

# EXAMINATION

April 2007

## Subject CA1 — Core Applications Concepts

### Paper 1

## 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.

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Chairman of the Board of Examiners

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### 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.*

Comments on individual questions are given in the solutions that follow.

- 1** The aim of catastrophe reinsurance is to reduce the potential loss to the ceding company due to any non-independence of the risks insured.

It smoothes the results and lowers the probability of ruin in most future scenarios that might be tested. It reduces volatility and avoids possible deteriorations in the solvency position.

It is non-proportional reinsurance; typically only available on a yearly basis and has to be renegotiated each year.

The reinsuring company will agree to payout if a “catastrophe”, as defined in the reinsurance contract, occurs. There is no standard definition of a catastrophe but, typically, there needs to be a minimum number of claims arising from a single incident occurring within a specified time of that incident. The cover would usually exclude war risks, terrorism, epidemics and nuclear risks.

The reinsurance treaty will also specify how much the reinsurer will pay. This might be the excess of the total claim amount over the ceding company's catastrophe retention limit. The total claim amount would be net of any amounts reinsured on an original terms or risk premium basis.

The reinsurer's liability in respect of a single catastrophe would be limited to a maximum amount. Any amount above that would fall back to the ceding company or to the next layer.

*This was a fairly standard bookwork question where most candidates scored well. Most candidates noted the main features though not many covered the exclusions. Too many candidates discussed reinsurance in general, especially the benefits of like reinsurance, without focusing specifically on catastrophe. With only five marks available the examiners were looking for specifics rather than generalities.*

- 2** (i) Marketability is the ability to trade an asset at a given price in given volumes. It essentially relates to the ease of trading. For example how long it takes to deal and at what cost.

Liquidity is about how close to cash an asset is. It measures how soon the asset will turn into cash without being marketed. For example a seven-day fixed term deposit at a clearing bank might be completely un-marketable, because the deposit cannot be transferred or assigned. It is however extremely liquid. If market conditions change, liquidity is a measure of how the capital value moves. Liquid assets tend to have stable market values.

- (ii) (a) **Growth fund**

The fund will hold unquoted shares, which will by their nature have low marketability. The capital values of the shares will probably be volatile given the nature of the companies. Hence there will be low liquidity.

There will be no quoted market value and the values used for many purposes could be quite stable, which means the fund appears to have lower volatility. Any actual transactions, especially large trades, will lead to a revaluation. The new value could differ a lot from the previous revaluation, which means that the fund could be very volatile.

**(b) Guaranteed return fund**

The investment is short term with a guarantee and so the assets held should have low volatility i.e. be liquid. A combination of assets could achieve this aim.

There is no guarantee in respect of early redemption (or possibly any option of early redemption). Hence assets do not need to be marketable (early redemption penalties could apply to cover any risk). Having assets with lower marketability implies that a higher guaranteed return can be offered.

**(c) Bond fund**

The fund aims to generate profits by trading and so it will hold marketable assets (in general). It could deal in large blocks of bonds, particularly as an intermediary between a seller and an ultimate buyer.

One of the ways to make profits is to switch between bonds that have different volatilities. So at any given time, the bonds held will have varying liquidity features and this makeup could vary over time.

**(d) Motor insurer**

The bulk of the liabilities will be short term and cash-like in nature. The assets to match will therefore need to be liquid and if outgo is uncertain, marketability will be needed to provide reliable cash flows.

There could be some longer term more real liabilities for personal injury claims. Assets to back these liabilities could have less marketability and liquidity to hopefully provide higher returns.

If the insurer has strong positive cashflow from premium income or large free reserves, it could hold assets with lower marketability and liquidity.

*Part (i) was generally very poorly answered. Most candidates thought marketability and liquidity were synonyms, and struggled to find any difference between the two definitions. The example given above clearly explains the difference.*

*In part (ii), the poor start from part (i) meant that many candidates concentrated on describing appropriate assets for the various entities, and why they were appropriate using asset/liability matching arguments, and without discussing the marketability and liquidity of the assets. This approach generated some marks, but did not answer the question the examiners were asking.*

- 3** (i) The freeholder owns the site on which the property stands. He is entitled to all proceeds from the property both income and capital gains. He can sell part of the rights to a leaseholder. At the end of the lease ownership will revert to the freeholder.

A leaseholder is entitled to rent from the users of the property for a given term. An agreement will set out the level of rent and the procedures for rent reviews (normally upward only) and the obligations of each party. At the end of the lease, the leaseholder will not receive any capital. Normally the leaseholder pays rent to the freeholder – this will be different from the rent it receives. Leases can be traded but they are not very marketable.

- (ii) 
$$\text{Price} = \text{Rent1} * a_{n1} + v^{n1} * \text{Rent2} * a_{(n2-n1)} + v^{n2} * \text{Rent3} * a_{(n3-n2)} + \dots$$

The initial rent is level at Rent1. There will be rent reviews at times  $n1, n2, \dots$ . Rent is assumed to increase at these points to Rent2, Rent3,...

*25% was given for the very general  $a_n$  at (i-g) type formula, 50% was given for a general  $\Sigma$  formula*

Rent should be net of expenses and tax.

It is assumed that the rent is received in perpetuity.

No allowance is made for refurbishment or modernisation. This should be consistent with the level of rent  $R1, R2$  etc.

Rents are discounted at an appropriate discount rate, which should allow for risks in the property, particularly of void periods.

- (iii) Essentially the investment is a short term fixed interest bond with no capital redemption at the end of the term. So the starting point is the return on short term government bonds — on income strips, or a series of zero coupon bonds if they exist.

There is a risk premium on the investment relative to similar government bonds. This risk premium may vary with individual properties. So a margin needs to be added to allow for the risks.

Risks relate to the tenant and particularly the chance of a void where no rent is received. If the tenant is a corporate body the covenant will be more secure and so voids are less likely. However there is the risk of a downturn in financial markets or business. This could reduce demand for the property.

There is a risk that the location of the financial centre could change or the area becomes unfashionable for a particular reason. These tenants could be fickle.

A margin will need to be added to allow for the lack of marketability relative to government bonds.

The discount rate may include an allowance for administrative expenses or they might be valued explicitly.

*Part (i) was reasonably well answered by most candidates, although some wasted time describing the attributes that increase the value of a freehold or leasehold or the features of property investment in general. In part (ii) it was disappointing that so many candidates could not set out a simple discounted cash flow formula, and made silly errors even when they understood the principles. The examiners were particularly looking for acknowledgement of the step nature of rent increases. In part (iii) most candidates appreciated that a risk premium needed to be added but few added it to the correct short-term bond return. Only the better candidates commented on the impact of the quality of the tenant.*

- 4** Consider the nature of the surpluses. The equity surplus is not realised, at least to the extent that the assets have not been sold, and may be reversed if markets fall. There is no indication that there will be future surpluses from this source. The withdrawal surplus is realised, and is one-off.

Consider the nature of the benefit improvements. The temporary contribution reduction is also a one-off benefit. The improved pension escalation rate is an ongoing benefit, as it will apply to future accruals of service (and possibly also salary in a final salary scheme), as well as to past service for both current and former employees.

It is therefore difficult to see how the actuary can state that this improvement can be made without detriment to the scheme's long term financial position. The employer needs to seek further information on this point. It may be that the actuary means that the additional benefit is affordable for the expected future membership of current scheme members, and new members will have to pay more or not be eligible for the benefit.

Consider the employer's contribution requirement. It is accepted that the employees contribute to the scheme, but if the employer fully sponsors the scheme, then he will be agreeing to be responsible for the balance of cost of the scheme benefits over the employee contributions.

In such a scheme, if the employer is required to pay additional contributions when strains arise, then it is highly reasonable for the employer to benefit from surpluses. This is particularly the case when surpluses are unrealised and reversible, such as the equity market surplus.

Whether the employer leaves the surplus in the scheme against future strains, or withdraws it, accepting the need for future additional contributions, is not significant. The former increases members' security should the employer have financial difficulties.

Equity investments are a good match for benefits in deferment; particularly for active members with salary increases matching inflation. Thus distributing the equity surplus to pensioners and deferred pensioners is a clear mismatch.

There is an argument, on grounds of fairness, that the withdrawal surplus might be distributed to those members involved in the staff reductions. Although these deferred pensioners would benefit from the pension increases, their benefit would be diluted among all members.

It would be necessary to consider the perceived value of the pension increases. Although the long term inflation proofing guarantee is valuable, it may be that in the short term pension increases may even be expected to be below 3%.

The termination payments in the staff reductions may have been generous, and designed to compensate for the poor scheme early leaver benefits that gave rise to the surplus. The employer may have made these payments in expectation of a partial recovery from the withdrawal surplus that would result. The employer may feel no duty of care to former employees, and reject any proposal to improve their benefits.

Employee representatives may question this proposal. Employees also contribute to the scheme and so may consider it is unfair for there to be no benefit improvements, especially when the actuary has advised that the changes in pension increases together with the contribution reduction are both affordable.

A reduction in the employer's contributions should increase the strength of the company and this should improve employment prospects. This may be an important factor to staff concerned about any further reduction in staff numbers.

Past decisions on distribution of surplus will influence expectations of employees. It will also be necessary to consider scheme rules, legislation and regulation, and the scheme's investment strategy.

*This was the longest single part question on the paper, and thus needed the greatest concentration on ordering a logical response rather than writing down random ideas. The best answers were concise, relevant, logically argued and structured and they answered the question. This question was the place to spend the bulk of the reading time. Performance on this question was a good indicator of performance on the paper as a whole: the better candidates did well here, the poorer ones did not.*

*Too many candidates "overcooked" the issue of Legislation/Trust-Deed/Scheme Rules even though the wording of the question was designed to circumvent this. Some candidates gave and justified alternative distributions for the surplus, rather than commenting on the proposal given, as required. However, in general, the balance of cost argument and that the employer ultimately covers risk (shy of a collapse of the scheme) were grasped and well explained.*

**5** (i) Good design for a product requires that the product

- is simple to understand
- is transparent in its structure and charges.
- provides benefits that demonstrably meet the identified needs of the client/customer.
- is profitable.
- provides benefits on discontinuance which are fair.
- is marketable.
- is competitive.
- is capital efficient.
- meets regulatory requirements.
- is simple to administer.
- is consistent with the provider's risk profile and risk appetite.
- must allow for costs of any options and guarantees.
- avoids cross-subsidies and anti-selection.

(ii) **Design factors to consider concerning the circumstances under which the benefit is payable:**

The more conditions that need to be fulfilled before the benefit is paid, the lower the cost leading to lower premiums. However, any conditions must not be so onerous that it makes the contract impossible to sell in the market or lead to adverse publicity in the future because claims have not been paid when some policyholders think they ought to have been.

A novel definition of the insured event (e.g. ability to pay part of the benefit in certain circumstances) may even differentiate the contract sufficiently in the market so that competitiveness on price is less significant, though this is dependent on the sales channel and the size of the market.

If the definition of the insured event is too loose, the company may either have to pay benefits that were not anticipated when the contract was written, or incur additional costs in disputing claims, and thus may also find it difficult to obtain reinsurance.

**Design factors to consider concerning the form of the benefit:**

The provider will want to ensure that the product meets the needs of its prospective customers in providing insurance for the long-term care services they may wish to use.

If benefits are defined as "meeting the costs of care" then the company must assess the costs of care to be covered. Alternatively, benefits may be defined

in cash terms to contribute towards the cost of care, but this may generate a marketing risk in that the benefits may not be enough to cover the eventual cost of care.

A cash benefit may be paid as a lump sum or an annuity. A benefit paid as a lump sum will reduce risk for the provider by avoiding longevity risk and the risk of the cost of care increasing, which may be significant for long term care

Consideration will have to be given to the reduction in benefits that would be provided if fewer premiums were paid than expected or the surrender value available if the policy were terminated. The extent to which early termination values are guaranteed will influence both the overall cost and the market perception of the contract.

Benefits may need to dovetail with any State social benefit schemes, and will need to take account of tax and legislation.

- (iii) *Marks were given for any appropriate pair of features, not just the examples below.*

**The desire for simplicity may conflict with the company's risk appetite**

To gain a marketing advantage the provider will want to make the contract as simple as possible for the customers to understand, which may involve cross-subsidies (for example, between large and small policies); or simple scales of benefits that would be provided if fewer premiums were paid than were expected, or if the policy were terminated.

These may create associated risks of anti-selection which are undesirable.

**The desire for profitability may conflict with marketability:**

In order to make adequate profit, premium rates must be adequate to cover benefits and expenses in most foreseeable circumstances.

However, the contract needs to be attractive to the distribution channels open to the company as well as the market in which it is intended to operate, which may distinguish on premium rates.

*Part (i) was standard bookwork and was answered very well. In part (ii) answers tended to be at too fine a level, some almost reproducing a policy document, rather than looking in more broad terms at the needs and risk of the provider and client, and using these to deduce the issues around the form of the benefit. Part (iii) was generally answered well, although quite a number of candidates wasted time describing two conflicts, when the question asked for one pair of items that were in conflict.*

- 6 (i) Thorough due diligence and appraisal of the project to establish what risks exist.

Decide how to measure the risks and which risks are most important.

Investigate correlations between the risks.

Decide on reasonable adverse scenarios to consider and model the effects of these.

Compare the outcomes against the risk tolerance of the consortium, allowing for risk exposures that the consortium may have on other business projects.

Investigate how risks can be mitigated, by reducing the risk of occurrence or by reducing the financial impact of occurrence.

Identify the costs of risk mitigation.

Implement the chosen risk mitigation techniques.

Establish procedures for monitoring, reviewing and controlling the risks as the project develops

- (ii) Risk: construction takes longer than expected, so deferral of income.

Mitigation: insurance against delay-causing events

*More than just "insurance" was required. Any sensible example gained the full marks.*

Risk: construction costs more than expected, so need for more finance.

Mitigation: transfer risk to sub-contractors.

Risk: fewer events in new stadium than expected, so lower income flow.

Mitigation: contracts with sporting bodies committing them to holding events.

Risk: lower income per event than expected.

Mitigation: sell tickets/debentures in advance.

*Marks were given for any other sensible risk*

- (iii) Covenants requiring the consortium to maintain appropriate insurance and other risk mitigation.

Covenants restricting the consortium from carrying out actions adverse to the bank's interests, for example further borrowing.

Control over how/when the consortium can draw on the loan.

The repayment schedule may be linked to the 15 year term during which the consortium will receive income. The bank may set the schedule as fast as the profitability would permit, and may also seek to prevent early repayment, in order to protect its interest margin.

The bank may take a guarantee or fixed charge, for example over the assets of the consortium, and will set the interest rate to take account of the risk.

*In part (i) almost all candidates restricted themselves to reproducing the core reading. The examiners were looking for an approach to risk management at a higher level than given in most of the scripts.*

*In part (ii) the risks chosen needed to be both significant and have suitable mitigation. The weaker candidates did not consider the features of the project as described in the question, and gave answers that were too general. Candidates who applied common sense to the specific problem rather than try to think of some core reading to reproduce did well.*

*In part (iii) most candidates came up with a number of sensible ideas, although some made suggestions that were beyond the terms that could be imposed on the loan, such as the bank approving operational plans. This part was generally answered well.*

- 7**
- (i) salaries and salary-related expenses  
commission to brokers  
property costs (rent, heating, lighting and cleaning)  
computer costs  
External fees (audit, regulatory, consultancy)  
investment costs (stamp duty, commission, custodian, etc.)  
capital costs  
office sundries e.g. stationery
  - (ii) Some expenses can be identified directly as belonging to a particular class of business, while others do not have a direct relationship to any one class of business. These need to be apportioned between the appropriate classes.

If direct expenses arise from areas dealing with more than one class of business then time sheets can be kept (either for a period or permanently) to help split costs between classes.

The indirect expenses are harder to allocate as the departments concerned are not related directly to any particular class of business, but form a support function for the provider. In this case, it is necessary to find a sensible apportionment of the expenses across direct activities.

For some costs a charging out basis could be used. Computer time and resources could be charged to the direct function departments according to the use made of them. Premises costs can be allocated by floor space.

For other costs such as statutory fees or senior management costs a more arbitrary basis may be required. These costs could simply be added at the end of the analysis as a percentage loading to all the other attributed costs.

As well as apportioning expenses to a line of business, costs need to be apportioned by function, so that they can be allowed for in determining product pricing or the provisions for existing future liabilities.

For most types of business the high level division is into the costs of:

- securing new business;
- maintaining existing business (renewal and investment)
- terminating business (including claims).

These items may be sub-divided. For example new business costs might be split into marketing; sales and commissions; processing and policy issue; and underwriting.

Investment expenses would normally be expressed as a percentage of funds under management. This enables them to be expressed as a reduction in the assumed investment return in product pricing or provisioning.

- (iii) It is important to consider the purpose of the model and the extent it will be used.

An important element of any product pricing process will be the inclusion of loadings for expenses.

These are required to ensure that sufficient premiums are charged to cover not only the expected claim costs, but also the costs of expenses related to administration and claims handling for the business written on these rates, and provide a contribution to the general fixed costs of the provider.

The loading for expenses could be allowed for as follows:

- as a fixed amount per contract;
- as a percentage of the premium charged;
- as a percentage of the sum insured/assured;
- as a combination of the above.

Some expenses are directly related to the size of the premium, e.g. renewal commission payments, and it may also be decided that overheads should be shared in proportion to premium size. A model using premium related expenses would deal with these well.

However, many expenses are independent of the size of the policy, for example premium collection costs and the costs of communicating with policyholders. If these are loaded in proportion to premium rather than on a

per policy basis, then the modelled expenses will be incorrect if the average size of policy is not as assumed.

It is very unlikely that the company does not sell single premium products, or has no paid-up contracts. These products do have an ongoing maintenance costs and should also contribute to overheads. Thus the company will need a loading for single premium product maintenance costs, even though there is no premium paid.

The combination of a percentage of premium and a per policy expense loading for contracts with no premiums payable will complicate both the model and the process of setting the assumptions. This will increase costs.

Alternatively the company could load all expenses onto regular premium policies. However, this approach will increase the exposure to the risk of the lapse rate being greater than assumed, and to lapses, deaths and surrenders not being of the assumed average size.

Because of this effect, sensitivity runs of the model will need to be interpreted with great care.

Future premiums are unlikely to increase in line with expense inflation. Some policies will have automatic indexation or voluntary increments. Group contracts with premiums linked to salaries will also have an element of inflation built into the premiums.

While initially the aggregate expense loadings will be set in order to meet current expenses, in future years the premium loadings will not keep pace with the inflationary increase in expenses incurred. To get round this the percentage of premiums will have to increase with duration. Hence the original simplistic approach will need to be made more complicated, and thus more costly to develop.

Termination expenses are best reflected as a per policy amount, whereas investment expenses are usually expressed as a percentage of fund.

*Overall parts (i) and (ii) were answered well. A number of candidates were confused about what constituted items of expense, for example putting both salaries and administration expenses in the list. Part (iii) was another question looking for the higher order skills; many candidates recalled a part of the core reading that was vaguely relevant and reproduced it, scoring few marks. In summary, an unusual proposal has been made as to a method of modelling expenses, and candidates were asked to comment on it, not just set out the obvious approach. The method has some advantages, particularly simplicity and hence run time, which almost no one pointed out,*

## **END OF EXAMINERS' REPORT**