is minimised by hedging about 50% of international exposure back into AUD. Here this would result in a foreign currency exposure of 25%, which is consistent with minimising "business risk" as outlined above.
  (1 mark)

Max 6 marks up to this point.

International Shares

- As this is a relatively volatile asset class, introducing currency risk does not result in a huge increase in risk as the return from currency is generally relatively uncorrelated with the return from equities. (ie. the volatility is not additive). (1 mark)

- Portfolios lying on the "efficient frontier" are likely to include some allocation to hedged international equities. Therefore hedging at least some of this asset class could be considered reasonable. (1 mark)

International Fixed Interest

- This is a relatively defensive asset class. Introducing currency risk significantly increases the risk involved with investing in the asset class. Therefore hedging 100% of this exposure is logical. (1 mark)

US Real Estate Investment Trusts & Hedge Fund

- Together these exposures make up 15% of the Fund. All of this exposure is USD, whereas the currency exposure created through investment in international shares and fixed interest is diversified across a number of countries (admittedly it is likely that 50% of this could be USD exposure). Given the risk that arises from this exposure it makes sense, if any of the exposure is to be hedged, to hedge it. (1.5 marks)

- Furthermore given the relatively simplicity in hedging a single currency, and the high liquidity of the USD it is likely to be "cheaper" in terms of management fees and transaction costs to hedge this exposure. (1 mark)

- Listed Property is a relatively "defensive" asset compared with Equities, and therefore it is reasonable to hedge the resulting currency exposure. (Similar argument to fixed interest applies, although it is not as strong as the volatility for this asset class is likely to be somewhere between equities and fixed interest) (1.5 mark)

- Arguments for not hedging include that the hedge fund is likely to be a relatively more volatile asset class, so a reasonably uncorrelated currency exposure is unlikely to increase volatility markedly. (1 mark)

Other information:
- Average age of members.
- Risk tolerance of members. (1 mark)

Other analysis:
- Perform an optimisation. However students who raise this possibility should point out the problems with such an approach. E.g. sensitivity to assumptions,

inaccuracies in or incomplete historical data, difficulty in creating forward looking assumptions (the past is unlikely to be a good guide to the future). Studies have shown that the standard deviation of the estimate of the optimal hedge ratio is so large that the results from an optimisation are not particularly enlightening. (2 marks)

(maximum 11 marks total)

b) The Hedge Fund in which the Fund intends to invest has the following characteristics:

- ***ability to short sell stocks to up to 100% of the value of investors' funds***
- ***ability to use investors' funds and the proceeds from short sales to invest in stocks to up to 200% of the value of investors' funds.***
- ***investable universe (for both short and long positions) is US and European telecommunications, media and technology stocks***
- ***fees are equal to 20% of the outperformance of the Hedge Fund over the returns from USD cash (calculated and payable quarterly in arrears). There is no requirement for underperformance in previous periods to be made up before the fee is payable. There is no base fee.***

Outline with reasons whether you believe the 10% allocation to this Hedge Fund is appropriate. (5 marks)

Model Solution
Part b)

- This is a relatively large proportion of assets to have with a single manager. Diversifying into a number of managers (possibly via a fund of funds approach) may be more appropriate. (1.5 marks)

- The ability to short up to 100% of the portfolio and invest the proceeds means that returns are going to be quite volatile & could result in significant losses reasonably quickly if the manager's stock selection proves to be poor. (1 mark)

- Volatility is further exacerbated by the fact that the investible universe is made up exclusively of technology stocks, which are expected to be even more volatile than the general market. (1 mark)

- The manager is able to invest in both US and European stocks. This introduces currency risk - it is possible that net short positions in one currency and net long position in another currency will arise. It is unclear whether there is any control on this risk. Furthermore these potentially unintended currency positions could upset any currency strategy put in place by the Trustee. (2 marks)

- The performance fee encourages the manager to take excessive risk to earn fees. Given that it is calculated quarterly, and past underperformance does not have to

be recouped before the fee is payable, there is a very large incentive to take on excessive risk. The manager effectively has a call option on the portfolio (the value of which increases as volatility increases). (2 marks)

- Since the manager is not charging a base fee, if performance is poor the manager could go out of business quite quickly. Whilst this is a strong incentive for performance, it also introduces significant risk to investors that the business of the manager could be unstable. (1 mark)

(maximum 5 marks)

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QUESTION 5 **(13 Marks)**

ShareEx Limited operates a securities exchange providing electronic transaction and listing services for trading Australian equities, warrants and other Australian equity derivatives. Companies currently listed on the exchange are mainly smaller, newly listed companies, and many operate in the technology sector.

Part of the transaction fee levied by ShareEx on trades that are made through the exchange is retained in a Reserve Fund. This Reserve Fund has been established to provide compensation to investors using the exchange in the event of stockbroker insolvency or fraud, or failure of a stockbroker to deliver securities after settlement. The assets of the Reserve Fund are currently on deposit with a major Australian bank.

The Directors of ShareEx Limited wish to improve the investment returns on the Reserve Fund and have asked you as a consulting actuary for advice in reviewing the Fund's strategic asset allocation to achieve this objective.

To assist in the assignment, the Directors have provided you a copy of a report from another actuary on an investigation into the expected liabilities of the Reserve Fund. This report looked at past compensation claims experience and analysed the sensitivity of Fund liabilities to a range of factors including trading volume and the underwriting activities of stock brokers.

a) You decide that you will develop an asset liability model to assist with the analysis required for your report to the Directors. Draft the section of your report that explains what is meant by asset liability modelling and the rationale for using it in this case. (3 marks)

b) Describe the key characteristics of the asset liability model you would propose for this project, the assumptions that will be required, an explanation of the output your model will produce and how this will be used in making your recommendations. (6 marks)

c) One Director suggests investing the Reserve Fund in the shares of companies that are about to launch an initial public offer (IPO) and list on the exchange. The Director argues that since share prices of companies increase following their IPO, the improved investment returns would assist in increasing the size of the Reserve Fund, therefore providing greater protection for investors using the exchange. The Director also suggests that this strategy would increase trading activity in these newly-listed companies, which would raise more levies for the Reserve Fund.

Draft your response to the Director's proposal stating why you would or would not support such a strategy. ***(4 marks)***

a) You decide that you will develop an asset liability model to assist with the analysis required for your report to the Directors. Draft the section of your report that explains what is meant by asset liability modelling and the rationale for using it in this case. (3 marks)

Model Solution
Part a

What is asset liability modelling?

- Quantitative tool to assist in investment strategy decision-making.
- The future expected behaviour of both assets and liabilities are modelled, typically using simulation techniques.
- ALM permits analysis of the interaction between the assets and liabilities of a particular entity under a range of potential economic or financial conditions.
- Appropriate for problems in which economic or financial factors have an influence on both assets and liabilities. Particularly useful where assets and liabilities are imperfectly correlated but are dependent on some of the same external factors.

Other sensible descriptions acceptable.

0.5 mark for each valid point up to max of 1 mark

Rationale for using ALM in this case?

- Claims on the Reserve Fund (i.e. liabilities) will be strongly linked to the frequency and severity of participating stock broker insolvency.
- Liabilities would therefore be affected by trading volume, market capitalisation of listed companies, and the volatility of listed share price movements – particularly large corrections where brokers undertaking proprietary trading are likely to be facing significant financial losses.
- Reserve Fund investment strategies (assets) with allocations to listed equities would also be affected by share price volatility and trading volume (i.e. liquidity).
- Too conservative an investment strategy for the Reserve Fund may mean the Fund's assets do not keep pace with the growth in the size of the Fund's liabilities.
- Information is available regarding the sensitivity of liabilities to various financial and economic factors through the actuarial report – it should therefore be possible to examine the impact of these factors on the assets under different investment strategies through an ALM study.
- A stochastic ALM approach would assist in understanding the chances of the Reserve Fund proving inadequate under different investment strategies.

0.5 mark for each valid point up to max of 1.5 marks.
0.5 mark for draft report language

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b) Describe the key characteristics of the asset liability model you would propose for this project, the assumptions that will be required, an explanation of the output your model will produce and how this will be used in making your recommendations. (6 marks)

Model Solution
Part b)

Students have considerable scope to propose different models. Markers should assess whether the student's proposed approach is sensible and that the student has provided adequate information/arguments to earn marks. One possible stochastic approach (a stochastic mean-variance model) is described below similar to the example discussed in the course notes and in Assignment 2. Students could also describe alternative models.

<u>Key characteristics of the asset liability model and assumptions required</u>

- Stochastic financial model which generates 10,000 (say) simulations of future values of each key financial factor over the next 10 years. Need sufficient number of simulations to generate statistically stable results – could be tested.
- Monthly or quarterly simulation periods will be used
- Mean, variance and correlation assumptions for each model variable will be determined.
- Using Monte Carlo techniques, random observations are drawn from a relevant probability distribution to generate year by year simulated results for each variable. Simulated correlations between variables are maintained consistent with those assumed through use of Cholesky transformation techniques.
- The model would ideally allow for serial correlation effects i.e. allow the simulated result for a variable in month n+1 to be partially correlated with the variable in month n (relevant for some asset classes particularly cash and other economic variables).
- Variables simulated (for which assumptions will be required) will be:

Asset class monthly returns (assuming normal distribution of ln(1+i)):

- broad Australian share market index returns
- subset of Australian sharemarket listed on ShareEx (small cap/technology sector)
- Australian listed property securities
- Australian unlisted property
- overseas broad sharemarket index returns (both fully hedged and fully unhedged)
- Australian fixed interest (market portfolio– ie composite bond index)
- Australian cash or cash equivalents
- Overseas fixed interest – fully hedged. (suggest assuming a market portfolio of government bonds only)

Other variables simulated (normal distribution?):

- Monthly trading volume of ShareEx
- Claim frequency and severity (based on assumptions in actuarial report with stochastic element (normal distribution)). Could also treat this as static assumption by using liability cash flows from actuarial report and not model it stochastically.

- Other inputs required include: levy charged on share transactions (as % of trade volume), initial Reserve Fund asset value, initial value of liabilities (from actuarial report).
- Using the simulated monthly asset class returns and the other modelled variables the model will project the future assets and liabilities of the Reserve Fund over the next 10 years.
- Would build the model using a spreadsheet or database computer program.

½ mark for each valid point up to max of 3 marks

<u>Output and how it will be used for making recommendations</u>

- For a given long term strategic asset allocation and levy, use model to generate distribution of monthly future Reserve Fund surplus of assets over liabilities:
  - Record median simulated surplus in each projection year.
  - Record median volatility of monthly surpluses over 10-year projection period.
  - Record lowest 5th percentile surplus (as a "worst case" outcome) over first 5 years, say
  - Record the number of simulations that result in the Reserve Fund moving into deficit over the 10-year projection period (this provides probability of insolvency)
- Could articulate results in "risk and return" space by plotting median surplus in year 5, say ("return") versus the 3 "risk" measures described above, for a given investment strategy or levy.
- Compare the results of different investment strategies to identify superior strategies, key points of inflexion etc
- One of the strategies examined should be the current 100% cash investment strategy and current levy.
- Other candidate strategies might include adding exposure to longer term defensive assets (e.g. Australian bonds), adding growth assets (10%, 20%, 30% etc), as well as including exposure to a portfolio of ShareEx listed companies (at different levels). Would also examine impact of adding international asset exposure.
- Use this analysis to support a discussion with ShareEx Directors over the impact of different investment strategies or levies in order to understand their risk tolerances and the range of plausible and extreme outcomes. Recommend a strategy that maximises the future median surplus at the level of risk acceptable to the Directors.

½ mark for each valid point up to max of 3 marks

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c) One Director suggests investing the Reserve Fund in the shares of companies that are about to launch an initial public offer (IPO) and list on the exchange. The Director argues that since share prices of companies increase following their IPO, the improved investment returns would assist in increasing the size of the Reserve Fund, therefore providing greater protection for investors using the exchange. The Director also suggests that this strategy would increase trading activity in these newly-listed companies, which would raise more levies for the Reserve Fund.

Draft your response to the Director's proposal stating why you would or would not support such a strategy. (4 marks)

Model Solution
Part c)

This is the classic "in house asset" problem. I.e. by investing Reserve Fund assets in ShareEx IPOs, the circumstances under which the investment strategy produces the very worst results is likely to be exactly the same time that the greatest number of claims are made on the Reserve Fund due to a higher frequency or severity of broker insolvency. In their answers, students would be required to identify and articulate this issue in their responses to achieve pass marks in this part of the question.

(up to 2 marks for a well-articulated explanation of this issue)

Other points that should be addressed in the answer include:

- Share prices of companies launching on an exchange via an IPO do not always increase on listing as claimed by the Director.
- Companies issuing IPOs are typically smaller companies, with no track record as a listed company by definition, and therefore there is considerable risk involved in investing in these companies
- A portfolio of newly-launched companies is unlikely to offer acceptable diversification in terms of both exposure to a concentrated group of securities as well as in terms of achieving appropriate industry exposure (as IPOs are often more prevalent in particular sectors or industries, in this case the Technology sector).
- Reserve Fund liabilities are likely to be positively correlated with increased trade in IPOs as opposed to trade in companies that have been listed for some time. If the proposed Reserve Fund investment strategy encourages investor interest in IPOs, one would expect the Fund's liabilities to increase at a relatively higher rate than would otherwise be the case. The impact on the liability profile alone would therefore result in an inferior financial position for the Reserve Fund.
- Students should include a well-reasoned recommendation

½ mark for each valid point up to max of 1½ marks, further ½ mark for appropriate language and tone of response.

QUESTION 6 **(20 Marks)**

You are the quantitative analyst at Wallaby Equity Investment Management (WEIM). WEIM's active quantitative Australian equity fund has a tracking error of around 2%pa. WEIM's active quantitative equity fund has a turnover of around 120%pa.

You are currently looking to enhance WEIM's active return factor labelled "Earnings Revision". "Earnings Revision" seeks to quantify to what extent broking analysts are revising their earnings expectations for any one stock.

a) What is the theory behind the use of "Earnings Revision" as an active return factor? (4 marks)

b) What are some of the many ways that an "Earnings Revision" factor can be measured? Can some of these measures be combined to produce a "Super" Earnings Revision factor? (5 marks)

c) How would you get the information to measure these factors, and which one is the preferred approach, and why? (3 marks)

d) Your CEO states to you that active quantitative funds tend to have very high turnover with resultant costs such as market impact costs and capital gains tax implications. Discuss this statement, and in that discussion, point out how you can alter the way that Earnings Revision is measured to help to reduce the turnover. (3 marks)

e) You have decided that you would like to test a few of the possible Earnings Revision factors that you have devised. Explain a simple backtest that you can apply, based on the quintiles of a single factor, to see how these various measures performed historically. Explain the key limitations of this "single factor" test.

(5 marks)

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a) What is the theory behind the use of "Earnings Revision" as an active return factor? (4 marks)

Model Solution
Part a)

The theory is that the value of shares is a function of its expected future earnings. Normally, shares are valued by using either a DDM (Dividend Discount Model) or DCF (Discounted Cash Flow), or possibly more rudimentary figures such as P/E, P/CF. Both future dividends and future free cash flows are ultimately a function of future earnings as well. (1 Mark)

Therefore, if one expects an increase in expected future earnings (compared to previous expectations), then one would expect the value of the company to rise.
(1 mark)

If we are using consensus data (i.e. average market expectations), we expect that consensus information is what is currently factored into market prices. That is, we expect valuations based on consensus data is pretty much the current market price.
(1 Mark)

Therefore, if the consensus earnings on stock ABC has been revised upwards we expect the share price of ABC to increase to reflect this increase in expectations by "the market", and vice versa (i.e. downward revisions to consensus earnings to result in falling share prices).
(1 mark)

Well, this is the theory anyway. This does not always hold true in reality for each single stock, or any one short time period. However, on average for a portfolio of shares, and over the medium to long term, it tends to hold true generally, or at least empirical evidence suggests that overweighting stocks with positive earnings revisions and shorting stocks with negative earnings revisions tends to add value (i.e. produce positive alpha).
(1 mark)

Empirical studies suggest that earnings revisions signals tend to last beyond the very short term. In an efficient market, we would expect it to be factored in almost immediately. However, it would appear that this is due to other analysts lagging behind the "lead" analysts with their revisions in the same direction, and due to positive earnings surprises being followed by further positive earnings surprises down the track (e.g Wesfarmers) and vice versa (e.g. Pacific Dunlop) (0.5 mark)

(Max 4 marks)

b) What are some of the many ways that an "Earnings Revision" factor can be measured? Can some of these measures be combined to produce a "Super" Earnings Revision factor? (5 marks)

Model Solution
Part b)

Ways to measure :

- % change in mean EPS (from say x months ago to now)

(0.5 mark)

- number of broker analysts EPS estimates up minus number of estimates down divided by number of EPS estimate changes (from say x months ago to now)

(0.5 mark)

- absolute change in mean EPS estimates (from say x months ago to now) divided by st dev of current EPS estimates: this is considered to be one of the better ways to measure it as it allows for dispersion of estimates

(1 mark broken down by 0.5 mark for method and another 0.5 mark for saying it is better than most and why)

- absolute change in mean EPS (from say x months ago to now) divided by current share price

(0.5 mark)

"x months" can be over any reasonable time period and can be over 1 month, 3 months, 6 months, 9 months, or even 12 months.
(0.5 mark)

The EPS figures can be at least for FY1 (current financial year) or combine FY2 (next financial year) and beyond.
(0.5 mark)

Another innovative approach is to give increasing weightings to better rated analysts instead of equal weightings to everyone when doing any of the calculations above. (0.5 mark)

("ways to measure" subject to max of 3 marks)

- Yes, it is possible to combine these measures to produce a super earnings revision factor (0.5 mark).

However the overriding issues before doing this are :

- The factors that are combined are shown to have very low correlation with each other (otherwise, they may be a proxy for each other) (1 mark).
- Each of the factors selected are shown to be independently tested to be shown to produce positive alpha (i.e. add value) (0.5 mark).

- When combined they are shown to produce more alpha (hopefully) than the average of them independently, and shown to produce greater consistency in alpha which will result in a far superior IR (information ratio) (0.5 mark)

(above subject to max of 2 marks)

c) How would you get the information to measure these factors, and which one is the preferred approach, and why? (3 marks)

Model Solution
Part c)

This can be done by one of two approaches. Either an information collating services such as IBES or collecting it yourself by asking a group of brokers for their earnings data on a regular basis. (0.5 mark)

Issues with IBES type services :

--- There is always a delay in collecting "up to date" date info. In fact, even their "express" service may be up to a month out of date for some stocks.

- IBES do make typographical mistakes or do not detect "obvious" mistakes sent to them from brokers.

- IBES is expensive

+ Simple and easy to use, and very time effective

(0.5 mark for each – max 1.5 marks)

Issues with direct collection from brokers :

- Typographical errors often occur with figures and also not detecting change in ASX codes properly e.g. Fosters Group changing from FBG to FGL.

- Some may refuse to provide data to you on the basis you do not provide them with sufficient brokerage. This is especially the case for the top tier brokers who expect a lot of brokerage, but are also likely to have the more highly rates analysts as well, whose omission from a consensus calculation would be of concern.

- To collect a consensus, you will have to deal with an inordinate number of brokers including small time brokers. This can be very time consuming to collect, chase up those who have forgotten to send their data in, check and collate. This may be made worse by the different formats some of them will send the data in.

+++ Very timely receipt of information, which can help to capture more alpha

+ Can do more things with the data as we receive the raw data and can ask for information not provided properly by IBES (e.g. net debt, interest cover)

(0.5 mark for each – subject to max of 1.5 marks)

Overall, the collection of data from brokers directly is a better approach mainly due to the timeliness issue. However, IBES should also be used as a secondary check.
(0.5 mark)

(Total max 3 marks)

d) Your CEO states to you that active quantitative funds tend to have very high turnover with resultant costs such as market impact costs and capital gains tax implications. Discuss this statement, and in that discussion, point out how you can alter the way that Earnings Revision is measured to help to reduce the turnover. (3 marks)

Model Solution
Part d)

Some parts of the CEO statement is true, and other parts not true.

Even though active quantitative funds tend to have a low tracking error (approx 1% to 2.5%pa), they also tend to have very high turnover. Typically, turnover in active quantitative funds tends to be anywhere from 100% to 200%pa (one side). Most traditional active equity funds tend to have turnover around the 45% to 70%pa (one side) turnover. (1 mark)

However, market impact costs don't tend to be high as the high turnover usually involves "fiddling" around the edges, as we have lots of small active positions, instead of a few large active positions. Market impact costs only come into play if we are dealing with a large chunk of the one stock (especially if relatively illiquid), which will lead to adverse price movements. However, with an active quantitative fund, we tend to deal in small parcels of lots of different stocks. (1 mark)

Similarly, due to the same issues discussed in market impact costs above, capital gains tax issues are not all that materially greater as we only tend to fiddle around the edges. As a result, there is a core component (typically 40% to 65% of the portfolio) that stays intact and is never traded, and hence a lot of the capital gains are left unrealised. This core component is comprised of positions in the very large stocks such as NCP, NAB, CBA, WBC, BHP as typically active quant funds will not underweight a stock by more than 0.5% to 1%, and as such it means active quants will always be holding at least some of the very large stocks. (1 mark)
(Max 2 marks for above)

To reduce the turnover, we need to do at least one of two things to our earnings revision signals:

Either, back test each of the possible earnings revision signals and choose the one that produces the best tradeoff between alpha and required turnover. (0.5 mark)

OR

Most likely route,….increase the number of months (x) over which the change in "earnings" are measured. This will result in the stock scores not moving around too much due to the longer time horizon, as shorter term figures tend to be very "whippy". This will mean that less turnover is required as fewer changes need to be made to the portfolio. (1 mark)

(Total max 3 marks)

e) You have decided that you would like to test a few of the possible Earnings Revision factors that you have devised. Explain a simple backtest that you can apply, based on the quintiles of a single factor, to see how these various measures performed historically. Explain the key limitations of this "single factor" test.

(5 marks)

Model Solution
Part e)

How to conduct the test:

- Firstly, measure the factor signal for each stock for each time period selected (say monthly or weekly). As an option, the factor signal measures can be normalised (z-scored), but doing this will not affect the ranks for the quintile tests, as normalised scores are only used at the alpha generation stage for portfolio construction which is not part of this question.

- Rank the stocks, and then divide them into quintiles.

- We now have a history of what the portfolio of quintiles 1 to 5 looks like, and we should then estimate the returns of each quintile on an equally weighted basis. (Equally weighted as we are looking to get a proxy for active positions which tend to be subject to constraints of +/- X%)

- It is then very important to measure the turnover required within each quintile for each time period. This is so we can then allow for transaction and market impact costs later, or detect undesirable levels of turnover.

- An overriding consideration in all of this is the depth and quality of data. It is important we have an extensive history of stocks (including those no longer in

existence – survivorship bias is a real issue!) and to be able to deal with ASX code changes (e.g. in the space of a year RVS changed to MCD which then recently changed to GGL). We also need a history of prices, dividends, and adjustments for changes to capital structure so that we can calculate total returns for each stock over time.

- For each quintile we then calculate monthly performance. Ideally, the top quintile stock will have the highest performance, and the lowest quintile will have the worst performance, with the other quintiles performing accordingly in-between in the right order. If this is the case, it would suggest that this factor adds value. After this we need to deduct expected transaction and market impact costs, to see if it still adds value

- For each quintile we then calculate tracking error and resultant information ratio (IR). We are looking for quintile 1 to have and IR well in excess of 1.5, and with this declining as we moved down the quintiles. In addition, we are likely to calculate other information such as proportion of months where the quintile has outperformed the index.

- After all of this has been done we also calculate the figures for a portfolio that is long Q1 and short Q5 (i.e. Q1-Q5), as this gives us a better idea of the potential alpha that can be delivered in a real life portfolio where we overweight favoured stocks and underweight poorly ranked stocks.

(0.5 mark for each point subject to max of 3 marks)

Key limitations of single factor quintile test :

- (problem with quintile test) Another key issue, is in reality we would never construct a portfolio based on quintiles and with equal active weights. To maintain a low tracking error fund, as active quant funds to be, we need to ensure there are no major factor or sectoral biases. This is not something that is done with the quintile tests. It is possible that Q1 could be full of small caps, and Q5 full of large caps, but this would not be something we would allow in real life as it leaves us with a massive small cap bias which would be unacceptable. In addition, we would also use the information that is available in all the quintiles, and not just Q1 and Q5, as we would need to have lots and lots of small bets, with the size of the bets being a function of the magnitude of the generated alphas (which are a function of the scores) and the risk constraints in place.
(1 mark)

- (problem with single factor approach) In reality, an active quant fund would have multiple factors and as such just running single factor tests excludes the impact of the "interaction effect" of a multi-factor model. This interaction may be significant, it will affect the alpha (pre costs), consistency of alphas (pre-costs), and the turnover which will also affect the previous two items after costs.
(1 mark)

(Question Total: 20 marks)

QUESTION 7 **(23 Marks)**

You are the fund manager for an insurance portfolio in run-off. The current valuation date is 31 December 2000. The actuary has given you an estimate of the liability payments, as shown in Table 1 below. You may assume that the payments in each year are paid in the middle of the year.

Table 1 – Projected Liability Payments

Year	Payment ($m)
1	30
2	22
3	17
4	12
5	5

The Macaulay duration of these liability cashflows is 1.707 years and the convexity is 5.404 years.

You have available to you the following Commonwealth Government Bonds to invest in.

Table 2 – Commonwealth Government Bonds

Coupon rate	Maturity date	Yield	Price	Duration	Convexity
11%	30-Jun-01	5.00%	108.325	a	0.680
7%	30-Jun-02	5.50%	105.558	1.435	b
6%	30-Jun-03	6.00%	102.956	2.332	7.142
5%	30-Jun-04	6.25%	98.638	3.214	12.522
4%	30-Jun-05	6.45%	92.656	4.103	19.401

Table 3 – Spot rates of interest

$$\frac{105(1+z_1)+7(1+z_2)^2+6(1+z_3)^3+104(1+z_4)^4}{105+7+6+104} = 0.725$$

These bonds pay annual coupons. The yield to redemption assumes an annual compounding period. The bonds will be redeemed at their face value. The duration shown is the Macaulay duration, not the modified duration.

a) Complete Tables 2 and 3 above by calculating the missing values a, b and c. Calculate c to the nearest 0.01%. Calculate the other values to 3 decimal places. (3 marks)

b) Using the bonds maturing in 2001 and 2005 only (i.e. bonds 1 and 5 above), use Redington immunisation to construct a portfolio which is protected against small interest rate movements. (5 marks)

c) Construct a cash-flow matched portfolio using all bonds available. What do you notice about the value of this portfolio compared to the value of the portfolio in part b)? (6 marks)

d) List and comment on the features of these two approaches to minimising interest rate risk that should be considered before implementing them in practice.

(5 marks)

e) Describe how you would protect the solvency of the fund against interest rate fluctuations if you were provided with an estimate of the distribution of payments in the future, where some payments are functions of interest rates.(4 marks)

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a) Complete Tables 2 and 3 above by calculating the missing values a, b and c. Calculate c to the nearest 0.01%. Calculate the other values to 3 decimal places. (3 marks)

Model Solution
Part a

The completed tables are:

Table 2 – Commonwealth Government Bonds

Bond no.	Coupon rate	Maturity date	Yield	Price	Duration	Convexity
1	11%	30-Jun-01	5.00%	108.325	0.500	0.680
2	7%	30-Jun-02	5.50%	105.558	1.435	3.194
3	6%	30-Jun-03	6.00%	102.956	2.332	7.142
4	5%	30-Jun-04	6.25%	98.638	3.214	12.522
5	4%	30-Jun-05	6.45%	92.656	4.103	19.401

Table 3 – Spot rates of interest

Term to maturity	Spot rate
0.5	5.00%
1.5	5.51%
2.5	6.03%
3.5	6.29%
4.5	6.49%

(0.5 marks for each correct answer, 0.5 marks for correct working for each – 3 marks in total)

a. Duration (Macaulay throughout … see question) for bond number 1 is 0.5 years as it is effectively a zero coupon bond with term to maturity of 0.5 years.

b. Convexity for bond number 2 is calculated below

t	c(t)	v(t)	c(t)v(t)	tc(t)v(t)	t(t+1)v(t+2)
0.5	7	0.976	6.831	3.416	4.647
1.5	107	0.923	98.727	148.090	332.557
2.5	0	0.864	0.000	0.000	0.000
3.5	0	0.808	0.000	0.000	0.000
4.5	0	0.754	0.000	0.000	0.000
Total		4.324	105.558	151.506	337.204
			Duration	1.435	
			Convexity	3.194	

c. The spot rate of interest for a term of 3.5 years is derived from the valuation of bond number 4

$$98.638 = 5v_{5.00\%}^{0.5} + 5v_{5.51\%}^{1.5} + 5v_{6.03\%}^{2.5} + 105v_x^{3.5}$$

leading to x = 6.29%

b) Using the bonds maturing in 2001 and 2005 only (i.e. bonds 1 and 5 above), use Redington immunisation to construct a portfolio which is protected against small interest rate movements. (5 marks)

Model Solution
Part b

Using the following notation:

A(t) : asset cash flow at time t

L(t) : liability cash flow at time t

s(t) : spot rate of interest at time t

v(t) : discount factor at time t based on s

$B_n(t)$: cash flow from bond number n with face value of 1, at time t

First calculate the present value of the L(t)'s as $77.72 million. (1 mark)

If x dollars are invested in bond 1 and y dollars in bond 5 then we require:

$$77.72 = x + y \qquad (1)$$
$$1.707 \times 77.72 = 0.5x + 4.103y \qquad (2)$$

(1 mark for equations)

Solving these simultaneously leads to x = $51.68 million, y = $26.04 million. A small rounding error may be ignored if the student has used rounded values in intermediate calculations. (2 marks for correct answers)

The convexity of this portfolio should be checked to make sure that it is larger than the liabilities. It is 6.951 compared to the liability value of 5.404, so immunisation works. (1 mark for check)

c) Construct a cash-flow matched portfolio using all bonds available. What do you notice about the value of this portfolio compared to the value of the portfolio in part b)? (6 marks)

Model Solution
Part c

(6 marks in total – 0.5 mark for the working for each point in time, 0.5 mark for each correct answer. 1 mark for calculating value of dedicated portfolio and concluding same as in (b)).

The process to find a cash-flow matched portfolio is to work backwards. Suppose the dollars of face value invested in bond n is X_n. Then:

Time 4.5 years:

$$\begin{aligned} L(4.5) &= 5 \\ B_5(4.5) &= 1.04 \\ X_5 &= \frac{5}{1.04} \\ &= \$4.808\ million \end{aligned}$$

Time 3.5 years:

$$\begin{aligned} L(3.5) &= 12 \\ 12 &= 4.808 \times 0.04 + X_4 \times 1.05 \\ X_4 &= 11.245 \end{aligned}$$

Time 2.5 years:

$$\begin{aligned} L(2.5) &= 17 \\ 17 &= 4.808 \times 0.04 + 11.245 \times 0.05 + X_3 \times 1.06 \\ X_5 &= 15.326 \end{aligned}$$

Time 1.5 years:

$$\begin{aligned} L(1.5) &= 22 \\ 22 &= 4.808 \times 0.04 + 11.245 \times 0.05 + 15.326 \times 0.06 \\ &\quad + X_2 \times 1.07 \\ Y_2 &= 18.996 \end{aligned}$$

Time 0.5 years:

$$L(0.5) = 30$$
$$30 = 4.808 \times 0.04 + 11.245 \times 0.05 + 15.326 \times 0.06$$
$$+ 18.996 \times 0.07 + X_1 \times 1.11$$
$$X_1 = 24.321$$

The current value of this portfolio is

$$24.321 \times \frac{108.325}{100} + 18.996 \times \frac{105.558}{100} + 15.326 \times \frac{102.956}{100}$$
$$+ 11.245 \times \frac{98.638}{100} + 4.808 \times \frac{92.656}{100}$$
$$= \$77.72 \; million \; (2dp)$$

This is the same value as in part (b) above.

d) List and comment on the features of these two approaches to minimising interest rate risk that should be considered before implementing them in practice. (5 marks)

Model Solution
Part d

For immunisation: (Max 3 marks. Marks may be awarded for other valid points to a maximum of one mark)

The portfolio must continually (in theory) be re-balanced as interest rates change and the cash flow profile of assets and liabilities change. In practice the frequency of re-balancing will depend on transaction costs and the volatility of interest rates. (0.5 mark)

Immunisation is more flexible than a cash-flow matched portfolio. The fund manager has choices in terms of security or sector selection while maintaining the necessary duration and convexity positions. (0.5 mark)

Yield curves rarely behave in the manner assumed by Redington ie small parallel shifts. Different points along the yield curve move by different amounts, often quite large. (0.5 mark)

The Redington theory suggests arbitrage opportunities are possible, even if the yield curve undergoes a small parallel shift. Market yields and prices will adjust to remove these. (1 mark)

It does not remove liquidity risk. The strategy involves rebalancing, which typically involves selling some bonds before they mature and investing the proceeds in other bonds. (0.5 mark)

The true duration of both the asset and liability portfolios will depend on the option-adjusted duration (also known as effective duration) where the cash flows are interest sensitive. Immunisation does not take these into account when using the Macaulay duration. (1 mark)

For a dedicated (ie cash-flow matched) portfolio: (Max 2 marks, although marks may be awarded for other valid points to a maximum of 1 mark).

Liquidity risk is removed so long as the estimates of liability payments are accurate. If the liability payments are volatile by nature (eg general insurance portfolio in run-off) then liquidity risk is a concern. (0.5 mark)

Interest rate risk is removed. (0.5 mark)

The liability is always fully funded. (0.5 mark)

Constant re-balancing of the asset portfolio is not required. (0.5 mark)

The projected cash flows for both assets and liabilities are assumed to be deterministic. In practice, some cash flows are likely to be interest rate dependent, depending on the portfolio (1 mark)

e) Describe how you would protect the solvency of the fund against interest rate fluctuations if you were provided with an estimate of the distribution of payments in the future, where some payments are functions of interest rates.

(4 marks)

Model Solution
Part e

Use simulation. (0.5 mark) An analytical answer will be difficult and is unlikely to incorporate all real world features (0.5 mark).

The important features of this simulation approach are:

- An economic model is used to simulate interest rate paths. Inflation may also be simultaneously projected in a consistent manner (1 mark)
- These interest rates are used to derive interest sensitive cash flows (1 mark)
- A model of liability cash flows is then developed, incorporating these interest sensitive variations and the residual variation (1 mark)
- The asset and liability positions are projected. At each projection point, the surplus position can be calculated and monitored (1 mark)
- Different asset portfolio scenarios can be tested for the volatility on the surplus of the fund (1 mark)
- Note that under these conditions, interest rate risk cannot be removed entirely. However, an asset strategy can be chosen to minimise the risk on the surplus position. (1 mark)

(Max 4 marks)

An alternative approach is the use of an interest rate lattice structure. This allows for cash flows to be functions of interest rates but does deal with other variation in liability cash flows. Partial marks may be awarded.