INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

24 April 2015 (am)

Subject ST8 – General Insurance: Pricing
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 10 questions, beginning your answer to each question on a new page.*

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 and your own electronic calculator from the approved list.

1 Outline possible sources of uncertainty that a general insurance company should consider when analysing historical claims data for a pricing exercise. [5]

2 A general insurance company with a book of annual household business is reviewing its prices. The manager in charge of storing and providing data for risk pricing exercises is monitoring the amount of file space available. She has suggested that the pricing team will only need the following information for a risk pricing exercise:

- claims reported in the last six months, and
- exposure details for policies written in the last six months.

Discuss the problems with the manager's suggestion. [5]

3 (i) Explain the motivation for, and problems with, using a Tweedie distribution when building a generalised linear model of claims cost. [3]

(ii) Write down an example of the link function, error structure and prior weights that would typically be used when building a generalised linear model for each of the following:

(a) claim frequency
(b) average cost per claim
(c) probability of renewing

[4]
[Total 7]

4 A reinsurance company is considering offering excess of loss cover for a fleet of seaplanes.

Outline the information about the fleet that it may request from the primary insurer, to determine the rate that should be charged. [8]

5 A general insurance company is reviewing its expense allocation.

(i) Describe, giving examples:

(a) direct expenses
(b) indirect expenses

[4]

The company writes new and renewing business through the internet and over the telephone.

(ii) Describe the information that the company is likely to need, in order to allocate expenses to the policies. [5]
[Total 9]

6 (i) Outline the operation of the underwriting cycle, starting from a point of generally high profitability. [3]

The regulatory body in a certain country is considering introducing legislation, whereby the amount of capital required to support a portfolio of general insurance policies increases in line with the premium income for that portfolio.

(ii) Discuss whether this new legislation may intensify or dampen the underwriting cycle. [3]

A new entrant to a line of business has decided to ignore the position of the underwriting cycle. The premium that it charges is the risk premium plus loadings for expenses and profit.

(iii) Explain, with reference to the underwriting cycle, how this pricing approach may affect the performance of this line of business for the new entrant. [4]

[Total 10]

7 The customer retention manager of a general insurance company that underwrites private motor insurance has been looking at the variation in renewal premiums from one year to the next. The manager has selected a customer at random, whose premium paid in the last five years is shown below:

New business	€468.32
1st renewal	€515.15
2nd renewal	€732.28
3rd renewal	€706.33
4th renewal	€847.89

The company does not currently offer a no claims discount (NCD).

(i) Suggest possible reasons for the above pattern of premiums. [4]

The company wants to implement an NCD.

(ii) Describe the method that the company would use to determine an appropriate NCD scale. [7]

[Total 11]

8 A general insurance company is quoting for property insurance on a large warehouse complex, Borg. The company already provides insurance for three other smaller warehousing sites: Klingon, Romulan and Vulcan. The company has obtained detailed historical claims information for all four of the sites, and has used it to estimate the expected losses for each site separately. The following table summarises the information:

	Borg	*Klingon*	*Romulan*	*Vulcan*
Total warehouse capacity (m^3)	9,000	320	680	2,100
Number of warehouses on site	2	1	1	6
Distance from Borg (km)	0	0.1	20	350
Property sum insured (£m)	10	1	2	6
Business interruption cover limit (months)	3	12	0	3
Years of detailed claims information	5	7	10	1
Expected number of claims for the forthcoming year	11	3.2	4	38
Expected average amount per loss for the forthcoming year (£)	1,657	83,553	1,342	230

The expected number of claims and average amount per loss include all losses reported by the insured from the ground up, developed to ultimate, and adjusted for exposure and claims trends to a constant base for the forthcoming year.

An actuarial student suggests that the total expected loss costs for Borg for the forthcoming year be estimated by calculating the average annual loss per unit sum insured for each site, then taking the average and scaling up by the sum insured for Borg. The calculations are as follows:

	Borg	*Klingon*	*Romulan*	*Vulcan*	*Average*
Loss per £m sum insured (£)	1,822.7	267,370	2,684.0	1,456.7	68,333
Estimated loss (£)	683,330				

Discuss the actuarial student's suggestion. [11]

9 (i) State the advantages and disadvantages, to a primary insurer, of surplus reinsurance compared with quota share reinsurance. [5]

The following table relates to risks covered under a surplus reinsurance treaty with five lines and a maximum retention of $1m.

Risk	*Estimated Maximum Loss ($)*	*Retention ($)*	*Lines of cover used*	*Original premium ($)*	*Ceded premium ($)*
1	5,000,000	1,000,000	A	34,800	B
2	10,000,000	800,000	C	68,000	D

(ii) Calculate the figures A, B, C and D in the table above. [2]

Suppose that the following losses were to occur on the risks above.

Risk	*Gross loss ($)*
1	15,000
2	18,000

(iii) Calculate, for Risks 1 and 2 combined, the total gross loss ratio and ceded loss ratio. [2]

A reinsurance company is considering the level of profit commission that it should offer for renewal of the treaty. The reinsurance company requires a probability of at least 80% of making an underwriting profit of more than 5% of the capital required, after allowing for the outgoing profit commission and its own expenses.

(iv) Describe the method that the reinsurance company should use, and the matters that it should consider, in calculating the profit commission. [7]

[Total 16]

10 A general insurance company provides insurance to a holiday firm that hires out leisure boats to families for week-long trips. The insurance covers damage to the boat, and third party liability to indemnify the holiday firm and people hiring the boats.

(i) Suggest exclusions that may be placed on the cover provided. [4]

The insurance company is assessing the premium for the forthcoming policy year 5. The following information is available.

Policy year	*Boats at start of policy year*	*Amount paid for claims arising from the policy year (€)*
1	65	56,750
2	70	57,000
3	72	54,500
4	80	1,050,000
5	85	

- The number of boats at the end of policy year 5 is estimated to be 90.
- Claims inflation has historically been 2% per annum.
- In policy year 4, there was a liability claim that has been settled and closed at €1m. The insurance company's procedure for dealing with large claims is to assume that the number of such claims in a year has a negative binomial distribution type 2, with parameters $k = 2$ and $p = 0.99$, and is independent of the number of leisure boats. It is also assumed that the size of large claims will always be €1m, regardless of the policy year in which they occur.
- Non-large claims are not fully developed. Paid claims as a percentage of ultimate claims have the following development pattern:

Policy year in which claim reported	*Percentage of ultimate*
1	90%
2	85%
3	75%
4	60%

(ii) Determine the risk premium for policy year 5 using a burning cost approach, stating any further assumptions made, and showing all workings. [10]

(iii) List further adjustments that may be made to the premium calculated in part (ii) before providing a quote. [4]

[Total 18]

END OF PAPER

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

April 2015 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 pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton
Chair of the Board of Examiners

July 2015

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 April 2015 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.

Whilst candidates were tested on various aspects of the bookwork, it would have been difficult to pass this paper without displaying a good ability to apply the syllabus to problems posed. Candidates should take care to explain fully the points they are making, and to make sure they are answering the question that is being asked.

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 Claim types may be miscoded (e.g. escape of water miscoded as flood)

Date of loss may be wrong (possibly unknown or recorded as date of notification)

Development patterns change:
e.g.

- Naturally over time;
- Political pressures to settle quickly following disasters;
- Or delays in settlement due to staff shortages;
- Or changes in claims handling processes;
- Other valid example

Impact of claims initiatives the company has implemented will affect trends.

Inherent uncertainty in the timing and amount of individual claims.

Uncertainty in treatment of catastrophes or large losses.

Demand surge, following a catastrophe, may cause cost to change in an unpredictable way.

Inflation changes over time,

and different elements of claim will be affected by different rates of inflation.

Legislation and/or court awards may also impact the timing and amount of claims.

Impact of changes in case estimate reserving philosophy.

Impact of changes in the mix of business.

Impact of changes in policy terms and conditions (e.g. excess or limits) and/or strictness of underwriting over time.

Uncertainty arising from the data:

- Lack of sufficient volume
- Data is not detailed enough
- May not be reliable, e.g. if received from a broker

Unusually light/heavy experience

Changes in reinsurance conditions

Impact of changes in third party behaviour e.g. claims farming

Potential for latent claims

Changes in economic conditions and/or currency movements

Changes in distribution channels or relationship with distributors

Climate changes / global warming

Incorrect assumption of case closure.

Generally well answered, but a large proportion of candidates didn't generate enough points to gain full marks. Some candidates were also unclear in their answers, e.g. by writing "economy" rather than "changes in economic conditions".

2 Household business is exposed to natural catastrophes which vary by the seasons.

As a household policy is for 12 months, a six month analysis period would not capture all likely experience.

Many risks have a return period much longer than six months, even longer than 12 months (e.g. subsidence), thus an analysis period of several years is likely to be necessary.

It would not be possible, for long-tailed claims such as liability, to derive appropriate development patterns to project claims to ultimate

A short analysis period is unlikely to be very credible – the experience may have been unusually heavy or light.

There is little consistency between the exposure data and the claims data that the data warehouse manager is proposing to give

Although household business is relatively short-tailed, the most recent claims will be largely case estimates, and all will be under-developed.

Therefore the observed incurred development pattern in the data may relate more to the claims reserving philosophy of the insurer in question than to the true underlying claims process.

The volume of claims is likely to be low and the lack of payment development history will make any projections to ultimate flawed.

Reinsurers/regulators/auditors are likely to view this negatively

Would make it difficult to monitor performance and mix of business

May force the insurance company to use external third party data which may not be relevant or cheap

The limited claims history will also make trend spotting particularly difficult.

With six months' claims and exposure, after sub-dividing the data into separate perils and then into homogeneous rating cells, there is unlikely to be sufficient data for credible statistical analysis.

Some candidates spent time discussing the advantages of the proposed plan, though the question explicitly asked only about the problems. Most correctly identified that the exposure data and claims data would be inconsistent, which was the core point.

3 (i) The distribution combines claim frequency and claim amount into one distribution, i.e. it allows us to model the pure premium (or aggregate claims) directly.

This avoids the need to model them separately.

The Tweedie distribution is a member of the exponential family, which means that it is amenable to use in a GLM

The distribution of claims will be likely to have a point mass at zero…

…representing policies that have had no claims,

…then a wide range of positive claim amounts.

The Tweedie distribution has a point mass at zero, and so takes this shape.

Fitting GLMs separately to frequency and severity experience can provide a better understanding of the way in which factors affect the cost of claims.

This more easily allows the identification and removal (via smoothing) of certain random effects from one element of the experience.

(ii)

	Link Function	*Error Structure*	*Prior Weights*
Claim Frequency	Log	Poisson	Exposure or policy years
Average Claim Amount	Log	Gamma	Number of Claims
Probability of Renewing	Logit, i.e. $\ln(y/1-y)$	Binomial	1

Generally answered well, though some candidates seemed unfamiliar with the Tweedie distribution. A common error was to say that the point mass at zero in the distribution was in respect of nil claims, rather than policies with no claims Many did not generate enough

points in part (i) to score full marks; and a large number struggled with the prior weights in part (ii).

4 Cover types…

e.g. hull damage, theft, liability etc.

Primary excesses, limits, exclusions, changes in cover

Number of seaplanes to be insured

Total value of seaplanes, and/or cost of repairs

Types and/or size of seaplanes (therefore giving information about number of seats/numbers of passengers, fuel type)

Whether the hulls are to be insured on an agreed value basis (as opposed to market value)

Whether aircraft are hangared when not in use

Whether aircraft are owned or leased

Territories in which they operate and/or location of fleet

Whether they operate on enclosed bodies of water only, or on open seas

Past claims experience …

… such as dates of loss, causes, amounts, currency

Licensing requirements for pilots, or minimum number of flying hours

Experience of current pilots, including certificates and ratings held

Whether they are available for hire

Amount of use of aircraft (historic and proposed), by plane

What the planes are used for (passenger/cargo/mixed)

If they transport cargo, the type and value of the cargo

How regularly the seaplanes are inspected/serviced, or the time since last service

Age of seaplanes or their expected lengths of service

Whether they operate all year round, or seasonal

Safety features in the planes

Whether the planes can also land on ground as risks are different to open water

Proposed dates of cover

Need past exposure (risks and dates on cover) to go with claims …

… possible measures of exposure are plane years or air miles travelled

The main reasons for candidates not gaining high marks in this question were an inability to give points specific to this product, and not answering the question. The question asks for information about the fleet, however a lot of candidates suggested details about the product structure (e.g. attachment points), and other points not relevant to the fleet.

5 (i) (a) Direct expenses are those we can allocate accurately to individual policies/lines of business,

whether new business acquisition or administration of business on the books

Examples include
- policy documentation
- call centre staffing costs
- commission
- claims handling expense
- other suitable distinct examples

(b) Indirect expenses are all other expenses, relating to general management and service departments,

not directly involved in new business acquisition or policy maintenance activities

and are insensitive in the short term to either the volume of new business or the level of business on the books.

Examples include
- any property related costs (rent, heating, power etc.)
- staff costs for central services departments (e.g. reserving)
- other suitable examples

(ii) The company will need to understand how expenses are split between:

New business commission
Other new business costs

Administration
Renewal commission
Other renewal costs
Claims handling
Investments

As these are usually proportional to some measure of volume, the company will need information about:

new business volumes (policies and/or premium)
renewals volumes (policies and/or premium)
number of mid-term adjustments
claims volumes and/or costs

both in the past and expected in the future

The expenses will also have to be split between:

Lines of business
Source – internet or call centre
Office – different locations will have different costs

Therefore, the volumes should be split by these factors.

To allocate staffing costs, the actuary will need to know how each member of staff's time is spent (however this is likely to be summarised at department level)

Property/accommodation charges are likely to be split by headcount or floorspace

Future changes in staffing levels and accommodation need to be taken into consideration.

Computer costs will be apportioned according to usage.

Information about one-off costs will also be required

Part (i) was generally answered well. Answers to part (ii) tended to be poorly structured; some candidates went into detail on the different types of expenses. Few gave clear answers about what information would be needed to allocate expenses.

6 (i) Starting from a point where insurance is generally highly profitable – known as a hard market.

The level of profitability attracts new entrants …

… and encourages existing insurers to write more business.

To fill the extra capacity and/or remain competitive, premium rates are reduced to attract business.

Premium rates continue to fall to the extent that the business is generally loss-making – known as a soft market.

Insurers leave the market in response to the level of losses, …

… or write less business.

With restricted availability of insurance and/or reduced competition, premium rates increase.

Eventually premium rates increase to the extent that insurance is generally highly profitable again.

(ii) This would intensify the underwriting cycle

In a soft market, policies will generally be underpriced …

… however, the capital required to write this business will be less (because it's low premium)

As capital requirements are reduced, premium levels will get reduced further, making premiums even less profitable.

This exacerbates the downward path of the underwriting cycle.

Conversely, in a hardening market, insurers will require more capital to write business which is more profitable (over priced).

This will reduce entry to the market and/or existing insurers will exit, and may also limit the amount of business that may be written.

This will push premiums up even more as demand outstrips supply.

(iii) <u>In a hard market:</u>
All else being equal, the insurer will quote cheaper premiums than the rest of the market.

The insurer will tend to attract more business as a result.

This could put a lot of new business/capital strain on the insurer.

Competition will recognise the need to soften their rates and stop writing excessive profits.

The insurer's market share will be compromised as competition start quoting significantly reduced rates.

In a soft market:
All else being equal, the insurer will struggle to sell any business as its premiums will be the most expensive in the market.

The insurer may struggle to meet its overheads …

… and be forced to exit the market and/or face regulatory intervention.

In general
The insurer will feel the effects of the insurance cycle more quickly than others in the market, …

… and to a greater degree.

Part (i) was generally answered well, though many candidates didn't seem to appreciate the underwriting cycle can also be driven by existing firms expanding and contracting, rather than just by insurers entering or withdrawing from the market. Part (ii) was generally poorly answered; many failed to come to a clear conclusion, and those that did often came to the wrong conclusion. In part (iii), most candidates incorrectly said that the insurer would necessarily face anti-selection, and many seemed to equate pricing out of line with the market with mis-pricing.

7 (i) There may have been a general review of risk premiums :
e.g.

new claims frequency/severity models or risk premium model
inflation
movement in trends
revisions to rating area allocation or car group
other suitable distinct examples

The new business premium may include an introductory discount

Although there's no NCD, insured's claims history might be part of the risk model

Changes in expenses, capital charge, RI, company tax, premium tax etc.

There may have been changes in cover (different excesses, added an additional driver)

There may have been changes in the risk (larger car, moved house etc.)

Price increases may have been capped at renewal (e.g. 10% rise)

Could reflect a general hardening/softening of rates in the market

There may be regulatory restrictions on price movements

There could be errors in the calculation process

There may have been changes in legislation which impact the premium (e.g. gender neutral pricing)

The company may be taking account of price elasticity/inertia pricing

Retrospective rating may be being used such as Pay As You Drive

The different prices may reflect the company's changing strategy and/or target market

The customer may have received some discretionary discounts, depending on the company's retention strategy

(ii) Initially agree on operation of NCD

The insurance company must decide how many levels of no claims discount (NCD) it wants to operate,

…what the rules are for new entrants

…and what the rules are for moving up and down the scale (e.g. move up at most one for each claim-free year)

Which types of claim are allowable, i.e. don't result in loss of NCD levels (e.g. non-fault or windscreen)

It may also want to consider whether to allow customers to protect NCD, and how this might operate.

These choices may to some extent be driven by existing market practice
…and regulatory restrictions

But it should determine the optimal theoretical structure and possibly be prepared to compromise it, after doing impact analysis

The scale and how it operates should also be agreed with the marketing team

Model historic experience

The insurance company should take some historical exposure and claims data, and determine the NCD for these risks over time.

The insurance company can model the claims experience, using NCD as an explanatory factor in a GLM to determine the discount appropriate at each level.

The results of this may mean revision to the planned scale and rules required, …and the model should be re-fitted.

Review and implement
The insurance company should ensure that the level of discount offered and the operation of the NCD system is acceptable to existing and/or future customers.

The insurance company should consider the impact of the new NCD system on customer behaviour (e.g. elimination of smaller claims) caused by bonus hunger, …

which may also lead to a reduction in claims handling expenses.

Having agreed, across the business, the operation of NCD and the scale, it should be fitted as an offset term in the GLM.

Thus allowing the other factors to absorb the difference between the theoretical and chosen NCD scale.

Many candidates did well on part (i); but many struggled to generate enough distinct points. In part (ii), many answers lacked details on specifics of how an NCD scheme works. Very few candidates covered the practical process of agreeing an initial NCD scale to begin with.

8 Overall observations
The figure of £683,330 is much higher than the expected loss costs for Borg alone…

…i.e. £18,227.

This could make the premium very uncompetitive.

Practicality
Data is readily available

Simple/quick to calculate (low chance of error)

Calculation method is easy to explain/understand

The complementary risks have a logical relationship to the loss costs of Borg, which makes the approach justifiable.

Metrics used
EML might be a better measure of risk level (exposure) than sum insured.

Frequency and severity are treated the same and combined into one calculation, which might not be the most appropriate.

Analysing frequency and severity separately would better allow for trends affecting one or the other

BI cover levels for Klingon and Romulan are very different from Borg's, so the loss experience may need adjustment.

Credibility factors
The method assigns 25% credibility to Borg's experience and 75% to the other risks (or 25% credibility to each risk).

This seems quite arbitrary, with no obvious evidence to support it.

Use of several different risks should, in theory, help to stabilise the estimates.

However, lower weightings should be used for the risks with more volatile loss experience.

Suitable weights would be the SI

Relevance
It is appropriate to include Borg's own recent loss history because it is the most relevant.

Vulcan appears relevant…

…given its large size / multiple warehouses / similar cover level.

However, its loss experience is high volume and low value, so the risk characteristics may be different…

…and there is only one year of experience to go on.

So perhaps Vulcan should have a lower weighting.

Klingon and Romulan appear less relevant…

…because they are much smaller / have different BI cover levels.

So, perhaps Klingon and Romulan should also have lower weightings.

Also because Klingon and Romulan experience data is older and possibly less relevant today

It might not be appropriate to use the experience of Klingon, Romulan and Vulcan at all if the nature of the risk is very different.

e.g. due to materials stored, protective measures, natural hazards.

The sites closer to Borg may be more similar, or exposed to similar risks and therefore would deserve a higher weighting than those less close

Independence
Klingon may not be sufficiently independent from Borg…

…because of its proximity.

If so, it should be given a lower credibility weighting.

Other considerations
There appears to be no explicit consideration/expectation of unusual experience (large claims).

The losses per unit SI are swamped by Klingon's experience.

This is amplified when the losses are scaled up to Borg's very large sum insured.

It is probably appropriate to take a smaller proportion of this unusual experience (or truncate it/spread it out more, or use a lower or even zero credibility weighting).

A loading/allowance for catastophes, such as flood should be added

A more theoretically sound approach, such as Empirical Bayes Credibility Theory, could also be tried

Most candidates focussed on the obvious problems with the proposal, without recognising any advantages. The higher scoring candidates recognised that the proposal had merit, but needed to be refined. Most correctly identified the differences between the warehousing sites, but a number gave no detail on more general problems with the proposal (e.g. the need for frequency-severity modelling, large loss and catastrophe loadings), and thus scored relatively poorly.

9 (i) Advantages
It enables an insurer to write larger risks, which might otherwise be beyond its writing capacity.

It enables the insurer to choose, within limits, the size of risks that it will retain.

Can choose to cede which risks you want, which isn't possible with obligatory QS

It is better for those classes where a wide variation can occur in the size of risks.

As a result of all of the above, it can help the cedant to achieve a better portfolio balance.

Disadvantages
The administration is more complicated than for quota share…

…owing to the need to assess and record separately for each risk the amount to be ceded.

This makes it unsuitable for mass-market personal lines…

…since the size of risks is too small to merit individual attention.

The choice of reinsurers or terms offered may not be as favourable as QS…

...because of the possible anti-selection risk borne by the reinsurer.

If the facility is facultative-obligatory, the direct writer may forget to cede a large risk.

(ii)

Risk	*EML ($)*	*Retention ($)*	*Lines of cover used*	*Ceded %*	*Gross premium ($)*	*Ceded premium ($)*
1	5,000,000	1,000,000	A = 4	80%	34,800	B = 27,840
2	10,000,000	800,000	C = 5	40%	68,000	D = 27,200

(iii)

Risk	*Ceded %*	*Gross premium ($)*	*Ceded premium ($)*	*Gross loss ($)*	*Ceded loss ($)*
1	80%	34,800	27,840	15,000	12,000
2	40%	68,000	27,200	18,000	7,200
Total		**102,800**	**55,040**	**33,000**	**19,200**

Gross loss ratio = 33,000 / 102,800 = 32.1%
Ceded loss ratio = 19,200 / 55,040 = 34.9%

(iv) The capital required will have to be determined (it could use the current capital requirement as a starting point).

A stochastic model will have to be used to calculate the profit commission

It will need to generate a distribution of underwriting returns

…with the profit commission factor as a parameter

It should then vary the profit commission factor to target at least 80% probability of an underwriting profit of more than 5% of the capital required

It should build a model that includes the following:

Underwriting (loss) experience of the underlying risks
Distribution of limits (mix of business) underwritten
Cession rates of risks
How the cession rates vary with the type of risk
There are likely to be maximum and minimum cession rates

The above variables could be modelled from past experience under the treaty,

…or exposure analysis from other treaties (or external data),

…allowing for any likely differences (or trends) in the forthcoming period.

The reinsurer's loss experience can be very different from that of the cedant…

…depending on the cession rates for different types of risk, and where the large losses fall.

The greater the choice that the cedant has over the cession rate, the greater the potential for selection against the reinsurer.

So, there could be considerable interaction between the variables in the model.

For example, higher cession rates might be associated with higher loss ratios.

Even if the cedant doesn't cede more of the high loss ratio risks they may well cede more of the bigger risks, so this needs to be considered too

The reinsurer should allow for this by using multi-way tables, or possibly copulas to generate correlation.

The reinsurer's desire to retain a relationship with the cedant and/or attract more business from the cedant will have to be taken into account

How many years of data to use will have to be taken into consideration

Changes in the terms and conditions of the treaty itself over time

Trending will also have to be considered

The value of any other commission already paid, e.g. return commission

After the profit commission has been determined and the final distribution of outcomes modelled, the reinsurer should consider whether another iteration of the capital model is needed.

In part (i), some candidates didn't give advantages and disadvantages relative to quota share, and made only very generic points. Several candidates mentioned points which are relevant to both types of reinsurance e.g. "cedes profit". Parts (ii) and (iii) were generally well answered, however some said that risk 2 wouldn't be covered because the EML exceeds the capacity of the treaty, even though the question makes it clear that both risks are covered. In part (iv), candidates frequently lost out on marks as they failed to think through the practical aspects of setting the profit commission, or to provide points relevant to the specified situation. Most candidates recognised the need for a stochastic model.

10 (i) Malicious/deliberate acts carried out by the boat owners

Malicious/deliberate acts carried out by those hiring the boats

Wear and tear

Liability for a peril covered by another policy

Terrorism/war/riot

Losses above a certain limit

Losses below a certain limit

Claims arising from failure of the company to take appropriate risk-reducing actions e.g. ensuring carbon monoxide alarms are fitted, and boilers regularly serviced

Geographic limitations on where boats may be taken

Restrictions on the months/times they can be used

Exclude boats whose speed exceeds a certain value

Exclude high risk activities e.g. racing

Exclude radioactive risks

Illegal or negligent acts
E.g.

- Under influence of drugs, alcohol, other substances
- Negligent behaviour (e.g., open fires)
- Skippered by others than registered owners or authorised hirers
- Exceed number of people on the boat
- Other suitable distinct examples

(ii) Estimate exposure in each policy year

Assume boats are purchased/sold evenly through the policy year

Policy year	*Exposure*
1	0.5 × (65 + 70) = 67.5
2	71
3	76
4	82.5
5	87.5

Large claims adjustment

The mean of the negative binomial distribution is 2 × (1 – 0.99) / 0.99 = 2/99

So the expected cost in each year is €1,000,000 × 2/99 = €20,202

Develop non-large claims

Policy year	*Ultimate non-large claims*
1	56,750 ÷ 0.9 = 63,056
2	57,000 ÷ 0.85 = 67,059
3	72,667
4	83,333

Assume inflation will continue at 2% pa for the following policy year

Inflate claims to policy year 5

Policy year	*Claims adjusted to year 5*
1	$63,056 \times 1.02^4 = 68,253$
2	$67,059 \times 1.02^3 = 71,163$
3	75,602
4	85,000

Check for any trends in claims per unit exposure:

Policy year	*Claims per unit exposure*
1	68,253 / 67.5 = 1,011
2	71,163 / 71 = 1,002
3	995
4	1,030

No need to apply any further trending

Burning cost excluding large claims =

total non-large claims / total exposure = 300,019 / 297 = 1,010.17

Risk premium = burning cost × (policy year 5 exposure) + (large claim adjustment)

So risk premium = 1,010.17 × 87.5 + 20,202 = €108,591

Assume no change to type/risk intensity of boats, customers etc. other than that captured in the 2%

Assumes policy conditions are the same (or no material changes) in policy years 1 to 5

(iii) The premium will have to be adjusted for the following:

Expenses and commission

Reinsurance and catastrophe/large loss loadings

Profit or return on capital and capital loadings

Any discounts or other soft factors e.g. for good claims history or loyalty

Investment return and credit charges e.g. if paying by instalments

Changes in terms and conditions and other coverage changes

Changes in market conditions and the insurance cycle

Premium tax, corporation tax and levies

Other influences on the final premium quoted will include:

Competition and the need to maintain/build market share

The availability of capital to support new business

The impact of reinsurance capacity

The sophistication of sales/quotes systems

The demands of regulators in the rating area

Customer lifetime value considerations or inertia pricing

Company strategy and target market

Relationships with particular distributors/brokers

Part (i) was generally well answered, though some candidates suggested exclusions that would be entirely impractical, e.g. not allowing children on board the boats. Part (ii) was generally answered well, with many students scoring full marks. Some students stated unnecessary assumptions (e.g. assume the given data is correct, or simply repeating information given in the question). The most common reason for losing marks was not calculating a burning cost at each year (to examine trends). Part (iii) was generally answered well.

END OF EXAMINERS' REPORT

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

7 October 2015 (am)

Subject ST8 – General Insurance: Pricing 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 11 questions, beginning your answer to each question on a new page.*

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 and your own electronic calculator from the approved list.

1 A general insurance company writing employers' liability insurance is currently reviewing its rating structure.

Outline possible changes in the external environment that may have to be considered when analysing past data. [3]

2 (i) Define the term "ILF". [1]

The table below shows ILFs for reinsurance contracts written on 1 January 2012:

Limit	*ILF*
500,000	1.00
1,000,000	1.82
2,000,000	2.78
5,000,000	4.98
10,000,000	8.24
15,000,000	11.11
20,000,000	13.29
25,000,000	14.12

(ii) Calculate the ILF for each of the following two layers:

(a) 1 million xs 1 million
(b) 15 million xs 10 million

[1]

During the time since the ILF curve was produced, inflation has averaged 6% per annum. An actuary now wishes to use the ILF curve in order to price a reinsurance contract that commences on 1 October 2015.

(iii) Calculate the ILF for a reinsurance layer of 5 million xs 5 million, showing all workings and stating any assumptions you make. [5]

[Total 7]

3 (i) Define the term "burning cost". [1]

(ii) Recommend giving reasons, whether a burning cost or frequency-severity approach would be more appropriate to price each of the following contracts:

(a) A fleet of five luxury coaches used for a variety of holiday excursions. A full claims and exposure history is available for the last ten years.

(b) A reinsurance company pricing a risk excess of loss contract covering a general insurance company with a large portfolio of property business with a low attachment point. The contract has individual and aggregate deductibles, with reinstatements at further cost.

(c) Professional indemnity cover sold to dentists through the national dental association. Exposure and claims data exists for the last two years. However, there is also data available from medical negligence insurance provided by the same insurance company to doctors and surgeons for the last seven years.

[6]
[Total 7]

4 A general insurance company is proposing to sell a new product through a bank. The product would be sold to the bank's customers when they take out a loan; the product would repay the loan in full if the customer were to be made unemployed.

(i) Suggest terms and conditions that the company could put in place with the bank to control the cost of claims on this product. [4]

(ii) Outline the risk factors that would determine the expected cost of claims. [3]
[Total 7]

5 An actuary working for a general insurance company selling commercial property insurance has calculated the office premium of a policy to be £10,000.

Outline reasons why the premium actually charged by the underwriter may not be £10,000. [7]

6 (i) Explain the advantages and disadvantages of using annual mileage provided by the customer, as a factor to determine the premium for private motor insurance. [4]

(ii) Suggest sources and types of external third-party data that a general insurance company writing private motor insurance might use in determining the premium to charge. [5]
[Total 9]

7 (i) Define "experience rating". [1]

(ii) Propose an appropriate method for experience rating in each of the following classes of insurance business, including the key features of its application:

(a) private motor
(b) employers' liability

[4]

(iii) Outline the advantages and disadvantages of each of the proposed methods in part (ii). [4]

[Total 9]

8 A commercial lines pricing actuary is using a deterministic frequency-severity approach to price employers' liability insurance. The actuary is using ten years of claims and exposure data and the claims have been developed to allow for IBNR and IBNER.

Describe the considerations the actuary will have to take into account when trending the claim frequency and severity. [10]

9 A liability insurance company has in place a $15m xs $5m excess of loss reinsurance policy, with an aggregate deductible of $15m. The first $1m of each claim is non-ranking towards the deductible.

(i) Calculate the total recovery due if the insurer has the following losses in one reinsurance policy year:

Loss A: $4m
Loss B: $20m
Loss C: $22m
Loss D: $9m
Loss E: $10m

[6]

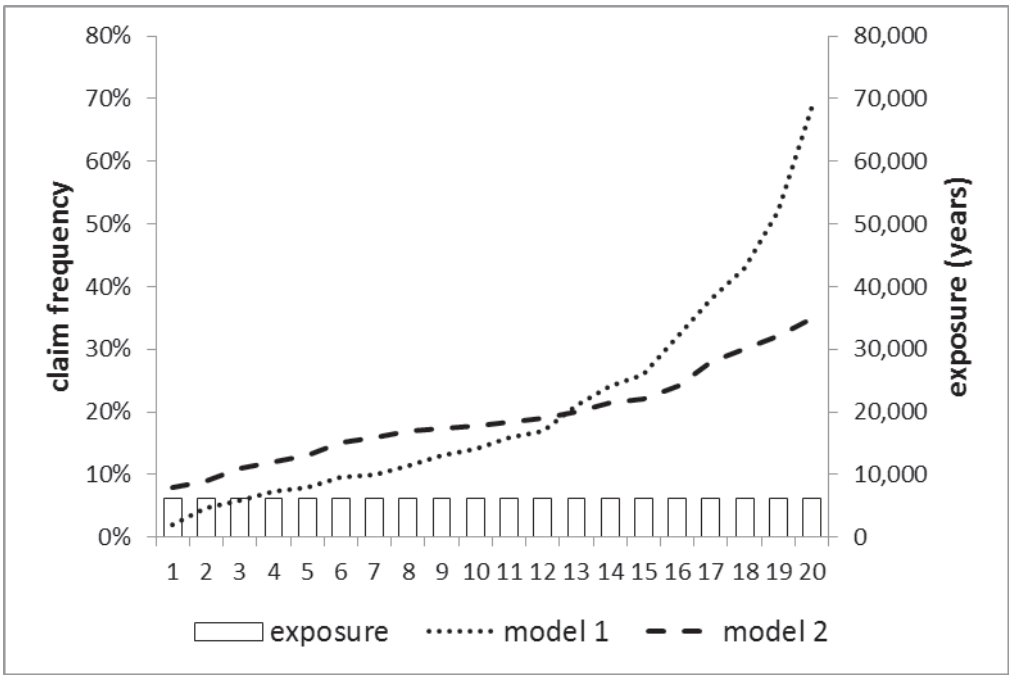
The reinsurer has proposed putting in place an indexation clause when the policy renews.

(ii) Describe how this clause would be applied in practice when settling a claim. [2]

(iii) State the advantages and disadvantages of the introduction of an indexation clause from the liability insurance company's perspective. [3]

[Total 11]

10 The chart below shows two lift curves used for model validation purposes. The models being considered in this chart are claim frequency models.



(i) Describe how a chart of the type shown above would be constructed. [3]

(ii) Justify which of the two models is a better predictor of claim frequency. [2]

(iii) Describe two other approaches to model validation. [8]

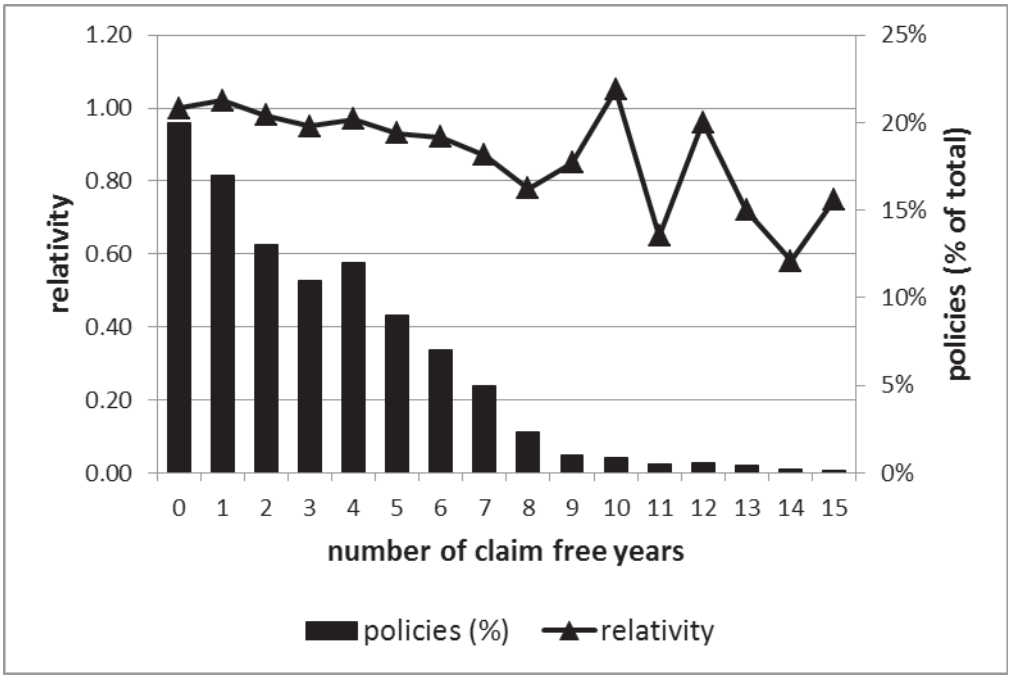
[Total 13]

11 (i) Describe four different approaches that may be used to determine whether or not a factor should be retained in a generalised linear model. Statistical formulae are not required. [6]

A generalised linear model is to be fitted to the risk premium of a cohort of private motor insurance policies to generate a multiplicative rating structure.

(ii) Write down an appropriate error structure and link function for this model. [1]

A no-claims discount factor has been included in the model as an explanatory variable. The chart below shows the model relativities for the no-claims discount factor.



(iii) (a) Explain why the relativities shown would not be used in the actual rating structure.

(b) Outline the steps that could be taken to make them useable. [3]

The insurance governing body has stated that the customer must receive a 2% compound discount for every claim-free year.

(iv) Suggest reasons why the insurance governing body has introduced this change. [2]

(v) Describe how the pricing model should be changed to meet the requirement for a 2% discount. [2]

(vi) Assess the likely impacts of the new requirement on market premiums. [3]

[Total 17]

END OF PAPER

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2015

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 pertaining to the date that 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 2015

A. General comments on the *aims of this subject and how it is marked*

1. The aim of this General Insurance: Pricing Specialist Technical subject is to instil in successful candidates the ability to apply, in simple pricing analysis situations, the mathematical and economic techniques and the principles of actuarial planning and control needed for the operation on sound financial lines of general insurers.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

B. General comments on *student performance in this diet of the examination*

1. 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 for well-prepared candidates.

2. 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.

3. 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 10 and 11, despite both

questions containing parts which asked for descriptions of approaches that are covered well in the Core Reading. It appears that many candidates are unable to distinguish between model fitting and model validation.

4. 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.

C. Comparative pass rates for the past 3 years for this diet of examination

Year	*%*
September 2015	41
April 2015	41
September 2014	38
April 2014	41
September 2013	39
April 2013	39

Reasons for any significant change in pass rates in current diet to those in the past:

The pass rate for this examination diet is broadly in line with recent pass rates. Some variation in the pass rate between sessions is expected as different cohorts of students sit the examination.

Solutions

Q1 Medical advances increasing life expectancy following prognosis of diseases.

The rate of inflation may have changed
e.g. due to court award inflation, wages inflation, general price inflation, or changes in court awards

Changes in health & safety legislation leading to safer work environments, or other legislation affecting employees that would affect claim frequency/severity

Or a rise in "claims farming".

People may have a higher propensity to claim than in the past due to societal changes.

Potential insurance legislative/political changes
e.g. increases in compulsory covers or minimum limits.

Emergence of latent claims which may have been observed in other books of business or advised through brokers/experts.

Distribution channel differences, e.g. could lead to technological changes such as a move to online claims handling.

Changes in currency exchange rates
The underwriting cycle and general level of competition.

Changes in the state of the economy and the knock-on effect on likelihood of claiming.

Availability and cost of reinsurance.

Changes in levels of price elasticity.

Trends in weather / global warming that might affect people working in affected occupations, e.g. farm workers.

Generally well answered. A number of candidates did not limit their answer to the external environment, and so wasted time. Many gave more details than required for an "Outline" question.

Q2 (i) An increased limit factor (ILF) estimates the cost for a new limit as a multiple of the cost for the basic (original) limit.

Alternatively it may be defined as the ratio of LEVs at different limits.

(ii) (a) $2.78 - 1.82 = 0.96$
(b) $14.12 - 8.24 = 5.88$

(iii) Inflation period = 3 years 9 months

Inflation factor = $1.06^{3.75} = 1.224219$

Deflated 5,000,000 limit = $5{,}000{,}000 / 1.06^{3.75} = 4{,}018{,}584$

Deflated 10,000,000 limit = $10{,}000{,}000 / 1.06^{3.75} = 8{,}037{,}167$

ILF for 5m

$$\frac{(4{,}018{,}584 - 2{,}000{,}000) \times 4.98 + (5{,}000{,}000 - 4{,}018{,}584) \times 2.78}{(5{,}000{,}000 - 2{,}000{,}000)}$$

$= 4.26$

ILF for 10m

$$\frac{(10,000,000 - 8,037,167) \times 4.98 + (8,037,167 - 5,000,000) \times 8.24}{(10,000,000 - 5,000,000)}$$

= 6.96

ILF for 5m xs 5m = 6.96 – 4.26 = 2.70

Alternatively the limits in the ILF table may be inflated but then no adjustment is required to the limits of the reinsurance layer. The result is the same.

The base level is now applicable to a base level of 622,000.

Alternatively the ILF is 3.36 (= $2.7 \times 1.06^{3.75}$) for a base of 500,000.

Assumptions

Inflation is constant across all claim sizes.
Policies on which the ILFs are based are the same length as the policies being priced
Can interpolate between the two ILFs.
ILF factors valid as at Oct 2015.
Other valid and distinct assumptions were credited.

In part (i) many did not give enough detail to score full marks. Part (ii) was generally well done. Common errors in part (iii) were: calculating the wrong inflation period; and errors in interpolation. Some failed to give any assumptions, and most gave assumptions that were not relevant.

Q3 (i) The actual cost of claims paid or incurred during a past period of years

expressed as an annual rate per unit of exposure.

This is sometimes used (after adjustment for inflation, incurred but not reported (IBNR) and so on) as a method of calculating premiums for certain types of risks or monitoring experience, for example, motor fleets and non-proportional reinsurance. *(This second sentence is included for completeness but was not required to gain full credit).*

(ii) (a) Burning cost is likely to be more appropriate.

Although there is ten years of historical data, this will not be enough to build a model of frequency or severity given there are only five coaches…

… especially if you try to model individual perils (e.g. property damage, third party liability, lost luggage).

(b) Frequency-severity is more appropriate.

Large portfolio with low attachment point is likely to have a high claims frequency, so there should be sufficient data to build credible models.

The models reflect the underlying process of generating losses …

… and will help spot separately any trends in frequency and severity.

The individual deductibles can be dealt with more accurately using a frequency-severity approach.

(c) Frequency-severity is more appropriate.

The frequency and severity models can be built using the medical negligence experience …

… with adjustments to the data to make it applicable to the dental cover …

… however the extent to which this is possible will depend on the suitability of the data and how detailed it is.

The two years of dental experience may be used to calibrate the models …
… though two years is quite short for long-tailed liability claims.

[*A burning cost approach was accepted in this case, but candidates had to justify clearly why this is more appropriate than frequency–severity to gain marks.*]

Many failed to give an accurate definition of burning cost to gain full marks in part (i).

Part (ii) was generally well done, though in (a) a number of candidates didn't recognise that with only five coaches the amount of claims data would be too limited for frequency-severity.

Q4 (i) Require the bank to carry out adequate credit checks at point of providing loan …

Include an exclusion period at the start of the policy.

Include a waiting period, (e.g. cannot claim if re-employed within a certain time.)

Only offer cover on loans under a specified limit.

Include an excess or some other participation by the insured

Exclude temporary/contract workers.

Exclude self-employed workers.

Exclude certain occupations.

Exclude workers in probationary periods/require min length of service.

Exclude interest-only loans.

Cannot lend when on notice period or reasonably expect to be made unemployed.

Limit the number of loans an individual can have.

Proof of unemployment and that the policyholder hasn't resigned.

Limit the term of the loans.

Limit the number of loans the bank can sell.

Exclude if loan is already covered by another insurance product.

Exclude certain regions.

Have a profit share arrangement with the bank.

Exclude unemployment if the policyholder:

Had been dismissed due to a misdemeanour
Had accepted voluntary unemployment or chosen to retire
Became unemployed due to the expiry of an apprenticeship or other training contract
Became unemployed after refusing reasonable alternative employment
Had been dismissed due to an illegal act

(ii) State of economy and growth prospects in area where policyholder resides

e.g. unemployment rate and incidence of unemployment where policyholder resides (would impact likelihood of claim).

Underwriting standards of the bank

e.g. if each is individually underwritten.

Factors specific to each customer, e.g.:

age;
state of health;
size of loan;
term of loan;
occupation and/or industry;
unemployment history.
level of experience/qualifications.
gender (unemployment rates may vary by gender).

There were no major problems with this question and many candidates scored highly. A common error was to assume this was a credit insurance product, and therefore make points that were not relevant.

Q5 Return premium may apply, or some kind of profit share.

Market conditions/position in the insurance cycle may mean the premium achievable is more or less than £10k.

For example:

due to brand of insurer;
or credit rating of insurer;
or non-price benefits (e.g. help with risk management);

This may be a renewal and the underwriter is likely to anchor the premium on that paid last year.

It may be a deliberate strategy e.g. relationship with insured/broker.

The insurer may be looking to expand their book and willing to write unprofitable business to do so

or looking to contract their book, and using premium to discourage new business.

Underwriter may have more or less up to date information about historical claims

or other information which may affect future likelihood and/or size of future claims

e.g. improved risk management on the part of the insured that has not been accounted for by the actuary

such as installation of sprinklers (*or other suitable example*)

May charge less for this policy as part of a wider package with other policies.

There may be considerable uncertainty in the price
e.g. due to lack of historical data

or uncertainty in the level of the catastrophe loadings.

So underwriter relies more on market rate than actuarially calculated rate.

Underwriter may have different view of key assumptions so disagrees with actuarially calculated rate.

Either party may have made an error.

The cover may have changed between underwriter and actuary calculations.

There may be regulatory requirements on minimum or maximum premiums.

The premium may be discounted for a certain promotion (e.g. to win new business).

May charge more if taking on the policy adds to an accumulation of risk in the portfolio (e.g. by location), …

… or charge less if it aids diversification.

Allowance for price elasticity of demand / lifetime customer value / profit optimisation. (i.e. some might be very price sensitive / insensitive).

The availability/cost of reinsurance.

Allowance for cross-subsidies between risk groups.

Generally well answered, with better candidates giving a wide range of different reasons. A common error was to give various loadings, which the office premium will already have included.

Q6 (i) **Advantages**

Annual mileage should be a good indicator of the risk…
… as the more time spent on the road, i.e. more miles, increases the likelihood of a claim (all else being equal).

Most people should have a good idea of annual mileage or at least be able to estimate it fairly accurately.

The factor is acceptable to customers because of the direct relationship with risk.

The factor is easy for the customer to obtain.
The factor is unlikely to be closely correlated with other typical rating factors.

Disadvantages

It is easy for the proposer to understate in order to get a cheaper premium.

It is not verifiable, unless tracking devices are installed.

Assumes that car usage is uniform over the year, whilst the risk is likely to be highest in the dark and in the winter.

Most proposers will base their estimate on historical annual mileage however the estimate should be for the forthcoming policy year, which could be very different.

Doesn't differentiate between:
Lots of short journeys or a few long journeys
Driving at night or during the day

Extremely low mileage could correlate with poorer driving skill

May require a year end adjustment which would add to the administrative overheads

(ii) Driving licence information, to verify years held licence and motoring convictions/penalty points.

Data from insurers' trade body, (car group, engine capacity, seats, body shape, gearbox, fuel).

Data from motor registration authority (e.g. ownership length, number of keepers, actual mileage, age of vehicle).

Residual value

Information about repair costs from trade bodies

Postcode/address related information, e.g.:

car crime rates;
car accident rates.

Data for fraud detection (at point of quote/sale or claim) and ID verification

NCD verification

Previous claims history (e.g. Claims Underwriting Exchange in the UK)

Credit data, e.g. to determine whether to allow proposer to pay by instalments. Socio-economic type data (e.g. Census).

Rates of tax e.g. IPT and/or corporation taxes

Competitors' prices/ aggregator info

Benchmarks or other information from brokers/reinsurers/consultants

Industry data to help with claims development patterns

IFoA third party bodily injury working party

Government Actuaries' Department for Ogden tables, e.g. for PPOs.

Court or medical inflation indices (for TP bodily injury claims)

Information about investment returns/yields

Most candidates scored well in part (i) but struggled in part (ii) to generate a wide range of points.

Q7 (i) A system by which the premium of each individual risk depends, at least in part, on the actual claims experience of that risk …

… usually in an earlier period, but sometimes in the period covered.

The latter case is sometimes referred to as swing rated or loss sensitive, and there are often upper and lower limits defining a "collar" or "corridor".

In the context of London Market rating for example, it is rating based purely on the experience of the historic risk presented.

(The last two sentences are included for completeness but were not required to gain full credit).

(ii) (a) **Private motor**

No claims discount (NCD) or bonus/malus.

A prospective

claim frequency/number based experience system.

Policyholder may be granted a discount from the base premium depending on his or her claims experience …
… sometimes with the option to protect the level in exchange for extra premium.
As the size of private motor claims is volatile, a cost based approach would not be appropriate.

(b) **Employers' liability (EL)**

A retrospective system

based on an initial (deposit) premium

which is adjusted at the year end in the light of the difference between the actual and expected experience of that risk in the year.

A premium adjustment for actual exposure differing from expected is usually made at the same time.

This adjustment is weighted according to the credibility that is given to the risk's actual result.

Large claims are not usually excluded, but may be netted for reinsurance.

This is essentially a profit-sharing agreement.

(iii) **Advantages**

In line with the market.

so helps to avoid anti-selection

Appears to reward good risks/penalises bad claims experience.

... so may attract new business from good risks seeking cheaper premiums and retain customers with good risks

Reduces number of small claims.

Incentivises policyholders to take precautions to avoid claims.

Premiums charged should be closer to the risk taken on, so helps with underwriting.

Hence results should be more stable.

Disadvantages

Poor discrimination between risks.
Creates cross subsidies between rate groups.

Can create ill-will when no fault applies.
Can distort expense loadings.

In the case of NCD, ties customers to one insurer unless the NCD is transferable.

Claims experience is sometimes not a good indicator of risk, e.g. some policyholders may experience losses but not report them.

Policyholders may be unhappy if after many years claim-free, they have a claim and are penalised for it.

It generally goes against the pooling of risk principle of insurance.

For EL, with a fully credible risk the insurer is only providing claims handling and admin services, and therefore the insured does not get any protection.

Administration can be complex or may require expensive IT.

Candidates did not score well on this question. In part (ii) many candidates did not focus their answer on experience rating and consequently were also unable to generate valid points in part (iii). Better candidates demonstrated that they had thought through the implications of experience rating in their answer.

Q8 Separate frequency and severity trends to losses should be applied.

First project historical frequencies and severities in line with assumed trends to current values …

… and then project frequency to the mid-point of the future exposure period…

… and project the severity to the mid-point of the future time when the claim is paid

… meaning the assumed trends will contain both past and future components.

Rather than applying a constant past annual trend rate a more realistic approach is to apply an index which can reflect periods of high and low trend …

… and incorporate discontinuities caused by one-off changes e.g. in the legal environment

Whether to use all the ten years of data – relevance vs maturity.

Unusually light or heavy experience should be considered separately.

Adjustments will be required for inflation i.e. put monetary values onto constant money terms.
Although the pattern of historical frequencies by year for the individual risk provides an indication of the frequency trend to apply, we rarely rely on this.

More often we apply a standard trend …

… but will be complemented by external information, e.g. from an industry body or reinsurer.

Known or assumed future changes will also have to be allowed for in the trends.

Latent claims or events not in the data.

It is good practice to check trends with underwriters and claims staff,

and/or against trends observed in other work, e.g. reserving, burning cost trends

Trends in frequency and severity may be caused by changes in:

court awards and legislation;
the structure of the risk, e.g. excesses/limits;
economic conditions;
claims handling procedures;
changes in cover, terms & conditions, e.g. adding or removing exclusions
mix of business;

Frequency

Frequency trends may be caused by changes in:

the type of work undertaken by the employees;
strictness of underwriting;
the propensity to make claims / litigiousness of society;
new health and safety regulations for employers;
steps taken by the employer to reduce risk e.g. training;
other suitable example.

As the exposure measure is likely to be turnover/payroll, inflation adjustments will be required.

Severity

The drivers of severity trends will include:

length of time taken to settle a claim;
currency movements;
other suitable example.

Severity trending is usually applied at the ground-up individual loss level.

Losses may be considered in aggregate, or banded into two or more size based groupings or peril based groupings …

… however if this approach is followed the frequency must be similarly split.

Adjustments will be required for the impact of large losses.
Approaches include:

capping large losses;
basing trends on the historical median rather than mean;

More sophisticated methods may apply a severity trend that is a function of the size of loss.

Consider whether there might be data errors or incomplete data.

Very few candidates showed detailed knowledge of the relevant bookwork on trending. Most were able to generate a good number of considerations, but struggled to describe these in any detail.

Q9 (i) Loss A : $4m
Below $5m retention so can ignore completely.

Loss B : $20m
Loss to the XOL layer is $15m.
The first £1m is non-ranking towards the deductible, so $14m of the aggregate deductible is eroded.
The $1m that is non-ranking is recovered.

Loss C : $22m
As with B, the loss to the layer is $15m.
$1m of this applies to the aggregate deductible to bring it to $15m
So the recovery is $14m.

The aggregate deductible of $15m has been exceeded so can now ignore it.

Loss D : $9m
The recovery now is simply that to the $15m xs $5m.
Therefore the recovery is $4m.

Loss E : $10m
As with D, the recovery will be $5m.

Total recovery is therefore: $0 + $1 + $14m + $4m + $5m = $24m

Alternative solution that assumes recoveries can only be made on losses that arise after the aggregate deductible has been eroded.

Loss A : $4m
Below $5m retention so can ignore completely.

Loss B : $20m
There can be no recovery as the aggregate deductible has not been eroded.

Loss to the XOL layer is $15m.
The first £1m is non-ranking towards the deductible, so $14m of the aggregate deductible has been eroded.

Loss C : $22m
There can be no recovery as the aggregate deductible has not been eroded.

As with B, the loss to the layer is $15m.
$1m of this applies to the aggregate deductible to bring it to $15m.

Recoveries are now possible as the aggregate deductible has been fully eroded.

Loss D : $9m
The recovery now is simply that to the $15m xs $5m.
Therefore the recovery is $4m.

Loss E : $10m
As with D, the recovery will be $5m.

Total recovery is therefore: $0m + $0m + $0m + $4m + $5m = $9m

(ii) A well-defined index would be specified in the contract (e.g. LMIC / average earnings).

A base date would be specified and the value of the index at that date would be the base value.

The excess and limit are adjusted in line with the index up to the time the claim is settled.

All details of the calculations will be outlined in the contract.

(iii) **Disadvantages**

The recoveries would be more complicated, and require extra. calculation/administration

The insurer pays indemnity (claims inflation related) to the insured,…

… but is not getting this back from the reinsurer.

Reinsurance recoveries will be lower in absolute terms in the future.

This is especially true for liability as some claims can take a very long time to settle.
Can lead to gaps in cover if some are indexed and some are not (or are indexed differently).

Difficulty of finding a true rate of inflation that matches one or more of the different claim types.

Advantages

The cost of reinsurance should fall.

The reduced cover may focus minds internally on risk management

e.g. to settle claims quickly.

If some reinsurers will only offer cover with an indexation clause, a willingness to use one means the insurer has access to more reinsurers.

The real levels of upper limits are preserved.

Part (i) was not well answered with few candidates showing an understanding of aggregate and non-ranking deductibles, but those who set out a logical argument gained more marks than those who offered no explanation. A common error in part (iii) was to assume that the indexation applied to the primary insurance policy rather than the reinsurance policy.

Q10 (i) The method here describes the process for one line (model 1), the process should be repeated for the other lift curve (model 2).

Start with an out-of-sample data set, i.e. one not used in the model building process.

For each policy in the dataset, determine the expected claim frequency using model 1.

Rank all the policies in the dataset in ascending order of expected claim frequency for model 1.

Group the policies into 20 bands …
… of equal exposure.

Calculate the actual observed claim frequency for each group.

Plot the observed claim frequency against group number to create the chart shown.

(ii) If the model predicts well, the policies with the highest actual claim frequency should also have the highest expected claims frequency and vice versa.
This means the steeper the gradient of the lift curve, the more predictive the model is.

In the example shown, model 1 is more predictive than model 2.

(iii) **Plot actual against expected**

Using an out-of-sample dataset,

order the policies by increasing predicted value.

It may be necessary to rescale the predicted, or observed values, so that the average of the observed and predicted values are the same

Divide into groups of equal exposure and for each group calculate the average observed and expected value …

… or group by predicted claim size, though the exposure in each group will differ and in some cases could be small.

For each group plot the average of the observed against the average of the expected values.

A perfect fit will have points along the line $y = x$.

Points above the line $y = x$ highlight where the model under-estimates and vice versa.

If exposure in each group is different, then we can expect more volatility in actual versus expected where the exposure is low.

Instead of dividing into groups of equal exposure, the data could be split by the levels of factors…

… which will also identify where there are weaknesses in the model.

Plot residuals

There are a variety of residual plots that should be viewed to check the appropriateness of the model.

Using out-of-sample data, calculate the residuals…

… often studentised standardised deviance residuals are used.

Create plots of the residuals against the fitted values.

The plot of the residuals should be centred around zero and …

… randomly distributed with a fairly constant range across the width of the fitted values.

Any pattern indicates a poorly fitting model.

The residuals can also be fitted against the levels of factors in the model.

Again these should display no pattern and will help identify any problem factors.

Gains curves

Closely related to the lift curve.

Policies are sorted high to low according to the fitted model values.

The cumulative observed values are plotted against the cumulative exposure.

A reference line is created by dividing the cumulative observed values evenly against the cumulative exposure.

The reference line represents a model that does no better than assigning predicted values at random.

The higher the fitted values line is above the reference line the better the model.

The Gini coefficient is a measure for the lift produced by the model.

This can be thought of as the area enclosed by the model curve and the diagonal reference line …

…expressed as a ratio to the area of the triangle above the diagonal reference line.

Parts (i) and (ii) were well answered. In part (iii), most candidates recognised the gains curve as a suitable approach but descriptions were often vague. A common error in part (iii) was to talk about statistical factor selection, apparently not appreciating that the question was about model validation.

Q11 (i)

Approach 1

Statistical tests can be performed to assess the significance level of a factor.

Such as chi-sq tests for nested models where the scale parameter is known,

F tests for nested models where the scale parameter is unknown, and Akaike Information Criteria if models are not nested

The process involves testing whether a model which includes the factor is significantly different to a model which does not include the factor

Approach 2

A hat (more precisely, Hessian) matrix can be used to give the rate at which the log likelihood falls off from the optimum solution in each direction.

Steep curvature indicates that the parameter is tightly defined.

A shallow curvature indicates a poorly defined parameter.

Approach 3

Compare the model relativities with expert judgment …

… the pattern of relativities should be consistent with the definition of the factor under consideration.

A factor which displays a counter intuitive trend should be discarded or at least fully investigated.

Generate graphs of predicted values ± 2 standard deviations …

… and check whether the error ranges of the relativities are distinct.

Approach 4

Consistency of the trend over time should be checked.

This is done by interacting the factor with time.

A factor whose trend varies in a random way over time should be dropped.

If this is not possible, a random factor can be used in place of time.

From a practical point of view, if the model is going to be used for prediction, then any factor which will not be available at time of prediction should not be used.

(ii) Acceptable error distributions include: gamma, log normal, Tweedie.

Log link

(iii) (a) A no claims discount should by definition reduce the premium for every claim free year.

In the example shown, all else being equal, a policy with 1 claim free year would be charged more than one with 0 claim free years (other examples apply).

Also, due to the lack of policies with the highest number of claim free years, the relativities produced by the model are very volatile.

(b) To ensure a decreasing trend over 0 claim free years to 6, a curve could be fitted.

Given the lack of policies from about 7 claim free years it seems sensible to group 7+ together
or extend the curve to 7+ years if appropriate.

The size of the cohort could be increased to reduce the volatility.

(iv) The insurance governing body is likely to be reacting to customer complaints …

… if customers find the operation of NCD difficult to understand

… or they are simply trying to introduce some standardisation across the market.

It may make it easier for customers to transfer claim free years between insurance companies.

If the operation of the previous discounts was not transparent to customers then it helps customers understand how making a claim could impact future premiums.

If discounts were previously very steep then this new scale will mean customers will be less afraid of making a claim as the impact on premium is fairly small.

Reduces the chance of insurance companies offering discounts that are too large and risk insolvency.

(v) Offsets should be used to "fix" the relativity values of the factor, thereby imposing the required trend.

The offset values applicable in this example are:

Claim Free Years	*Offset relativity*
0	1
1	0.98
2	0.9604
3	0.9412
etc.	etc.

The difference between that explained by the offset and that explained by the actual factor must be picked up by other factors in the model, hence the whole model must be refit with this offset included.

The method described imposes the discount condition on the risk premium. In practice, further steps might be needed to ensure that the actual premium complies with the NCD condition.

(vi) The insurers will no longer be able to charge the true risk reflective premium.

Hence the premiums they charge will be inaccurate

and this uncertainty will be reflected in a higher capital charge or margin,

therefore average premiums in the market are likely to increase (notwithstanding the changes to the NCD).

The impact will depend on existing NCD scales in the market

Those with steep discounts for a high number of claim free years are likely to see their premiums increase.

Those with little or no discounts will see small discounts

The small NCD scale is unlikely to promote bonus hunger …

… and may increase moral hazard.

So if NCD scales were historically steep, more policyholders may claim now when previously they would not have.

This will push up the claims cost,

and claims handling expenses,

increasing the size of premiums in the market.

If there was no previous NCD scale, or they were historically shallower than 2% p.a., there is unlikely to be much impact.

Candidates did not score well in part (i) because their answers focused on one approach – statistical tests. In part (ii), a Poisson distribution is not an acceptable error structure for a risk premium model. Responses to the other parts were mixed. Better candidates gave clear explanations and descriptions, and well reasoned arguments.

END OF EXAMINERS' REPORT