INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2014 examinations

Subject ST8 – General Insurance: Pricing Specialist Technical

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 ST8

Subject ST8 deals with applications of general insurance pricing techniques across many different types of product. Candidates should expect the examiners to draw these applications from all parts of the syllabus in order to test as wide as possible a range of skills and, in particular, to achieve a fair balance between personal and commercial lines.

Examiners will sometimes require the use of standard general insurance actuarial and statistical techniques that are covered in earlier subjects. Candidates should ensure that they are familiar with these when preparing for the ST8 examination.

As well as pricing techniques, ST8 also covers the workings and use of reinsurance products, so candidates should also expect the examiners to set questions on these aspects.

In questions with an element of calculation, different numerical answers may be obtained from those shown in these solutions depending on whether figures obtained from tables or from calculators are used in the calculations. Candidates are not penalised for this. However, candidates may be penalised where excessive rounding has been used or where insufficient working is shown. Where questions require looking up values in tables, candidates are expected to interpolate between two values if reasonable to do so, even when this is not stated in the question.

Where examples are given in the solution to illustrate the points made, marks were awarded to candidates who gave these particular examples or an equally valid alternative.

Comments on the September 2014 Paper

The level of difficulty of the paper and the general performance of candidates were similar to recent sittings. There was no evidence of time pressure in this paper around the pass mark area.

Yet again, a number of candidates displayed poor handwriting at this sitting, which made it difficult for examiners to award full credit. Candidates who struggle with the legibility of their handwriting are asked to contact the Examinations Team well in advance of the sitting for advice on what support may be available.

Bookwork questions were generally well answered, and better prepared candidates successfully tailored the answers to the questions, instead of making more general comments. Candidates did not score well on questions 6 and 10, despite question 10 closely reflecting an example given in the Core Reading.

The comments that follow the questions concentrate on areas where candidates could have improved their performance. Candidates approaching the subject for the first time are advised to concentrate their revision in these areas.

1 (i) An insurer wholly owned by an industrial or commercial enterprise

…set up with the primary purpose of insuring the parent or associated group of companies

…and retaining the premiums and risk within the enterprise (subject to reinsurance).

A captive may insure external companies but strictly speaking this is not a true definition of captive.

[2]

(ii) If the purpose of the captive is to provide cover exclusively for the risks of the undertaking or group to which it belongs and so does not provide cover for third parties or other insurable risks outside the group.

If the captive demonstrates good risk management or achieves risk diversification.

[1]
[Total 3]

Part (i) was generally answered well, however a considerable number of candidates did not give a sufficiently detailed answer to be awarded full marks. In part (ii), many candidates did not refer to the first of the above points, despite this being stated in the Glossary of Terms.

2 (i) D&O insurance indemnifies the insured against the legal liability to compensate third parties…

… owing to any wrongful (or negligent) act of the insured in his or her

capacity as a director or officer of a company.

The insurance is personal to the director or officer,

but is usually bought for him or her by the company.

The perils include financial loss arising from:

allowing a company to continue operating in circumstances when it should have been declared insolvent.

any act resulting in the insured being declared unfit for his or her role.

allowing false financial statements to be published.

Legal expenses are also usually covered.

[3]

(ii) A policy that covers all claims reported to an insurer within the policy period …
… irrespective of when the incident occurred.

There is normally a retroactive date, after which the incident must have occurred in order to be covered.

[1]

(iii) For the perils covered, it is usually not possible to determine the actual loss date.

For example, at what point should a company be declared insolvent, or what happens if there is a series of wrongful acts?

So a claims made basis avoids disputes over which insurer is liable,

and reduces the risk of a losses-occurring insurer no longer being able to cover the claim.

The insured (the company purchasing the D&O cover) wants protection against unknown incidents which may have occurred in the past but only affect the performance of the company in the future.

This basis leads to shorter tailed cover for the insurer, so underwriting years can be closed more quickly/less reserving risk.

This basis of cover might be required by law/regulation.

[2]
[Total 6]

Parts (i) and (ii) were generally answered well, however few candidates provided enough information to gain more than one mark in part (iii).

3 (i) A good rating factor should:

help explain the risk as much as possible

remove heterogeneity within each rating cell

have little correlation with other rating factors

…in order to minimise the number of questions and reduce administrative costs

be practical to obtain and record

not be open to interpretation/manipulation by the customer/applicant

be objective

be verifiable

be acceptable to the customer/applicant

be acceptable to the industry/to the regulator/market/legally

preferably remain constant over time.

[4]

(ii) Single trip, annual

Duration of trip

Countries covered/destination

Single person, couple, family (number of people)

Activities included/excluded (e.g., skiing, diving)

Optional limits or extensions chosen (e.g. value of luggage, piste closure)

Non-controllable characteristics of insured, such as age or sex

Type of trip (e.g. cruise/backpacking/business etc.)

Previous claims history

Existing medical conditions

Voluntary excess chosen

[3]
[Total 7]

This question was generally answered well, with candidates demonstrating a good knowledge of travel insurance. Credit was given to other suitable suggestions.

4 If the losses are not from the ground up, then they should be converted to FGU by adding the excess.

Each individual loss amount should be adjusted to its expected ultimate level…

…rather than only developing the aggregate amount for a cohort of claims.

A development factor is needed for each claim, according to its characteristics.

The issue here is how to classify the development factors, for example by:

type of claim or peril
maturity of the claim
claim status (open or closed)
claim size

Aggregating or subdividing the factors in different ways can result in higher or lower factors.

It is important to know whether the development factor contains an allowance for claims inflation or trends.

Particularly court decisions or awards that may change future claims patterns.

Adjustments for claims development, trends and monetary inflation would ideally be separated and the adjustments made in successive steps.

These can make a large difference when considering the portion of the claim that falls above the excess point or above the limit.

The development factor must also be appropriate to the loss, i.e. preferably ground up.

It is important to include (or estimate) claims whose incurred (paid + case reserve) amount is below the previous excess, because some of them may go above the new excess after development.

It is also important to include (or estimate) claims whose incurred (paid + case reserve) amount is above the previous limit, because some of them may fall under the new limit.

Claims over 10m might have been capped at 10m, in which case an estimate is needed to assess their full value.

Claims should be before outwards reinsurance.

The reported loss count for each historical policy period should also be developed to ultimate (to allow for IBNR).

For IBNR, an assumption of ultimate size is needed…

…which is normally based on the known losses and reporting delays.

This will depend on the reporting delays experienced.

Development factors might not be available, or might lack credibility.

Older underwriting periods will tend to be less relevant than newer ones.

For example, they may relate to periods when:

the nature of the insured's business was different (risk management, size, processes, type of employee)
the risk was underwritten by different insurers, or the claims handling processes were different
claims or legal environment was different
policy terms and conditions were different (other than excess or limit)

However, more recent periods are less developed.

There might be unusually heavy or light experience (e.g., an accumulation of claims from a single event) in the data, which needs to be adjusted for.

Estimates will be uncertain, so a development method that yields a range might be needed.

If the insurer does not have appropriate internal development factors it can use it should consider the use of benchmark claims development patterns.

ILFs may be useful if available as a comparison/check.

Due to the long tailed nature of EL cover, tail factor development may be necessary.

[8]

This question was generally poorly answered. Many candidates failed to tailor their answer to the question, giving points that were too general. Relatively few candidates recognised that individual (as opposed to aggregate) claims needed to be developed, and few candidates recognised why the changing excess was an issue for developing losses.

5 Define:

P net premium
K capital charge

Building up the net premium from the components specified in the question:

$P = 850{,}000 + 0.15 * P + 0.08 * 4{,}542{,}104 + K$
$0.85P = 850{,}000 + 363{,}368 + K$

(1) $0.85P = 1{,}213{,}368 + K$
or $P = 1{,}427{,}492 + K / 0.85$

Underwriting profit at 1:200 level, as specified in the question:

Profit $= P - 6{,}906{,}690 - 0.15 * P$
$= 0.85P - 6{,}906{,}690$

So capital charge (K) is 10% of 70% of (6,906,690 – 0.85P)

(2) $K = 483{,}468.3 - 0.0595P$

Solving the simultaneous equations (1) and (2), e.g. by adding them and cancelling K:

$0.85P = 1.213.368 + 483{,}468.3 - 0.0595P$
$0.9095P = 1{,}696{,}836$
$P = 1{,}865{,}680$
Gross premium = P / 0.9 = 2,072,978

A more algebraic solution is also possible, with numbers substituted as a final step, as follows.

Define:

P	net premium
C_E	expected annual recovery
V	volatility charge
K	capital charge
E	expenses excluding commission
C_K	annual recovery at the 1 in 200 level
r	capital charge rate applied to UW profit at 1:200 level

(3) $P = C_E + V + K + E$

Underwriting loss at 1:200 level is:

$-(P - C_K - E)$
$= -(C_E + V + K - C_K)$ (using equation 3)

So, $K = -r\,(C_E + V + K - C_K)$
$K\,(1 + r) = -r\,(C_E + V - C_K)$

(4) $K = (C_K - C_E - V)\,.\,r\,/\,(1 + r)$

Substituting equation (4) into equation (3) gives:

$P = C_E + V + E + (C_K - C_E - V).\,r\,/\,(1 + r)$
$P - E = (V + C_E + r\,.\,C_K)\,/\,(1 + r)$

$C_E = 850{,}000$
V = 8% of
4,542,104 (from OEP table)
= 363,368
C_K = 6,906,690 (from AEP table)

So $P - E = 1{,}585{,}829$
$P = 1{,}585{,}829 / 0.85 = 1{,}865{,}681$
Gross premium = $P / 0.9 = 2{,}072{,}979$

[7]

Candidates who adopted a systematic approach to answering this question generally scored well. It is noted that the two approaches shown above offer slightly different answers. Candidates were not penalised where their answers differed slightly due to rounding.

6 (i) Past experience is used as an input.

However, the period of observation of past events is normally much shorter than the return period of the events.

A scientific understanding of the underlying causes of the natural hazards is used.

Allowing for changes to weather patterns such as global warming and latest research on hydrodynamics and meteorology.

And geographical information systems (GIS) software.

Together, these provide a basis to create other possible future events including ones that have never been observed historically.

[3]

(ii) The vulnerability module measures the degree of loss to a particular system or structure

…resulting from exposure to a given hazard (often expressed as a percentage of sum insured).

[1]

(iii) What is possible will depend on the volume and accuracy of the data available.

For each historical storm:

Obtain detailed storm data suitable for input to the cat model,

…such as track, max wind speed, radius, forward speed, rate of decay of wind field

Obtain the corresponding exposures at the time
…with detail on exposures to analyse vulnerability:
- Construction type e.g. steel, wood frame
- Age
- Location
- Number of storeys

Property type
Occupancy type
Other valid suggestion

Run the data through the Catastrophe model and capture the expected losses

Ensure the actual losses are projected to ultimate

…and adjusted for time value of money to a specific point in time.

Compare the losses coming out of the model with the actual losses.

Segment the losses to find areas of significant difference.

For example:
By exposure factor (see above)
By occupation e.g. office, restaurants
By type of coverage e.g. flood

Consider any "one off" factors unusual to the storms
e.g. another large event at the time causing a massive demand surge.

The vulnerability model relies, partly, on data and assessments from engineering studies etc.,

…so we might also want to consider:

how comprehensive these were
how long ago they were done

If possible, check the results using another Catastrophe model.

Check whether the module is up-to-date

[6]
[Total 10]

This question was generally not answered well, with a surprising number of candidates suggesting in part (i) that 10,000 years of historical data should be obtained. Many answers lacked detail about the sources of data that could be used to generate the event set. In part (iii), many candidates tried to explain what may be wrong with the module, instead of describing the investigations that could be carried out.

7 (i) Suitable factors are those that would:

affect the likelihood of a claim;
affect the size of a claim;
be easily measured, or categorised and ranked.

Extent of standard car security/ease of theft.

Extent of standard car safety measures to prevent accidents, such as Autonomous Emergency Braking and parking sensors.

New Car value/purchase cost/list price.

Cost of replacement parts.

Type of construction/body shell material/bumpers.

Vehicle size/weight/no of seats/number of doors.

Ease of repair/time to repair.

Performance/top speed/acceleration rate/engine size.

Fuel type/transmission type/ 2-wheel vs 4 wheel drive.

Paint finish/trim level/modifications.

[4]

(ii) <u>Advantages</u>

More accurate: if they have lots of data, using their own classification will help them to refine the rates charged,

…to make the groupings more applicable to their own portfolio

…and cover types of vehicle that are excluded from the industry classification.

More control over changes, so may be able to synchronise rate changes more easily

…and keep the classifications more up to date.

Allows a potentially greater understanding of what drives the risk and claims trends

e.g. petrol vs diesel, 5-door vs 3-door, effect of top speed, 4WD vs. other, etc.

Gives a competitive advantage and enables them to make higher profits.

<u>Disadvantages</u>

May not be possible unless they have a large quantity of relevant and recent data.

For brand new make/models, would need to decide how to treat them itself rather than using an industry view.

This might mean that the firm may need to make an assumption, decline business or use an "other" category.

More time-consuming and expensive:

It might take so long to do the groupings that they lose their competitive advantage as the other insurers get their rates out quicker.

They might not have the expertise or relevant computer software in-house.

Can't directly compare or benchmark their data with industry association's because the groupings are different.
May contain mistakes leading to inaccurate classification and rating.

If incorrect, prices more out of line with market, leading to anti-selection or loss of business.

Using own classification may not fit with broker rating engines/question sets.

[6]

[Total 10]

Better candidates tailored their answer to part (i), as opposed to just listing factors, whereas a significant minority focussed predominantly upon factors relating to vehicle performance. A surprising number of candidates suggested rating factors that do not relate to the classification of motor vehicles, but that may be used in generating an insurance premium. Those who tailored their answer to part (ii) often scored highly.

8 The excess level has varied over time, which has not been allowed for.

To allow for the variation in excess, the analyst should estimate the claims that would have been incurred, had the excess been the same level as for year 8.

The excess for years 5 and 6 was higher than it will be in year 8, so there may be some claims missing below the excess point.

Ideally, estimate the missing amounts and add to the total claims amount for these years.

Judging by the excess and claim amounts, the claims are not from the ground up.

It may be easier to make the above adjustments for excess levels if the data could be adjusted so that the claims are from the ground up.

Exposure has changed dramatically from year 5 onwards.

There might have been significant changes to the level of risk as a result of this.

Could weight experience by amount of exposure in each year.

The policy terms and conditions (or cover level, apart from SI and excess) may have changed over the years, or may be changing in year 8.

The analyst should get the underwriter's views on what adjustments may be needed to earlier years.

The earlier years might even not be relevant enough to include in the analysis at all.

We are not told exactly when the analysis is taking place but if it is before the end of year 7, there might be retrospective adjustments to exposure and claims that are not in the figures.
Claims development for recent years is uncertain.

The overall rate could give a lower weight to very recent years to compensate for this.

Use different factors for different sized claims.

Claims development factors may have insufficient allowance for IBNR and IBNER

and insufficient allowance for unexpired risk.

If not, the estimate of ultimate claims for recent years may be significantly understated…

…particularly since the analysis is done by underwriting year.

Use case estimates rather than just paid claims.

There is no allowance for monetary inflation of sum insured and claims.

Particularly necessary if inflation for the two is different.

Inflation indices should be used to adjust these values.

There is no allowance for trends in claims experience.

Claims should be adjusted to be as if they arose from the contract year being priced.

This requires a claims trend index (which might be built into the claims inflation index).

Analysis of claims by accident year might help to identify inaccuracies in the development pattern and trends in claims experience.

There is no allowance for unusually heavy or light claims experience.

Some years have no claims so special consideration needs to be given to this, e.g. in the case of IBNR development

The large claims amount in year 2 has a large impact on the average rate.

It could be truncated and only a proportion used in the calculation of the average.
…or spread over the underwriting years,

There might be some exposure to large claims in the more recent years that has not materialised yet.

The analyst should consider using a catastrophe model to ensure that there is enough allowance for very large claims.

We don't know where the development factors come from, how they were derived, or whether they are appropriate for this book of business.

Knowing how they were derived will help us to assess their appropriateness. (Ideally, we should get the information / triangles used to derive them to check this.)

Other changes over time not taken into consideration such as:

claims handling procedures
strictness of underwriting
the nature of the risk, e.g. improved fire safety measures in the insured building(s).

If the risk has changed significantly, the use of a benchmark, or pricing based on a similar risk may be better than using past data from this risk or use credibility weighting.

[11]

The responses to this question were mixed. Better candidates tailored their answers to refer to specific features of the data, and used these to suggest improvements. Candidates who provided more generic answers often failed to score well.

9 (i) <u>Advantages</u>

It allows an insurer to accept risks that could lead to large claims.

It reduces the risk of insolvency from a catastrophe, a large claim or an aggregation of claims.

It stabilises the technical results of the insurer by reducing claim fluctuations.

It helps make more efficient use of capital by reducing the variance of the claim payments.

Disadvantages

It cedes profit,

i.e. the insurer pays a premium to the reinsurer that in the long run, if priced accurately, will be greater than the expected recoveries under the treaty.

Reinsurer may default.

It is difficult for the ceding insurer to determine how much it should pay for the reinsurance.

[2]

(ii) It is a form of non-proportional reinsurance/excess of loss reinsurance.

Covers the accumulated losses from one or more risks

above an excess point

subject to an upper limit
sustained from a single event or from a defined peril(s), or for a class of business

over a defined period, usually one year.

It is often bought in layers from several reinsurers.

The excess and limits may be index-linked through a stability clause.

A limited number of reinstatements may be available, for which there may be a reinstatement premium.

Brokerage fees will normally apply.

[3]

(iii) Whether the losses provided are from the ground up,

and if not, what the total losses were.

Whether losses provided are uncapped (ideally need limit if not).

Specifics for each loss, such as peril, date of loss, location, number of claims.

The level of exposure (SI, EML or premium written), or at least the extent to which it has changed.

Changes in the limits over time.

If claims are not from the ground up then an ILF table will be required.

Any changes in the claims environment which may account for some of the changes observed to date and in the future.

Whether the losses are finalised or paid plus outstanding.

The extent to which IBNR and IBNER has been allowed for.

The retention and excess (current and historical);

…which may vary by peril, or act in aggregate.

The operation of reinstatements (current and historical).

Other elements of coverage (hours clause, regions, exclusions…)

and how these have changed over time.

What the claims inflation has been over time.

What share the syndicate has in the risks it insures,
and whether the losses shown are the total loss or its proportion.

Other suggestions:

Premium charged last year
Underwriting expertise/strength of syndicate
Expenses
Retrocession cost
Profit or cost of capital load
Underwriting cycle and competition in the market
Environmental /climate change considerations
Brokerage/commission
Dates on cover
Contingencies
Investment return/discounting of claims payments over time

Results of alternative methods for comparison (e.g. output from a cat model)

If premium is used as the exposure measure then rate change information will be required

[7]
[Total 12]

Part (i) was generally well answered, with many candidates scoring full marks. In part (ii), many candidates provided a general description of excess of loss reinsurance, instead of focussing upon aggregate excess of loss. Some candidates struggled with part (iii), however those who tailored their answer to the detail in the question tended to score well.

10 (i) Note that the observed values, **y**, are from the question, i.e.:

$$\begin{pmatrix} 0.34 \\ 0.63 \\ 0.15 \\ 0.70 \end{pmatrix}$$

$$\mathbf{X} = \begin{pmatrix} \mathbf{1} & \mathbf{1} & \mathbf{0} \\ \mathbf{1} & \mathbf{1} & \mathbf{1} \\ \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \mathbf{1} & \mathbf{0} & \mathbf{1} \end{pmatrix} \qquad \boldsymbol{\beta} = \begin{pmatrix} \boldsymbol{\beta_0} \\ \boldsymbol{\beta_1} \\ \boldsymbol{\beta_2} \end{pmatrix}$$

(a) Beta: see above

(b) X: see above

(c) Column 1 is the base level
Column 2 means "is young?"
Column 3 means "Is dog?"
(*note that other orders are equally valid*)

[4]

(ii) Total error,

$$l^* = (34\% - \beta_0 - \beta_1)^2 + (63\% - \beta_0 - \beta_1 - \beta_2)^2 + (15\% - \beta_0)^2 + (70\% - \beta_0 - \beta_2)^2$$

(1) $$\frac{\partial l^*}{\partial \beta_0} = 0 = -2(34\% - \beta_0 - \beta_1) - 2(63\% - \beta_0 - \beta_1 - \beta_2) - 2(15\% - \beta_0) - 2(70\% - \beta_0 - \beta_2)$$

(2) $$\frac{\partial l^*}{\partial \beta_1} = 0 = -2(34\% - \beta_0 - \beta_1) - 2(63\% - \beta_0 - \beta_1 - \beta_2)$$

(3) $$\frac{\partial l^*}{\partial \beta_2} = 0 = -2(63\% - \beta_0 - \beta_1 - \beta_2) - 2(70\% - \beta_0 - \beta_2)$$

Simplifying (2): $34\% - \beta_0 - \beta_1 = \beta_0 + \beta_1 + \beta_2 - 63\%$

(4) $\therefore \beta_2 = 97\% - 2\beta_0 - 2\beta_1$

Simplifying (3): $63\% - \beta_0 - \beta_1 - \beta_2 = \beta_0 + \beta_2 - 70\%$

(5) $\therefore 2\beta_2 = 133\% - 2\beta_0 - \beta_1$

Substituting (4) into (5): $133\% - 2\beta_0 - \beta_1 = 194\% - 4\beta_0 - 4\beta_1$
$\therefore\ 2\beta_0 + 3\beta_1 = 194\% - 133\%$

(6) $\quad\therefore\ 2\beta_0 = 61\% - 3\beta_1$

Substituting (6) into (5): $2\beta_2 = 133\% - 61\% + 3\beta_1 - \beta_1$
(7) $\quad\therefore\ \beta_2 = 36\% + \beta_1$

Simplifying (1): $8\beta_0 + 4\beta_1 + 4\beta_2 = 364\%$
(8) $\quad\therefore\ 2\beta_0 + \beta_1 + \beta_2 = 91\%$

Substituting (7) into (8): $2\beta_0 + \beta_1 + 36\% + \beta_1 = 91\%$
(9) $\quad\therefore\ 2\beta_0 + 2\beta_1 = 55\%$

Substituting (6) into (9): $61\% - 3\beta_1 + 2\beta_1 = 55\%$
(10) $\quad\therefore\ \beta_1 = 6\%$

Substituting (10) into (7): $\therefore \beta_2 = 36\% + 6\% = 42\%$

Substituting (10) into (6): $\therefore \beta_0 = \dfrac{61\% - 3\times 6\%}{2} = 21.5\%$

$$\therefore\ \boldsymbol{\beta} = \begin{pmatrix} \mathbf{21.5\%} \\ \mathbf{6\%} \\ \mathbf{42\%} \end{pmatrix}$$

$$\therefore\ \mathbf{E[Y]} = \begin{pmatrix} \mathbf{21.5\% + 6\%} \\ \mathbf{21.5\% + 6\% + 42\%} \\ \mathbf{21.5\%} \\ \mathbf{21.5\% + 42\%} \end{pmatrix} = \begin{pmatrix} \mathbf{27.5\%} \\ \mathbf{69.5\%} \\ \mathbf{21.5\%} \\ \mathbf{63.5\%} \end{pmatrix}$$

Alternative approach

A solution of the form $\boldsymbol{\beta} = (\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$ is also acceptable for full marks, as follows.

The estimate of the beta values that minimises the sum of squared errors is $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$

$$\mathbf{X}^T\mathbf{X} = \begin{pmatrix} 4 & 2 & 2 \\ 2 & 2 & 1 \\ 2 & 1 & 2 \end{pmatrix}$$

Matrix inverse of $\mathbf{X}^T\mathbf{X} = \begin{pmatrix} 0.75 & -0.5 & -0.5 \\ -0.5 & 1 & 0 \\ -0.5 & 0 & 1 \end{pmatrix}$

Candidates could find the inverse by using determinants, or more simply by using elementary row operations (the Gauss-Jordan method).

$$(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T = \begin{pmatrix} 0.25 & -0.25 & 0.75 & 0.25 \\ 0.5 & 0.5 & -0.5 & -0.5 \\ -0.5 & 0.5 & -0.5 & 0.5 \end{pmatrix}$$

$$(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}: = \begin{pmatrix} 0.215 \\ 0.060 \\ 0.420 \end{pmatrix}$$

[8]
[Total 12]

Part (i) was generally answered well. Despite a similar example being shown in the core reading, relatively few candidates attempted part (ii), however those who did were generally rewarded well.

11 (i) The report might form part of the company's governance (or risk management) process.

May be a regulatory requirement.

A major risk to the insurer is that the premiums charged do not reflect the risks being insured.

It is used as an early warning indicator as part of the actuarial control cycle
- signalling that the model(s) may no longer be fit for purpose
- and therefore that the premiums being charged are too high/low
- a poor rating structure may highlight anti-selection issues
- and/or that claims trends are changing
- which may inform future reserve projections
- and monitoring of the claims handling function.

May detect possible fraud activity.

May detect underperforming segments, such as distribution channels.

May detect underperforming peril model.

May help to support commercial negotiations over terms of business, such as commissions.

May be used to validate model assumptions.

Helps the company to understand the nature of claims and models, so make better decisions.

[4]

(ii) The model predicts an average (and possibly a normal range), whereas claims will deviate from this over the short term through randomness.

Certain perils will have low numbers of claims – increasing volatility of frequency.

Certain perils have high volatility in claims amounts (fire, bodily injury).
The prediction from the model might not be adjusted for seasonal variation (e.g. freeze).

Some perils are catastrophic in nature and claims occur in clusters (e.g. flood, storm)

- and certain catastrophes are susceptible to demand surge which is unlikely to have been modelled.

Can sometimes get very large claims that distort the analysis.
The observed may not include IBNR or IBNER, whereas the models are based on fully developed claims.

- or if they do, the projections to ultimate may not be totally reliable if development patterns have changed.

The model may be wrong or not fit for purpose for a variety of reasons:

the model is out of date
the model was built on incomplete or inaccurate data
insufficient interactions
the rating factors used by the insurer for the product do not allow a highly predictive model to be built
…e.g. if constrained by legislation
the insurer has introduced new rating factors which are not in the models
business is being written through channels or in areas where the insurer has no previous experience
exclusion or addition of cover
change in compulsory excess
changes in other terms and conditions
incorrect error structure/link function/offset
errors when simplifying factors, e.g. when grouping levels of a factor or fitting curves
poor choice of base period for GLM, e.g. unusually light experience

errors in grouping data, e.g. errors in grouping postcodes using spatial smoothing

Changes in the external and internal claims environment e.g.:

Claims handling processes may have changed, resulting in different experience.

Claims inflation may be different from that expected and allowed for in the models (if any).

Changes in claims behaviour due to external environment e.g. recession / road safety campaigns leading to changing frequency/severity trends
Changes in legislation such as limits on the size of claim payments.

Changes in the exchange rate if the insurer has overseas risks.

Data errors in recording of claims

…particularly where claims handling is outsourced

…or where there is a mixture of data systems involved.

Unexpected mix or sales channel, which influences claims
e.g. more business from price comparison websites (or other suitable example).

[10]
[Total 14]

Most candidates offered a considerable number of points for part (i). In part (ii), stronger candidates applied their knowledge of standard bookwork to the example given, generating a wide range of different ideas.

END OF EXAMINERS' REPORT