

# **INSTITUTE AND FACULTY OF ACTUARIES**

## **EXAMINERS' REPORT**

September 2014 examinations

### **Subject ST9 – Enterprise Risk Management**

#### **Introduction**

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context at the date the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton  
Chairman of the Board of Examiners

December 2014

## **General comments on Subject ST9**

The ST9 exam generally requires bullet point form or short form essay style answers that apply general principles to directly address specific circumstances. The answers given below are just one possible set of acceptable answers. Candidates are awarded marks for all reasonable answers including different but still reasonable numerical solutions. Marks are awarded for working in the case of numerical answers.

Candidates' answers are made up of a series of points. For example, a point can be stating a valid type of risk, describing the type of risk or (part of) a calculation. Some points are more fundamental to the correct answer but, in the main, candidates earn one-half mark per correct point up to the limit of marks available for the question.

## **Comments on the September 2014 paper**

The paper was made up of three relatively small questions and three relatively large questions. Unusually question 4 was in part about setting exam questions and the answer is instructive. The question addressed the desire to maintain consistent standards from one diet to the next across many diets. The answer suggested that it is important to ensure that the overall paper contains the targeted balance of bookwork and application and the range of content needed to reasonably cover the syllabus. This exam fulfils those objectives.

As is common practice, the large majority of the questions were:

1. based heavily on bookwork;
2. based on simplified case studies or;
3. loosely based on actual and often relatively recent events.

For example, questions 1 and 2 were largely bookwork and the remainder of the questions were loosely based on relatively recent events.

The examiners seek to test the candidate's knowledge of the syllabus. The core reading is an important source for framing questions but not the only source. For this reason, candidates are encouraged to read the financial press and to consider how current news items can be applied to the issues and concepts contained in the core reading.

Well-prepared candidates scored acceptably well across the whole paper. The comments that follow the questions concentrate on areas where candidates could have improved their performance.

- 1** The advantages of separate functions are the disadvantages of a joint function and vice versa.

Separate:

- One function can provide an independent review of / check on the other.
- It facilitates the independence of the risk function.
- It allows for clear reporting lines.
- It avoids conflicts of interest by separating the risk roles from the front line business operations such as pricing.
- It can encourage more communication between teams and parts of the business on risk issues.
- It achieves a dedicated central risk function which can cover a wider remit than just “actuarial risk”.

Together:

- It reduces the need for specialised / skilled resource in the firm.
- It may therefore also be cheaper.
- Arguably it is the more integrated approach, achieving a better relationship between risk specialists and operational staff.
- May be a more collaborative approach; less likely to try to “hide” problems.
- Decisions may be made and implemented more quickly.
- It could reduce the possibility of duplication of effort, if there is a blurred distinction between some responsibilities.

[5]

*The question was handled well by most. Virtually all of the candidates made at least some of the above points. As ever, additional marks were given for other valid answers including that if the functions were together then communication might be easier and the company might need fewer people.*

2	(i)	Claims Type A	Claims Type B	$A-\mu_A$	$B-\mu_B$	$(A-\mu_A)^2$	$(B-\mu_B)^2$	$(A-\mu_A)^*$ $(B-\mu_B)$
	2009	164	769	-6.4	200.4	41	40,160	-1,283
	2010	149	463	-21.4	-105.6	458	11,151	2,260
	2011	125	426	-45.4	-142.6	2,061	20,335	6,474
	2012	211	685	40.6	116.4	1,648	13,549	4,726
	2013	203	500	32.6	-68.6	1,063	4,706	-2,236
	Sum	852	2843			<b>5,271</b>	<b>89,901</b>	<b>9,941</b>
	Mean ( $\mu$ )	170.4	568.6					

The sample standard deviations and covariance, from dividing by  $T - 1 = 4$ , are thus:

$$\begin{aligned}
 s_A &= 36.3 \\
 s_B &= 149.9 \\
 s_{A,B} &= 2485.2 \\
 \rho &= 0.457 \\
 &= \frac{s_{A,B}}{s_A \cdot s_B}
 \end{aligned}$$

[4]

*The question was handled well by most. The statement made in the summary section earlier said that marks were given for working. This is true. It does not however mean that the candidate needs to show working to gain full marks. If, as in this case, the question simply says "Calculate..." without reference to workings or reasoning then simply writing down the answer would gain full marks.*

(ii) Kendall's  $\tau$

			v2009	v2010	v2011	v2012
2009	164	769				
2010	149	463	c			
2011	125	426	c	c		
2012	211	685	d	c	c	
2013	203	500	d	c	c	c

$$\begin{aligned}
 p_c &= 8 \\
 p_d &= 2 \\
 t_{A,B} &= 0.6 \\
 &= 2(p_c - p_d) / T(T - 1) \text{ where } T = 5
 \end{aligned}$$

[3]

*The comments made for part(i) above also apply here.*

- (iii) Both methods are fairly simple to calculate.

However Pearson's  $\rho$  depends on the distribution of claims being jointly elliptical. If the results are not from elliptical underlying distributions, the results may not be valid.

Kendall's  $\tau$  depends only on the rank of the data points and so is always valid, irrespective of the underlying distribution of the variables.

Kendall's  $\tau$  has a simple relationship with the parameters of a number of copula functions.

Pearson's  $\rho$  can be used directly in some common multivariate distributions.

[2]

*The question was handled well by most. As ever, additional marks were given for other valid answers.*

- (iv) The results of both correlation tests are positive, suggesting that the claims move in similar directions and therefore may have important risk factors in common.

However, the correlations are lower than 1 and so there must also be other underlying claims drivers which affect one class more than the other.

Examples could be house insurance contents claims and motor vehicle accident claims (as both increase with bad weather but are also affected independently by other "perils").

[2]

[Total 11]

*Marks were given for other examples that are likely to have relatively high but not perfect correlation e.g. buildings and contents insurances.*

- 3** (i) Operational risk is the risk of losses resulting from inadequate or failed internal processes, people and systems, or from external events. [1]

*Most candidates scored full marks.*

- (ii) The company may want to measure its risk exposure as the impact of operational risk events on one or more of:

- Additional short term costs of staffing, property, and systems.
- Fines for failure to comply with regulatory requirements that apply.
- The fall in turnover / the reduction in new business sales.
- The reduction in customer satisfaction scores.
- The increase in lapse rates.
- Overall impact on ABC's embedded or economic value.

- Overall impact on surplus capital or VaR/TVaR.

To model this, the company may be able to source data internally (although unlikely given ABC's small size) or externally through any industry databases that may exist.

By its nature the risk is bespoke and it may be impossible to get sufficient data to model and measure this risk statistically, particularly for low frequency, high severity events.

However it may be possible to get input from experts in this field to help guide the assessment of the exposure.

The experts might be internal or external.

Both severity and frequency need to be considered.

Scenario analysis techniques may be used.

Correlations between operational risk events need to be considered.

The exposure measures should reflect the mitigations or controls that are in place.

It may be necessary to use other losses as a proxy for the exposures to operational risk.

[5]

*The question was handled poorly by most. Many candidates made two or three of the above points but no more. Similar questions have been asked in past papers.*

(iii) Advantages:

- gets input directly from people who understand the business processes
- assessments will be bespoke to ABC Life and not for an average company in the industry
- the interview process may help build an understanding of how the different teams depend on each other
- interviewing (as opposed to questionnaires or surveys) allows immediate clarity to be sought if the answer is unclear
- interviewing on an individual basis reduces bias or "group think"
- and it ensures that all of the required contributors are engaged

Disadvantages:

- people responsible for the separate processes may not be familiar with the wider risk management / economic capital modelling requirements
- individual senior managers may be biased and overstate the importance of their area
- it is difficult for individuals to estimate impacts in extreme or hypothetical scenarios, which could result in unrealistic impact assessments
- it might be a relatively time-consuming process
- care has to be taken to avoid bias resulting from framing within the questions used or due to using different interviewers

[4]

*The question was handled reasonably well by many. Other extra points include:*

- *Advantage: that the persons doing the interviews are risk experts.*
- *Disadvantage: could be difficult to aggregate the responses (particularly if done by different interviewers).*

- (iv) Following a disaster ABC Life may not have access to its systems or to its premises.

Staff may not be able to report for work.

The disaster may not have affected ABC Life directly; the impact might be indirect via its suppliers and customers.

A disaster recovery plan would help the company focus on critical processes to the business and proactively set out how it will ensure these are able to continue under these circumstances.

[2]

*The question was handled reasonably well by many. Other extra points include that the DRP should increase other stakeholder's confidence in the company e.g. shareholders and regulators.*

- (v) The company should hold capital against this risk.

It fits with the definition of operational risk.

It will help to raise the profile of disaster risk (and the need for a disaster recovery plan) within the company.

It allows risk diversification, since operational risk is not perfectly correlated with other risks such as market and credit risk.

It may be difficult, however, to quantify the high severity, low frequency exposures required for economic capital modelling and in particular to obtain sufficient extreme event data with which to calibrate the model.

It may be necessary to use Extreme Value Theory techniques within the economic capital model, which increases the complexity of the modelling.

Correlations with other risks will also be difficult to determine. E.g. 1 potential impact on financial markets if the disaster is widespread. E.g. 2 potential positive correlation with insurance risk.

The mitigating actions that can be taken to minimise the impacts in the event of a disaster should be taken into account. This may be difficult to do in an economic capital model as the impact of the actions may not be the same in the high severity, low frequency scenarios as in the lower severity higher frequency scenarios.

[4]

*The question was handled reasonably well by many. Other extra points include that the company is small and including disaster risk in this way in the ECM may be a relatively inexpensive and practical way of modelling it.*

- (vi) Risk appetite can be interpreted as reflecting the setting of targets and limits across the organisation as a whole, plus the breakdown of these high level statements into more detailed risk tolerances.

Risk appetite is usually presented as a probabilistic statement.

Examples are:

- The solvency level, X, should stay above the threshold Y with 99.5% probability over the next 3 years.
- The probability that the company's credit is reduced from the current AAA to A, or worse, in the next twelve months should be no more than 1%.
- Earnings volatility over the next year should be no more than Y%.
- The company is prepared to lose \$Y with a probability of no more than 0.5% over the next 12 months and \$Z with a probability of 0.1% over the next 5 years.

[3]

*The question was handled well by most.*

- (vii)
- Since regulatory profit is based on prudent assumptions it will be unrealistic in that the release of margins is materially deferred (profits too low early on).



- Accounting profit is likely to be more realistic than regulatory profit.
- However, it won't fully reflect all the constraints imposed on ABC, e.g. it is unlikely to reflect fully the cost of capital imposed on ABC as a result of the solvency regulations, and is unlikely to be risk-adjusted.
- Economic profit will allow the most realistic assessment of risk-adjusted profit.
- It can take into account regulation and other business constraints.
- However economic profit is not subject to audit, unlike accounting (and potentially also regulatory) profit.
- It is therefore potentially more readily manipulated.
- As it gives the most realistic assessment, economic profit can be considered to be the most appropriate for the risk appetite statement.
- It may also be easier to assign a probabilistic interpretation to economic profit.
- However, accounting profit will be more widely understood by stakeholders and so could lead to more engagement with staff and better integration of risk into the management of the company.

[5]

*The question was handled well by most.*

- (viii) A focus on profit can lead to short termism amongst the Board and senior management.

Short termism could also encourage profit reporting manipulation.

If the remuneration structures are aligned with the profit focus, they could in turn incentivise management and staff to focus on sales rather than longer term value creation.

There could be a related mis-selling risk.

High sales volumes could jeopardise the solvency of the company.

To reduce profit volatility, the company may prefer to offer products that have more stable profit streams; these less risky products may have lower value to customers which could lead to lower sales and lower ultimate added value to the business.

Basing risk appetite on a balance of different metrics will likely result in relatively less risky (volatile) behaviour for a given targeted return.

[2]

[Total 26]

*The question was handled well by most. Extra valid points include that the primary focus on profit ignores many other important targets and risks that other stakeholders will be interested in to a greater or lesser extent than profit e.g. risk of ruin and more particularly the risk of ruin resulting from short-term funding difficulties.*

- 4** (i) Business risk and more particularly strategic risk, being the risk of not achieving ERMI's plans and objectives.

This could also have knock-on implications for the wider reputation of the APB (contagion of reputational risk).

Failure to achieve these plans and objectives will likely come from one or more failures, such as:

- Failure to develop clear plans and objectives regarding targeted market, projected numbers of students and fellows, positioning of the perceived status of the fellowship compared with alternatives.
- Failure to develop appropriate syllabus and coursework
- Failure to properly advertise the institute and the fellowship
- Failure to keep up with competition and with ERM developments
- Failure to build the reputation required to attract new students and hold on to existing members
- Failure to meet the expense budget

Reputational risk can also arise from high profile failures of the examination system once it is established, e.g. lost exam scripts, advance leaking of exam papers.

Or the risk that the standard of those passing the exams is not set at the appropriate level (unrealistically high: will deter students from registering for these exams; too low: will diminish the perception of the quality of the qualification).

Risk of financial ruin will most likely be the result of failing to attract a minimum number of students from year to year.

New systems and staff will be required, increasing operational risk (at least until established).

Operational risks may be exacerbated if significantly higher numbers of students register for the exams than expected and the process and staff are unable to cope.

Operational risks may also be increased once it starts to work internationally, as the logistics become more complex.

[6]

*The question was handled well by the large majority of candidates. Marks were given for any other valid points including:*

- *Regulatory risk: risk of adverse intervention (or changes in approach) of the regulator for the professional body.*
- *Fraud risk: exposure to exam cheating.*
- *Agency risk: conflicts could arise between the objectives of ERMI and APB.*
- *Legal risk: from individuals who do not consider themselves to have been treated fairly in the exams.*
- *FX risk: in relation to costs incurred for any overseas exam centres and/or the relative expense of overseas exam fees.*
- *Market/counterparty risk: in relation to working capital including the initial funds from APB.*
- *Liquidity risk: e.g. in relation to repayment of the loan.*

- (ii) The APB is likely to support ERMI in several different ways (and thus help to reduce many of the above risks) once ERMI can evidence to the APB that it has developed appropriate syllabus, coursework, exam systems and continuing professional development.

To reduce the risk of not attracting enough students:

- Some of APB's members are likely to be interested in ERM and the APB is likely to want to market ERMI to them.
- APB will also have relationships with other professional bodies around the world. It will likely promote ERMI to them.
- APB is likely to be in regular contact with employers, government and educational bodies. It will likely promote ERMI to them.

To reduce the risk of failing to develop appropriate syllabus, coursework and exams:

- ERMI could work with academics and experienced ERM professionals. It could for example hire as consultants a number of recognised ERM experts from universities and management consultancies. It could develop a panel of experienced senior ERM professionals to review and refine the draft syllabus and coursework.

- These same people together with educational consultants should be able to help ERMI to develop an appropriate exam setting and marking system as well as continuing professional development program.
- The syllabus and educational material should be subject to regular review by the expert panel in order to maintain its relevance.
- ERMI could outsource the development and maintenance of the syllabus, coursework, exams and continuing professional development to a suitable university.

To reduce operational risks:

- In the early years ERMI could outsource the bulk of IT and administration.
- For example, it could do this to APB, which would already have its own qualification assessment systems.
- ERMI needs to develop and document robust processes and governance systems.
- And to ensure that it has sufficient resourcing levels and that its staff are well trained.
- And that all qualification support systems undergo thorough testing protocols.
- Tight security measures should be put in place and also rigorously tested.
- ERMI needs to have robust processes and recovery plans in place to deal with adverse operational events e.g. loss of exam papers in transit or leakage of information.
- ERMI also needs to control its expenses.

[5]

*The question was handled well by the large majority of candidates. Marks were given for any other valid points including:*

- *Regulatory: engage with the regulator and work closely.*
- *Legal: consult lawyers at each stage.*
- *FX: use of derivatives if appropriate.*
- *Market/counterparty: invest working capital in secure assets.*
- *Liquidity: make sure the loan agreement with APB is on flexible terms.*

(iii) Setting the exams

Break the syllabus into sections and seek to examine those sections relatively regularly from diet to diet to test fairly those candidates with different strengths and weaknesses.

Break the questions into categories of difficulty ranging from straightforward to requiring original thought. Endeavour to keep a constant percentage of marks in each level of difficulty from diet to diet.

The exams should pass through a process of review including experienced personnel actually sitting the exams (e.g. those who have recently passed the ERMI exam).

The aim of this review is to maintain consistent language from diet to diet, ensure that the questions are clear and unambiguous and to test that the exam can be answered in the allowed time.

If the exam is being sat by candidates who do not have the language used as their first language, then the papers should also be reviewed by such personnel.

Multiple choice questions, calculation questions and questions requiring a list answer require no or little interpretation to mark and thus can help to ensure consistency if included in a target proportion.

Marking the exams

The examiners will produce draft solutions and a clear and detailed marking schedule.

The draft solutions will be updated by the markers during the marking process as the candidates will collectively make other valid points and take other valid approaches.

All markers can be required to mark the same “test batch” of scripts and these marks can be analysed and discussed to ensure that appropriate and consistent standards of marking are being applied.

It would be reasonable for a team of experienced markers to mark all the papers once and to separate out the clear passes and failures.

A more rigorous approach would be to mark all papers twice before separating out clear passes and failures.

After taking account of marking differences between markers, some or all of the questions on the remaining papers would be remarked – particularly those where the first two markers' marks were significantly different.

Multiple marking of exams would ensure that each candidate receives an appropriate mark.

The markers should be experienced in ERM.

Over time, students who have passed the ERMI exam should be encouraged to become markers.

The group of markers used should not change materially from session to session.

Markers who do not allocate marks within an acceptable tolerance should be removed from the marking pool.

#### Determining the pass mark

The examiners will set the draft pass mark at the time of setting the exam.

The draft pass mark will be revised if the candidates as a group discover any difficulties in understanding or finishing the exam in time.

The examiners will review scripts above and below the draft pass mark and decide whether the pass mark is set correctly based on the knowledge displayed in the answers compared with the knowledge displayed by prior candidates at the pass mark in previous diets.

Clearly it is important that past examiners are available to review scripts at this stage.

Examiners must be able to provide robust justification for material changes in the pass mark (and pass rate) from diet to diet.

[5]

[Total 16]

*The question was handled well by many. Marks were given for any other valid points including:*

- *Monitoring the exam process across diets to ensure the various steps are being followed.*
- *Reviewing the governance structure regularly.*

5

(i)

- Level
- Volatility
- Catastrophe
- Trend

[2]

*The question was handled poorly by the large majority of candidates. This was a bookwork question.*

(ii) Generalised linear modelling will be principally used to model the “level” risk.

Generalised linear modelling requires us to first risk rate the data.

This works as follows:

- Divide the data into homogenous groups
- Derive expressions for the mortality of each group in terms of the risk factors
- Analyse the structure of the group of lives of interest in terms of these risk factors
- Use the risk factor exposures to infer the underlying mortality of the group of interest

Generalised linear modelling usually involves logit or probit regression analysis.

This places the mortality rate as the dependent variable and the risk factors as the independent variables.

[4]

*The question was handled poorly by the large majority of candidates. ST9 candidates should have some understanding of GLM.*

(iii) The premium rates it charges will load margins for expenses and profit on top of the pure risk premium.

High levels of competition in the market may force Predictable Life to (temporarily) charge lower premium rates than the risk levels its models are suggesting in order to maintain market share.

Alternatively, a lack of competition in the market (or offering niche features on its products) may enable Predictable Life to charge a much higher premium rate and still retain a healthy market share.

[2]

*The question was handled well by most candidates.*

- (iv) Diversification between different product lines suggests that the “worst case” scenario for one product is not the same as on another product. As a result, combining the two products into a single offering may result in a lower combined economic capital requirement. The benefit of this can be passed on to customers.

[2]

*The question was handled well by most candidates.*

- (v)
- Number of products/policies per customer.
  - Profit per customer.
  - Risk capital per customer.
  - Customer retention rates.

[2]

*The question was handled well by most candidates. Other reasonable suggestions included customer satisfaction ratings and rankings.*

- (vi) Penny Saved Bank will most likely have on average:
- Slightly less healthy – more risky – lives because of lower underwriting standards (since any protection products are likely to be purchased specifically to cover a home loan rather than on a standalone basis)
  - Slightly wealthier – less risky – lives because of the different target markets the companies operate in: bank customers have at least one other financial services product so on average are likely to have a higher net worth
  - Slightly higher sums assured where the policies are sold specifically as part of the collateral on a home loan

This suggests that per policy Penny Saved may have a higher life insurance risk exposure than Predictable Life.

However, Predictable Life will likely have a larger number of policies and so will probably have greater exposure overall.

Although Predictable Life is more likely to have longevity exposures (if it writes immediate annuity business), which might partially offset its mortality risk exposure.

[2]

*The question was handled well by many candidates. Most candidates made at least two valid points.*



- (vii) There is an element of self-selection at work. People taking part in extreme sports are likely to be younger, fitter and healthier so that the lives insured by Extreme Life are likely to be younger, fitter and healthier on average than those insured by Predictable Life.

This should reduce the frequency of non-extreme sports claims.

However, there will be the additional claims arising directly from participation in extreme sports, the frequency experience under which could be more volatile if the portfolio is relatively small, given the restricted target market.

The fixed sum assured under Extreme Life policies reduces the variability of the claim amounts.

The business written by Extreme Life is short term and therefore it can probably change its pricing more rapidly to reflect changes in expected insurance risk, thus reducing its exposure to this risk.

If sold to small groups of travellers, Extreme Life business might have greater potential aggregation risk.

However, Predictable Life is more likely to have offsetting longevity exposures.

[3]

*The question was handled well by most candidates.*

(viii) For:

- Extreme Life is taking a non-standard risk and so a “standard” formula approach is inappropriate.
- Extreme Life is the only player in this market and developing a more sophisticated risk assessment tool could help it ensure a longer term competitive advantage.

Against:

- Noting the simplistic pricing approach, it would appear that the internal model won't have a track record of being used in the business.
- Extreme Life appears to be a relatively small company and hence the cost of developing and implementing an internal model might be too onerous.
- As Extreme Life has a monopoly on this market it is likely to have exposure to the “good” and “bad” risks, and the expected frequency of claims should be relatively low. Hence a simple model could be adequate.

[2]

[Total 19]

*The question was handled well by many candidates. Most candidates were able to make at least one point for and one point against an internal model.*

**6** (i) Exposure: Calculate the number of lawyers taking up the PLI

- The average of 1,2 and 3 is 2. Assume each of the small member firms taking up insurance has 2 lawyers.
- Assume that the most common and best way of pricing the insurance (and calculating the exposure) is per lawyer.
- Since the assumed take-up rate is 30%, the insurance will cover  
 $.3 * 300 * 2 + .3 * 30 * 50 = 630$  lawyers

Calculate the premium income

Assume that in order to entice member firms to switch to NIC, NIC decides to charge each lawyer £3,000 rather than the market price of £4,000.

Hence the total premium income net of expenses of £200 per lawyer equals  
 $630 * 2,800 = £1,764,000$ .

This ignores any 99.5% stress of the expense assumption, which is assumed not to be material.

Calculate the claims cost at the 99.5th percentile

- The implied average claim per lawyer equals  
 $.995 * 20,000 + .005 * 1,000,000 = 24,900$
- Assume that all claims are independent from one another.
- The mean aggregate claims cost equals  
 $630 * 24,900 * .12 = 1,882,440$
- The coefficient of variation of the aggregate claims cost distribution equals 0.3 of the mean so that the standard deviation equals  
 $.3 * 1,882,440 = 564,732$
- The 99.5th percentile of the aggregate claims cost distribution equals  
 $3.5 * 564,732 + 1,882,440 = 3,859,002$
- So the additional claims cost (reduces year end assets) under the stressed scenario =  $3,859,002 - 1,882,440 = 1,976,562$

Calculate the investment income net of the credit default losses at the 99.5th percentile

- Assume that the 1,764,000 is invested for one year at 4% before the claims are paid out.
- At the 0.5% percentile the investment income will be  
 $.04 - .04 * .25 * 2.2 = .018$
- Also the 1,764,000 invested funds are assumed to be subject to one year's credit default losses whilst they are invested.
- At the 99.5% percentile this will be  $.005 + .005 * .5 * 2.6 = .0115$
- Investment income and credit risk are stated to be 100% correlated. Hence the net investment income at the 99.5th percentile will be  
 $(.018 - .0115) * 1,764,000 = 11,466$
- The mean net investment income will be  $(.04 - .005) * 1,764,000 = 61,740$
- So the reduction in investment income earned (reduces year end assets) under the stressed scenario =  $61,740 - 11,466 = 50,274$

Calculate the operational risk at the 99.5th percentile

- In the best estimate scenario, neither risk is expected to happen.
- The probability of Risk B occurring is beyond the 99.5th percentile and hence the capital cost is zero.
- Since the probability of Risk A occurring is below the 99.5th percentile, it could be assumed that the capital requirement for it is 500,000.
- Alternatively, assuming that Risk A is relatively uniformly spread in the tail, it could be considered to have a 90% chance of occurring  
 $(= (.05 - .005) / .05)$  at the 99.5th percentile. Hence the capital cost for Risk A can be taken to be  $500,000 * (.05 - .005) / .05 = 450,000$
- So the reduction in assets due to operational events under the stressed scenario = (say) 450,000

Calculate the diversification credit

As given in the question, claims cost, operational risks and market/credit risk are independent.

Assume that a normal approximation can be used for the aggregation (although this is less reasonable for operational losses)

Diversification credit formula = { square root of the sum of the squares of the three individual capital amounts, i.e. 1,976,562 and 50,274 and 450,000 }

Gives the required minimum capital requirement = 2,027,764

[16]

*The question asked candidates to calculate a capital requirement for a hypothetical company. The question was handled well by some and quite poorly by others. Candidates were given credit for different approaches and particularly where they stated their assumptions. For example the above calculations for investment income could be done on a higher amount to reflect the fact that the start year best estimate liabilities would exceed the premium income under these assumptions and thus additional investment return would be earned on the additional assets that would have to be held to back those liabilities.*

- (ii) Whilst theoretically sufficient, initial capital of this amount is unlikely to be acceptable to the regulator on its own because:
- There are no guarantees that the £1,764,000 of net premium will actually be received.
  - Claims might be due to be paid prior to receipt of the bulk of the premiums.
  - There exists a theoretical chance of more than two £1m claims and the total capitalisation of NIC would not support this.
  - In practical terms the regulator is likely to require NIC to hold sufficient capital to cover at least three or more large claims implying a minimum capital requirement of either £3m or more.
  - The actual take-up rate might be far higher than expected, making the capital requirement insufficient (obviously held premium reserves would increase to at least in part compensate).
  - The regulator might not like the model including its construct and its parameters, so it may impose a prudential margin.
  - The capital calculations are predicated on several assumptions, some of which may be incorrect e.g. that the risk categories are fully independent.
  - Similarly the regulator might not be happy with the approach taken to operational risk if Risk B is effectively ignored completely.
  - The regulator might require an additional buffer to be held so that NIC continues to demonstrate sufficient solvency even after an adverse event.
  - The cost of placing long-tailed liabilities into run-off might exceed the best estimate liability implicitly assumed.
  - Additional capital could be required to cover other risk categories.
  - For example, liquidity risk.

- Additional capital could be required to cover an expense stress.

[4]

*The question was handled well by some and quite poorly by others. Additional valid points included that the new company is likely to have extra operational risks which were not modelled.*

- (iii) Need to investigate the reason for the higher claims and research the extent to which it is likely to continue.

Also would investigate whether the higher claims are resulting from specific law firms only, and if so whether they are linked to the particular strategy or practices of that firm.

The most likely reason for the higher claims is that there have been systemic losses, meaning that the assumption that claims are independent from one another is not correct.

In order to test this assumption it would be necessary to conduct a survey of a random selection of claims to determine whether they are related in any way.

Assuming that the factor of 3.5 standard deviations to reach the 99.5th percentile of the aggregate claims cost distribution was made assuming that claims were independent from one another then it would be necessary to develop the assumption to allow for positive correlation between claims and possibly very strong positive correlation in the extreme cases.

The impact will be to increase the minimum required capital.

[3]

[Total 23]

*The question was handled well by many.*

## **END OF EXAMINERS' REPORT**