

EXAMINATION

September 2006

Subject CA1 — Core Applications Concepts

Paper 1 (Assets)

EXAMINERS' REPORT

Introduction

The attached subject report has been written by the Principal Examiner with the aim of helping candidates. The questions and comments are based around Core Reading as the interpretation of the syllabus to which the examiners are working. They have however given credit for any alternative approach or interpretation which they consider to be reasonable.

M A Stocker
Chairman of the Board of Examiners

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Comments

Individual comments are shown after each question and after each part question where relevant.

General comments

As the title of the course suggests, this subject examines applications of the core techniques and considers broad actuarial concepts in practical situations. To perform well in this subject requires good general business awareness and the ability to use common sense in the situations posed, as much as learning the content of the core reading.

The notes that follow are not to be interpreted as model solutions. Although they contain the majority of the points that the examiners were looking for, they also contain more than even the best prepared candidate could be expected to write in the time allowed in the examination room.

- 1** (i) The equity risk premium is the additional return that investors require from equity investment to compensate for the risks relative to risk free rates of return.

- (ii) The simplified equity valuation formula is:

$$V = \frac{D_0(1+g)}{(i-g)}$$

Where: D_0 is the most recent dividend received
 i is the required rate of return
 g is the dividend growth rate

Credit was also given for defining D_0 as the next dividend provided that the $(1+g)$ term was omitted.

The point to note is that i features only in the denominator.

If this point was made, there was no need to state the formula, as long as there was a satisfactory verbal argument.

Changing the risk premium changes the i term in the above formula. Increasing the risk premium increases the i term increasing the divisor and therefore reducing the valuation of equities, and vice versa.

- (iii) The systematic risk premium, i.e. for a diversified portfolio, fluctuates over time and depends on the overall level of confidence of investors in equity markets, and their view of risks associated with equities in general. Examples are changes in interest rates, changes in oil prices, onset of recession.

Any two events that will affect equities in general or a particular sector were acceptable. No marks were given for events that affect only individual stocks and therefore the specific risk premium.

Comments on question 1: *This was well answered by most candidates although many omitted to mention that the additional return was relative to the risk free rate.*

- 2** (i) The uses to which indices can be put include:
- (a) A measure of short-term market movements.
 - (b) Providing a history of market movements and levels.
 - (c) As a tool for estimating future movements in the market, based on past trends.
 - (d) As a benchmark against which to assess the investment performance of portfolios.
 - (e) Valuing a notional portfolio.
 - (f) Analysing sub-sectors of the market.
 - (g) As a basis for index funds which track the particular market.

- (h) To provide the basis for the creation of derivative instruments relating to the market or a sub-section of the market.
- (ii) The Dow Jones Index is made up of 30 shares. Although commonly quoted, the small number of companies does not make it a good indicator of overall market performance.

Suitable for (a) and (e), could have some use for (g) and (h).

However the Dow Jones has a very long history, so despite the disadvantage above it might also be used for (b) if a long time period is involved.

The Standard & Poor's Composite Index is made up of the 500 leading companies in the USA representing a broad cross-section of all sectors of the market. It is often suitable to use for performance measurement of a fund's portfolio of USA equities.

Suitable for all uses in part (i).

Comments on question 2: Part (i) was bookwork and was well answered by the majority of candidates, although a number did not appreciate the restricted sector coverage of the Dow Jones index. Part (ii) was disappointing with only the stronger candidates linking the features of the two indices to all the points they had considered in (i).

- 3** Projects need to be led by strong experienced people who can drive them forward. Such individuals should be able to establish direction, decide on action, organise resources and motivate the project team. However, there should be checks and balances on the enthusiasm of the project's champions.

A key element of any sizable project is to have a comprehensive master schedule for the project which ensures that the right people do the right things at the right time to ensure the project moves at an appropriate pace. Tools such as critical path analysis will aid this. The right people include both those internal to the project and external suppliers.

It is vital that setting the standards of performance required from the parties involved is undertaken early in the life of the project, as these will have a major impact on the whole project.

Once the strategy and objectives have been written and the objectives of the project have been set a development schedule is needed setting out how and when the project will be undertaken.

The written strategy should be shared with the key individuals who will bear the responsibility for implementation of the project. It will be necessary to review the development schedule at regular intervals and particularly when the key milestones in the schedule are reached. Good communications between all parties at all stages will be essential.

The budget must be set and performance measured against this regularly at appropriate intervals.

A thorough risk analysis should be carried out.

Technical and design changes should be avoided once implementation has begun. Design parameters should be broad enough to give the developers some freedom of approach and to avoid the need for subsequent changes. Strict change control management should be implemented.

Any new technology should be fully tested before being released for use.

A competent team should be in place from the outset. Where appropriate the end users of the project's output should be involved from the start. It is important that all the team members are committed to the success of the project and that the project leaders provide support.

The distinction between the project owner as the sponsor and future operator of the project outcome and the project management team as the designers and builders of the project is a particularly important one. A successful project outcome requires the right balance to be struck between project sponsor and the project implementation specialists.

Project owners should concentrate on the key points in the project's development schedule that should be reached at certain times to ensure that they are properly scheduled and that the project is fully reviewed each time it reaches a milestone review point. At these milestone review points, critical questions on all aspects of the project should be raised by all those involved in the project. Project managers will need to have conflict management skills.

Comments on question 3: Most candidates had a reasonable attempt at this question but only the well prepared candidates scored very well by considering how the project would be successful, timely and cost effective as well as mentioning the general project management points. The distinct role of project owners and their relationship with the project management team) was not always appreciated.

- 4 (i) Frequently assets may be valued alongside liabilities. It is necessary to adopt a method that values assets and liabilities on a consistent basis. Depending on the method used to value the liabilities, market value will not be suitable for this purpose. For example, volatility of market values may be an issue.

No marks were given for volatility without an explanation.

The market value depends on the circumstances surrounding the transaction. A market value requires a willing buyer and a willing seller. When either the buyer or the seller is not willing the market price will be distorted, for example when there is the forced sale of a large volume of assets.

There may be no market in the assets concerned, and thus no market value may be available.

The market value equates buyers and sellers at the margin, normally of a small part of any stock issued. These circumstances may not give a good value for a large holding.

Accounting or other regulations may require another value e.g. book value or amortised book value to be used.

- (ii) (a) Book value: historic book value the price originally paid for the asset. Written up or written down book value is historic book value adjusted periodically for movements in value.
- (b) Smoothed market value: where market values are available they can be smoothed (for example by taking some form of moving average over a specified period) to remove daily fluctuations. Smoothing would be over a short period — days or weeks.
- (c) Discounted cash flow: this method involves discounting the expected future cashflows from an investment. It has the advantage of being easily made consistent with the basis used to value an investor's liabilities.

However, it relies on the assessment of a suitable discount rate, which is straightforward where the assets are government guaranteed fixed interest stocks but is less so otherwise. Assumptions are needed for default rates.

Where cash flows are uncertain, such as for equities, property and inflation linked securities, further assumptions have to be made.

- (d) Stochastic models: these are an extension of the discounted cash flow method in which the future cash flows, interest rates or both are treated as random variables.

The results from a stochastic model are a distribution of values from which the expected value or other statistic can be determined. In

practice, computer simulation would usually be used to perform the calculations.

- (e) Arbitrage value: arbitrage value is a means of obtaining a proxy market value and is calculated by replicating the investment with a combination of other investments and applying the condition that in an efficient market the values must be equal.
- (iii) (a) Book value is often used for fixed assets in published accounts. Companies other than financial product providers often use book value (written down if necessary) for all accounting purposes.
- (b) Smoothed market value: This method can be used where markets are volatile, in particular where values are driven by sentiment rather than underlying fundamentals. This may be suitable if the objection to market value is its volatility.
- (c) Discounted cash flow: this method is most commonly used when the cash flows from assets and liabilities are certain and they can be discounted at the same interest rate. It is the most straightforward tool where it is necessary to compare asset and liability values.
- (d) Stochastic models are particularly appropriate in complicated cases where future cash flows are dependent on the exercise of options, for example the option to wind up an investment trust in certain financial circumstances. Options can exist in either assets or liabilities.
- (e) Arbitrage value is often used in the valuation of derivatives.

Comments on question 4: In part (i) most candidates realised that assets and liabilities needed to be valued consistently and that market values did not always exist. Only the stronger candidates picked up the additional points. Many candidates omitted the 'marginal' nature of market prices as well as the need for a willing buyer and willing seller. Part (ii) was bookwork and was answered fairly well by most candidates and so it was disappointing that its application in part (iii) was much weaker with very few candidates scoring well.

- 5** (i) The liabilities are extremely long term. The actual timing of the payments is unknown. Further the in-service liabilities increase as salaries increase and the pensions in payment are likely to also be increasing to some degree in line with inflation. The amounts of the future liabilities are therefore unknown.

Some liabilities may crystallise on discretionary events — for example a highly paid, long serving member leaving service or electing to take early retirement.

The total contributions may be volatile. If members contributions are fixed then the company's contribution will be geared and thus more volatile.

While the returns from fixed interest stocks are known, there may be a default risk. The returns from equity and property investment are unknown, and assumptions will need to be made.

- (ii) Because of the uncertainties in amount and timing of both asset proceeds and liability outgo, full matching of cash flows will not be possible. One reason is that there may not be assets available of sufficiently long duration.

Over the long term shares are generally considered to be the most appropriate asset to meet long-term real liabilities. Indexed linked bonds would also be appropriate. For fixed liabilities such as pensions in payment, a substantial proportion of fixed or index linked bonds would be appropriate.

Most asset types have uncertain returns.

If the changes are not managed over time then there would be large trading costs associated with one-off changes. The costs of trading to adjust the portfolio frequently to achieve full matching may be prohibitive.

Given infinite resources, it is possible to try to meet outgoings by buying excessive amounts of securities. In practice, the matching portfolio is the portfolio which costs the least and which still provides the required certainty of meeting the liabilities. The scheme may have to alter its investment guidelines to allow this.

- (iii) The current investment objective does not take any regard of the risk the investment manager may have taken. This may lead to volatile returns and lead to volatile contributions being needed.

The scheme may wish to reduce the relative risk of the investment strategy probably at the expense of some future returns.

The objective may not be a fair comparison if other schemes are required to operate under more restrictive conditions. For example other schemes may be required to match pensioner liabilities with fixed interest stock, even if full cash flow matching is not required.

The definition of “comparable benefit schemes” is not precise and is potentially easy to manipulate to achieve a top quartile return.

- (iv) The scheme could establish an asset allocation benchmark that reflects the proportion of pensioner liabilities to liabilities relating to current employees.

The part of the benchmark relating to fixed liabilities could have a high proportion of fixed interest and index linked securities. The portion relating to “real” liabilities could be heavily weighted to equities and property.

Investment could be restricted to companies with a minimum credit rating. High risk investments such as speculative use of derivatives could be prohibited. Requiring a minimum number of individual holdings in certain

categories (e.g. domestic equities) would increase diversification and reduce risk, but might require the manager to hold stock that he did not consider appropriate, merely to have sufficient lines.

The scheme could require that the market value of individual holdings remains within a pre-agreed range. As market values change and these ranges are exceeded steps would be taken to rebalance the portfolio within a reasonable time frame given costs and market opportunities.

Further, if the scheme's liabilities are solely domestic then it may be reasonable to constrain the fund to limit investment in foreign shares and fixed interest investments. The benefits of further diversification may not outweigh the currency risks. This constraint would be expected to reduce both the risk and returns from the fund.

Comments on question 5: *This question was poorly answered by most candidates. In part (i) very few candidates considered volatility of contributions or returns from assets. In part (iii) most candidates appreciated that there was no regard of the risk taken and many realised that the objective may not be fair but these ideas were not developed further. Part (iv) was badly answered by nearly all candidates with few mentioning any points beyond an asset allocation benchmark.*

- 6**
- (i) National governments
Local authorities
Large companies
Supra-national organisations
Overseas governments
 - (ii) Term/duration
Currency
Coupon level
Size of issue
Credit rating
Income cover
Asset cover
Seniority/ ability to issue further debt
Security backing issue
Parental guarantees
Repayment options e.g. variable redemption dates
Option features (e.g. callable and puttable bonds)
Type, Fixed or Index Linked
Country of origin

(iii) **Default risk**

This is the risk that a borrower will be unable or unwilling to make the payments required under the agreements.

Liquidity risk

This is where a market does not have the capacity to handle (at least, without significant adverse impact on the price) the volume of an asset that an investor wishes to buy or sell at the time when the deal is required.

In the context of an individual or a company rather than a market the term is also used to refer to an inability to meet debts when they fall due because of inadequate cash or other liquid assets. The company or individual may still be solvent were they able to realise illiquid assets.

Counterparty risk

This is the risk that a counterparty will not honour its obligations. A counterparty might be a custodian, a bond broker, a party involved in transmitting money, etc. (settlement risk). If the default occurs before the date when settlement of the underlying transaction is due, the party who has been let down is exposed to the risk of having to bear any costs of replacing or cancelling the deal. Counterparty risk increases as the time between a deal being transacted and settled increases.

Concentration risk

This is the exposure to a high level of risk on any instrument or in any sector. An extension of concentration risk is where a market is dominated by a small number of firms. Concentration can be within an industry, currency or geographical region. Most of these factors are considered by rating agencies in evaluating a firm's credit rating.

Credit risk

The term credit risk is sometimes also used to describe the risk associated with any kind of credit-linked event. This could include:

- changes to credit quality (up or down)
- variations in credit spreads in the market

as well as the default events described above.

Correlation risk

The risk that the behaviour two or more bonds is correlated. This is because factors affecting one company within an industry are likely to be relevant to other companies. This means the benefits of diversification are not fully realised.

Economic risk

Risks due to variation in interest rates, inflation and reinvestment risks.

Comments on question 6: Parts (i) and (ii) were well answered by well prepared candidates. Most candidates picked up some of the relevant points in part (iii) but few scored very well.

7 (i) Good asset models should possess the following characteristics:

They should incorporate simulation techniques to generate the distributions of key outputs.

Representative — the model should mimic the most important characteristics for real-world financial assets

Economic interpretation — the behaviour of assets in the model should be consistent with generally accepted economic principles. In particular, the results should be arbitrage-free. The model should also exhibit sensible joint behaviour of model variables.

Parsimony — models should be as simple as possible, while retaining the most important features of the problem.

Transparency — the workings of the model should be easy to appreciate and communicate. The results should be displayed clearly — graphic formats are often used.

The model should be well documented and the results should be verifiable.

Evolution — the model should be capable of development and refinement nothing complex can be successfully designed and built in a single attempt.

For evaluating investment policies the following features are particularly important including:

- The key focus is on the central range of outcomes in terms of magnitude and probability, there is less emphasis on the extremes as it is recognised these are heavily influenced by personal judgement.
- The central range of outcomes should reflect the reasonable expectation of the market, this is heavily influenced by recent historical experience e.g. up to the last 30 years.
- There is a balance to be struck in using a long enough recent history and that history being relevant.
- For investment decisions sensible joint behaviour of variables is as important as the relative behaviour.

- For investment decisions it is important to reflect behaviour up to the time horizon for investment decisions.

For evaluating fair values the following characteristics are important:

- The ability of the model to replicate market prices in particular scenarios and conditions.
- The replication of market prices is effectively the average outcome; therefore there is greater emphasis on the average outcome, including joint behaviour of linked variables, than on replicating a particular distribution.

For setting capital requirements the following characteristic are important:

- Capital requirements are based on adverse outcomes. Adverse outcomes are represented by the tails of the distributions.
- It is important that the model replicates adverse outcomes in terms of probability and magnitude. It may be necessary to forgo accuracy in the central part of the distribution in order to model the tail.
- Similarly the joint behaviour of variables in adverse outcomes is more important than the joint behaviour in other parts of the distribution of outcomes.
- For capital requirements it is the capital determining time horizon that is important. There is a greater emphasis on the behaviour to this time horizon with compromises possible at other time horizons in order to achieve this.

- (ii) Asset modelling requires a balance to be struck between realism (and hence complexity) and simplicity (for ease of application, verification and interpretation of results).

Having a single model that is suitable for all three uses does not alter the requirements in relation to being representative, economic interpretation and parsimony it just places additional constraints. Using a single set of parameters means there will need to be a compromise – this is not ideal.

Within investment markets there are areas where arbitrages exist to various extents, e.g. liquidity constraints can create arbitrages. Asset models suitable for all three uses should be arbitrage free. This is an additional constraint to that which exists in actual investment markets. The complications that this causes should not be underestimated.

In particular there are the following additional constraints:

- Need to replicate the outcomes in terms of probability and magnitude over the entire range of the distribution. There are no areas where compromises are possible.

- There is a need to replicate the required behaviour over a much wider range of time horizons than for an individual model.
- There is a requirement to replicate prices for a wide range of potential assets rather than the actual assets held.
- The areas where compromises can be made are considerably restricted.

Increasing the number of constraints that have to be satisfied can only be achieved by increasing complexity, which significantly increases the development and maintenance requirements.

The additional complexity makes the calibration progress more difficult and time consuming. The additional computational requirements also need to be considered. Additional complexity does not help transparency of the model.

Comments on question 7: This question was poorly answered by most candidates. Most provided a satisfactory general explanation of a good asset model in part (i) but very few candidates considered the particular features needed for the three purposes given in the question. In part (ii) many candidates realised that there would need to be a compromise and that the model would be more complex, but there was little reference to arbitrage issues, the conflict between the focus on central and outlying results and the problems of addressing a wide range of time horizons.

END OF EXAMINERS' REPORT