

EXAMINATION

12 October 2010 (am)

Subject ST9 — Enterprise Risk Management Specialist Technical

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 seven 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.

*In addition to this paper you should have available the 2002 edition of the
Formulae and Tables, the ST9 formulae sheet for 2010 and
your own electronic calculator from the approved list.*

- 1** (i) (a) State three risk categories which would be analysed as part of an economic capital assessment undertaken by an insurance company. [3]
- (b) State three business risk categories which are unlikely to be relevant to the investigation. [2]
- (ii) Give two examples of risks that are not always categorised consistently. [2]
- [Total 5]

2 Outline the benefits of applying ERM to a mature corporation. [7]

- 3** (i) Explain what is meant by:
- (a) Stress testing
- (b) Sensitivity analysis
- (c) Scenario testing [3]

A life insurance company specialises in writing term assurance and income protection (health) business. It is concerned about the impact that a pandemic event could have on its business and is developing a series of pandemic scenario tests to evaluate its exposure. A critical factor in developing a pandemic scenario is the recognition that a single event could trigger losses from many different risks.

- (ii) (a) List six different risks that should be included in the tests.
- (b) Explain how these risks could result in losses from a pandemic. [6]

Much of the risk from a pandemic stems from currently unknown viruses and diseases meaning that the additional impact on mortality and morbidity cannot be estimated with any degree of accuracy. As such the usual approach of building a model to forecast losses based on inputs does not work because the inputs are not known. Accordingly the life insurance company has decided to use the model in reverse. It will choose a total loss amount and then analyse the inputs and processes that would produce it.

- (iii) Explain the insights that the insurance company should gain from using the model in this way. [2]
- [Total 11]

- 4** Company A, a large department store chain retailer, has fully implemented ERM. It has recently bought Company B, a much smaller company and one of its major suppliers. Company B manufactures fresh sandwiches, salads and bakery goods. It sells these products to various retailers including Company A. Company A intends to install its own ERM framework, procedures, guidelines, handbooks and reporting requirements at Company B.

Explain why it may not be appropriate for Company A to do this. [10]

- 5** A life insurance company sells immediate annuities. It seeks as far as possible to match its future annuity payments with receipts from a portfolio of corporate bonds and equity release mortgages.

The corporate bonds are purchased with the intention of holding them to maturity. The equity release mortgages are loans taken out on residential property by the homeowners, and are written with a loan to property value ratio of 25%. These loans are repayable on death, transition to long term care, or at the request of the homeowner. Interest rolls up at the agreed interest rate until the mortgage is repaid. The eventual mortgage repayment is equal to the lower of the house value and the principal together with accrued interest, both determined as at the repayment date.

- (i) Define liquidity risk as it applies to this insurance company. [1]
- (ii) Explain whether it is appropriate to hold capital to mitigate liquidity risk. [2]
- (iii) Discuss how the insurance company could investigate and manage its liquidity risk. [10]

[Total 13]

6 The regulator of the banking industry in a specific country notes that:

- (1) Extreme events happen very infrequently meaning that there exists relatively little observed data.
- (2) Notwithstanding (1), the banking industry has had two events in the past three years which were considered to be plausible but extreme.
- (3) The banking industry has had one extreme event ten years ago which had not hitherto been thought possible.
- (4) None of the regulated banks declared bankruptcy as a consequence of these three events although several of them did recapitalise or merge with other banks.
- (5) Overall the protection of customers was maintained in the current system throughout the entire period. Confidence in the banking system was impacted by each of the three events but only for a relatively short period of time.

(i) Define systemic risk and give a “real world” example. [3]

(ii) (a) Explain strict stationarity and its importance in forecasting time series.

(b) Explain the term covariance stationarity and give one example of a covariance stationary time series.

[4]

The regulator’s department has produced a number of GARCH models to predict future investment returns. The recent extreme events have resulted in fitted parameters which imply infinite variance.

(iii) Explain the concept of infinite variance GARCH models. [2]

(iv) Explain the consequences to the banks if the regulator were to employ infinite variance GARCH models for the purposes of stress testing each bank’s economic capital model. [2]

The regulator has suggested to the banks that they should hold additional capital because three extreme events in the last ten years suggests that large and volatile market losses are not as infrequent as once thought. In reply, the banks point out that the current levels of capital have proved to be adequate to withstand three large systemic shock losses in the past ten years. On this basis they claim that the current capital requirements are more than adequate.

(v) Outline other model based approaches that the regulator could use as part of its investigation into whether or not to increase the banks’ minimum capital requirements. [5]

(vi) Suggest requirements that the regulator might introduce which would reduce the banks’ financial risk in lieu of increasing the minimum capital requirement. [4]

[Total 20]

7

A general insurance company has identified several operational risks and has decided to quantify them as follows:

- (1) Adopt separate frequency and severity distributions for each risk.
 - (2) Combine the various frequency and severity distributions into a single aggregate operational loss distribution using Monte Carlo simulation.
- (i) (a) State, defining all terms, a formula for the simulated aggregate operational loss distribution.
- (b) Outline how the Monte Carlo simulation would be performed. [7]

You have been given the following historical loss data on internal frauds over the five year period since the company was established, being from 2005 to 2009 inclusive. Each represents a single separate incident.

September 2006	£46,500
April 2007	£3,100
December 2008	£1,700

- (ii) Fit a frequency distribution to the historical loss data on internal frauds, explaining your particular choice of distribution. [2]

You have been asked to fit a gamma distribution to the severity data. You should assume that:

- The gamma probability density function is:

$$f(x; k, \theta) = x^{k-1} \frac{e^{-x/\theta}}{\theta^k \Gamma(k)} \text{ for } x > 0 \text{ and } k, \theta > 0.$$

- The likelihood function for the gamma distribution is:

$$L(k, \theta) = \prod_{i=1}^N f(x_i; k, \theta).$$

- The log of the likelihood function is a strictly increasing function.
- The maximum likelihood estimate for k is:

$$k \approx \frac{3 - s + \sqrt{(s-3)^2 + 24s}}{12s}$$

where:

$$s = \ln \left(\frac{1}{N} \sum_{i=1}^N x_i \right) - \frac{1}{N} \sum_{i=1}^N \ln(x_i).$$

- (iii) (a) Show that the maximum likelihood estimate for θ is $\hat{\theta} = \frac{1}{kN} \sum_{i=1}^N x_i$.
- (b) Hence fit the gamma distribution. [7]
- (iv) Outline the advantages and disadvantages of using historical loss data to calibrate the frequency and severity distributions for the simulation model. [6]
- (v) Describe two other sources of data that could be used to help calibrate the frequency and severity distributions for the simulation model. [2]
- (vi) (a) Explain the approaches you would use to collect the data described in your answer to (v).
- (b) Describe the issues that you would expect to encounter and the methods by which they could be mitigated. [10]
- [Total 34]

END OF PAPER