

2010 Examinations

SPECIMEN EXAMINATION

Subject ST9 — Enterprise Risk Management

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*
2. *You have 15 minutes before the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have three hours to complete the paper.*
3. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*
4. *Mark allocations are shown in brackets.*
5. *Attempt all six questions, beginning your answer to each question on a separate sheet.*
6. *Candidates should show calculations where this is appropriate.*

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

<p><i>In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.</i></p>
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- 1** (i) Define four major risks which can be effectively modelled quantitatively. Explain the reasons for each choice. [4]
- (ii) Define four major risks which cannot be effectively modelled quantitatively. Explain the reasons for each choice. [4]
- [Total 8]

2 Your answers to the following questions should assume that the firm already employs a Chief Risk Officer.

- (i) Describe eight practices that a firm could introduce to reduce risk without incurring significant additional direct or indirect cost to the firm as a whole. [8]
- (ii) Describe four practices that a firm could introduce to reduce risk which would predominantly incur an indirect cost rather than a direct cost to the firm as a whole. [4]
- (iii) Describe four practices that a firm could introduce to reduce risk which would predominantly incur a direct cost rather than an indirect cost to the firm as a whole. [4]
- [Total 16]

3 You have recently completed an ERM model for your employer, a large publicly owned bank. Your manager has asked you to supervise the process of validating that the model is both working as intended and is appropriate for its intended uses. The bank is listed on a major stock exchange and subject to sophisticated government regulation.

- (i) Describe all aspects of the initial model validation process. [10]
- (ii) Describe the ongoing re-validation process, with reference to the actuarial control cycle. [4]
- [Total 14]

- 4** A bank has decided to launch a new fund. The fund will raise debt and equity at the outset. No distributions will be made during the life of the fund other than interest payments to the debtholder(s). At the end of 5 years the fund's assets will be sold and the proceeds distributed to the stakeholders.

The bank's wealthy private investors will invest a total of £20m in the fund as equity. The remaining £80m raised will be in the form of floating rate debt, with all of the principal to be repaid at the end of year 5. The initial coupon on the debt is expected to be 5% p.a. The bank will not guarantee any future returns to either the equity holders or the debt holders.

The fund will invest solely in BB rated corporate bonds. There are no restrictions on issuer, currency, interest payment type or term to maturity. The sole restrictions are that the investments must be bonds issued by companies and the rating of each bond must be BB at all times during the holding period. That is, a bond must be sold if its rating changes and replaced with another suitable bond. The initial average bond coupon is expected to be 7% p.a.

- (i) Explain four of the most significant risks impacting the equity investors' ultimate return. [4]
- (ii) Explain the most significant risk impacting the bank. [1]

The following table shows the one year rating transition probabilities for BB bonds and the probabilities of default over time for a bond that is rated BB at time zero.

<i>Rating</i>	<i>Rating of BB Bond at Year end %</i>	<i>Year</i>	<i>Probability of Default at the end %</i>
AAA	0.03	1	1.06
AA	0.14	2	3.48
A	0.67	3	6.12
BBB	7.73	4	8.68
BB	80.53	5	10.97
B	8.84		
CCC	1.00		
Default	1.06		

- (iii) Calculate the total expected default losses to be incurred by the fund over the 5 year term. State any assumptions that you make. Your answer should incorporate the anticipated cash flows of the fund. [5]
- (iv) Explain the credit and interest rate spread which is most relevant to the equity investors. [2]
- (v) Describe an appropriate model to simulate future values of the spread identified in (iv). [6]
- (vi) Describe the AIC and BIC model selection criteria that could be used to select the most appropriate model. Your answer should include the model minimizing formulae. [2]

[Total 20]

5 ABC Ltd. is a UK-based general insurance company specialising in underwriting natural catastrophe risks on property.

- Around 90% of its underwritten risks are losses arising from US wind storms.
- Its loss ratio (total losses/total premium net of direct acquisition costs) in each of the last 5 years was: 10%, 140%, 50%, 30%, and 90%.
- Premium income has been constant from year to year for many years.
- ABC maintains underwriting offices in both New York and London.

Pro-Forma Balance Sheet as at 31 December 2008 (GBPm)

Assets:

Cash	100
Government securities	100
Equity investment in US house builders	<u>100</u>
Total Assets	300

Liabilities:

Outstanding claims liabilities	240
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Net Shareholders' Funds:	60
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Pro-Forma Profit & Loss Statement for the year ended 31 December 2008 (GBPm)

Gross written premium income	150
Less: direct acquisition costs	<u>30</u>
Net written premium income	120
Investment income (expense)	–30
Claims incurred	108
Operating expenses	<u>24</u>
Profit before tax	–42
Tax at 28%	<u>0</u>
Profit after tax	–42

(i) Describe ABC's key business risks, meaning the risks to which it is specifically exposed due to the business undertaken. For each risk identified your answer should include:

- A description of the risk
- A rough estimate of the size of the risk expressed in GBPm
- A description of any potential interdependencies

[8]

(ii) Explain the construction of a simple model which could be used to perform both sensitivity analysis and scenario analysis on this business.

[6]

- (iii) (a) Explain how sensitivity analysis could help ABC improve its understanding of its business risks.
- (b) Give four examples of a suitable sensitivity analysis. [4]
- (iv) (a) Explain how scenario testing could help ABC improve its understanding of its business risks.
- (b) Give four examples of a suitable scenario test. [4]
- [Total 22]

6 A general insurance company has written three classes of business for many years. In the distant past the actuary for the company used to estimate single point estimates of the loss reserves for each class. These three estimates were invariably adopted by management for the purpose of compiling the company's annual accounts. In recent years the actuary has included reserve range estimates in his report to management, using a Value at Risk measure to estimate extreme events. The actuary calculates the 97.5% quantile of the overall loss reserves as follows:

- Estimate the best estimate of loss reserves for each class of business using traditional actuarial methods. Assume that these best estimates are equal to the mean of a loss reserve distribution.
- Assume that the loss reserve distributions are lognormal.
- Judgmentally select coefficients of variations for each class based on work published by other actuaries from time to time.
- Judgmentally select correlation coefficients between the three classes based on work published by other actuaries from time to time.
- Use a Monte Carlo simulation model to aggregate the outstanding losses from each of the three classes into one overall loss reserve distribution for the purpose of estimating the 97.5% quantile.

- (i) Discuss the actuary's approach. [12]
- (ii) Describe the four axioms of a coherent risk measure. [4]
- (iii) Prove that Expected Shortfall satisfies the subadditivity condition of a coherent risk measure for loss distributions. You can use the "law of large numbers for Expected Shortfall Lemma" without needing to prove it. [4]

[Total 20]

END OF PAPER