INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

April 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 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.

D C Bowie
Chairman of the Board of Examiners

July 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 April 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, despite the higher than normal number of questions.

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.

Question 9 was a relatively straightforward bookwork type question on credibility, but candidates did not generally score well. Answers to question 11 often suggested that candidates know the basics about catastrophe models but do not actually understand how they work in practice. Scores for question 12 were highest amongst those whose answers followed a methodical approach.

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

1 Time taken for sufficient claims experience to develop from the historical data

Time taken to analyse the claims experience

Time taken to reach and agree the new premium rates and premium structure

Time for testing the new prices before implementation

Time taken to administer and implement the new rates (including communications)

Waiting for current marketing offers to expire before introducing the new rates

Time taken to prepare new marketing material/offers for the new rates

There is often a delay between the occurrence and notification of a claim

There is often a delay between the notification and settlement of a claim

Time taken for any approval needed from a regulatory body

Reinsurance recovery delays

Waiting for exposure information from third parties (e.g. brokers)

Information about claims if being handled by a third party may be delayed

Most candidates focused on reporting and settlement delays, failing to pick up on the many other delays that arise in a pricing exercise.

2 Restrictions on the type of business that can be written or the classes for which the insurer is authorised

Restrictions on the amount of business that may be written

Restriction upon the territories in which the insurer may write business

Controls on the premiums rates that can be charged…

…e.g. by requiring the insurer to file rates with the regulator, or publish in advance, or imposing min/max rates

Restrictions on the information that may be used in underwriting and rating, e.g. EU Gender Directive

Restriction on the types, or amounts, of assets that can be held to demonstrate solvency

Restrictions upon the ability to write business unless:

Assets are deposited to back claims reserves

A minimum level of solvency is maintained…

…measured in a prescribed manner

Prescribed bases are used to calculate premiums, assets and liabilities for demonstrating solvency

Individuals are authorised to hold key roles

Agents are licensed to sell insurance

Levies are paid to consumer protection bodies/funds

Reinsurance of suitable quality/amount is purchased

Financial returns are supplied to the regulator at prescribed intervals

Data protection measures are followed

Policyholder protection measures/complaints procedures in place

Renewal terms are offered to certain groups of policyholders

Restrictions regarding the acceptable methods of sale, and the information that must be disclosed during the sale process

Restrictions on the minimum level of cover (perhaps unlimited) that must be offered for certain classes of business

Restrictions upon the proportion of certain types of business that must be written

Restrictions upon Mergers and Acquisitions

Generally well answered with most candidates scoring highly.

3 List specific causes covered, to avoid unforeseen causes

Specify any exclusions e.g. War

Avoid any cause that is within the insured's control (to avoid moral hazard)

but allow closures in the interests of visitor safety, e.g. avalanche threat

Ensure that the benefit doesn't exceed normal profit per visitor (to avoid moral hazard)

Ensure that the visitor threshold is not set too low compared with the normal visitor level

Restrict number of consecutive days covered

Restrict number of days covered in any year, or specify a maximum annual benefit

Allow for differences in visitor numbers depending on the season

Cap the exchange rate if the benefit is in a different currency from the normal for the book

This is a form of business interruption cover so should only apply where this cover doesn't already exist (e.g. commercial fire)

The company will require proof of the number of visitors and

the means of qualifying for a claim will have to be clearly defined

e.g. if the required number come in the morning but the centre has to close at midday and the visitors get a partial refund

The insurer may want to restrict the length of time between the claim event and claim notification

Requirement for ski centre to maintain facilities to reasonable standard, including staffing levels

Changes in entrance fees require prior agreement

Introduce a no-claims discount / put in place a profit share arrangement

This question was reasonably well answered, but a significant minority made suggestions that would not be practical, or contradicted the question – for example an excess is not appropriate when the benefit is fixed.

4

Band	*Excess*	*Top of ceded cover*	*Effective retention*	*Effective RI top*	*Proportion of expected loss in reinsured layer*	*Cedant's expected losses*	*Expected recoveries*
B	1	10	5	10	0.320	6,300	2,016
C	10	15	10	15	1.000	16,835	16,835
D	10	20	10	15	0.620	2,610	1,618

Band A is entirely below the excess point of the treaty
so there is no recovery (expected recoveries=0).

Band C is entirely within the limits of the treaty, i.e. 100% reinsured
Recovery for Band C is $48{,}100 \times 35\% = 16{,}835$

For Bands B and D, the formula for the proportion of the expected losses that fall in the reinsured layer is:

[ILF(RI top) – ILF(RI excess)] / [ILF(cedant top) – ILF(cedant excess)]

The size of the reinsurance layer in the formula must be restricted if necessary, in order to reflect the effective reinsurance coverage for the band.

Band B

ILF (RI top) = ILF (10) = 3.263
ILF (RI excess) = ILF(5) = 2.539
ILF (cedant top) = ILF(10) = 3.263
ILF (cedant excess) = ILF(1) = 1

Expected recovery = 6,300 * (3.263 – 2.539) / (3.263 – 1)

Band D

ILF (RI top) = ILF (15) = 3.635
ILF (RI excess) = ILF(10) = 3.263
ILF (cedant top) = ILF(20) = 3.863
ILF (cedant excess) = ILF(10) = 3.263

Expected recovery = 2,610 * (3.635 – 3.263) / (3.863 – 3.263)

Better candidates scored full marks in this straightforward question. A disappointing number failed to realise that no recovery was possible for Band A and that a full recovery would be made in Band C.

5 It would seem sensible to include the country of destination as a rating factor…

…as visiting different countries would be likely to result in differences in claim frequency…

… and severity…

e.g. Medical expenses, flight delays, weather events, theft, etc.

The models are nested

Difference in number of parameters = 24 – 15 = 9

Two nested models can be compared using a χ^2 test…

…as the change in scaled deviance i.e. $D_1^* - D_2^* \sim \chi^2_{df1-df2}$

Scaled deviance, D_1^* = 365,128 / 1.15567 = 315,945

Scaled deviance, D_2^* = 362,144 / 1.15958 = 312,306

Difference in scaled deviance, $D_1^* - D_2^*$ = 315,945 – 312,306 = 3,639

Upper 5% point of χ^2_9 is 16.92 *(credit given up to 10%)*

3,639 > 16.92 hence implying that Model 2 is a better fit

OR This implies a p-value of 0.0%

…hence implying that Model 2 is a better fit.

There is a reduction in AIC going from Model 1 to Model 2…

…suggesting that Model 2 provides a better fit.

Most candidates scored well for the calculation parts of the question, but only the better candidates looked beyond the statistics and considered whether the additional factor was actually sensible.

6 Verification

Replicate the difference by re-running the cases if possible

Speak to the Sales Director or otherwise check how the quotes were run (or check details entered, or other check on the quote process)

Run a basket of risks through both quote engines to see if this is an isolated case, or quite common (perhaps plot the distribution of premium differences).

Data and models

Investigate whether data quality for building models on the two channels is equally good.

Look for errors in the pricing engine or model

Cost of claims

See if the cost of claims is lower for the branch-based product, even though cover is higher

Check whether the same rating factors are used

Collect data and adjust as necessary for the model being used

For example, adjust for inflation (or other valid example)

Include a variable for channel/product

Use a method that separates channel/product from other explanatory factors, e.g. GLM

Is it possible to tell if it is the channel or the product that drives the claims cost differences? Perhaps use data on historical products

See if there are sections that have very low total claims amounts, i.e. cover is not really significantly better for the branch product

…or very few claims over a certain amount

See if there is more of a concentration of risk with the telephone product

…or other increased risk level (e.g, increased fraud or other valid example)

…has this led to a higher volatility charge?

This might be seen by looking at an external model or catastrophe model.

Expenses

Analyse expenses by channel / Investigate the differences in the cost of running the two different channels.

Split by:

Commission
others incurred on inception of the policy

Within the above expenses, a split of fixed and variable expenses is needed.

Investigate any different reinsurance costs.

Compare the results of the expense analysis with the loadings in the prices.

Strategy, profitability and return on capital

Establish what (if any) cross-subsidies have been included in the prices

Or other deliberate strategies, such as trying to boost or suppress sales in one channel (or other valid example)

Look at price gradient from NB to subsequent renewals to see if it is steeper for the branch product

See if this is justified by models of customer lifetime value, and/or investigate elasticity, renewal demand, cancellations, up-sales

Look at the capital model to see if these factors are driving a higher capital loading for telephone product.

Marketing

Establish whether there were any special offers or price tests, or different negotiable margins running in the channels

This question was generally poorly answered. Whilst many were able to state why there might be differences, few gave any details about the investigations and analysis that should be carried out, thus failing to answer the question.

7 (i) Inflate all claims to the same point in time…

… usually 6 months after the mid-point of the period in which the rates are deployed.

Adjust for any other differences in cover, i.e. put it all on constant cover basis

Remove any types of claim that do not carry a compulsory excess
(e.g. windscreens, third party liability).

Develop claims to ultimate

Consider whether to adjust for periods of particularly heavy or light claims experience,…

… or for any other known trends or environmental factors

Subtract £300 from each claim if claims are recorded from the ground up,

or subtract £50 from each claim if only paid is recorded.

Any resulting negative claims can be removed from the analysis.

A more sophisticated approach may also eliminate smaller resulting claims, to allow for policyholders not claiming for small amounts.

Changing the excess may attract a different mix of business, probably to more careful drivers.

(ii) The complication arises because it is unlikely that policyholders will report claims that are below the current excess of £250.

Similarly for claims that are just above £250 if NCD system in operation

Therefore the company will have very little reliable data below this amount

It will be necessary to estimate the increased number of claims

and estimate the increase in size of future claims.

Data may be available from other similar products, or from external sources.

Otherwise, we must use more approximate adjustments, based on any knowledge available regarding the claim cost distribution

The extent of the effect of reducing the excess will also depend on any no claims bonus system in operation.

An increase in the number of claims may increase claims leakage.

A change in excess level could lead to an adverse mix of business

This question was generally well answered. In part (i) many of the answers lacked detail about the adjustments required. Only the better candidates recognised that claims just above the excess might not be reported if a no claims bonus system is in operation.

8 (i) Professional indemnity cover is a type of liability insurance.

It indemnifies the insured against legal liability to pay compensation to a third party …

… for losses resulting from negligence in the provision of a service,

for example:

incorrect advice from a solicitor,
or unsatisfactory medical treatment,
or other suitable example

Legal expenses are usually also covered

There are several types of professional indemnity insurance sold, including Directors' and Officers' and Errors and Omissions cover

The perils depend on the profession,

The most common exposure measure is turnover

Risk and rating factors include type of profession and number of employees

It is usually written on a claims-made basis.

Claims are usually long-tailed, owing to legal disputes

Professional indemnity is prone to accumulation risk (a successful legal case may lead to more claims)

It is often a legal, professional or regulatory condition of being allowed to practise a profession,

There are excesses, per claim and per annum limits

Illegal acts will be excluded

(ii) Equate first three moments

$$\text{Mean} = 500 = k + \frac{\alpha}{\delta}$$

$$\text{Variance} = 200^2 = \frac{\alpha}{\delta^2}$$

$$\text{Coefficient of skew} = 2 = \frac{2}{\sqrt{\alpha}}$$

Solving gives

$\alpha = 1$

$\delta = 0.005$
A negative value for δ is not valid.

$k = 300$

(iii) For 40 employees

$$E(S) = 40 \times 500 = 20{,}000$$

$$\text{Var}(S) = 40 \times 200^2 = 1{,}600{,}000$$

Want p such that $P(S > p) = 0.01$

Let $S \sim N(20{,}000, 1{,}600{,}000)$

$$P(S > p) \cong P\left(Z > \frac{p - 20{,}000}{\sqrt{1{,}600{,}000}}\right) = 0.01$$

$$\Rightarrow \frac{p - 20{,}000}{\sqrt{1{,}600{,}000}} = 2.3263$$

$$\therefore p = 22{,}943$$

This question was well answered, but a surprising number of candidates were unable to give a precise definition of professional indemnity insurance. Parts (ii) and (iii) caused few problems, though a common mistake was incorrectly calculating the variance for the Normal approximation.

9 (i) Credibility theory is used to calculate quantities that feed into a pricing structure…

…such as expected claims frequency or average claims amount

It allows for the consideration of actual experience…

…as well as external information…

The external information is known as the complement of credibility.

The calculated quantity used in pricing is normally expressed as a weighted average of those obtained from the observed data and external data sources *(credit given for an appropriate formula)*

The external data is given more weight if there is limited observed data…

…or if the observed data varies significantly from one period to another

(ii) Classical credibility

Can be used where estimates of $E[s^2(\theta)]$ and $\text{Var}[m(\theta)]$ are not available

Defines the standard for full credibility, i.e. how much data is required before full credibility can be assigned to the actual experience

It then uses this standard for full credibility to calculate the credibility factor

Often used in the calculation of overall rate increases

Simpler to work with, and easier to explain

Bayesian credibility

Never reaches $Z = 1$

Generates more accurate insurance rates where estimates of $E[s^2(\theta)]$ and $\text{Var}[m(\theta)]$ are available.

(iii) Practical Issues

Readily available

and up to date

Ease of computation…

…leading to ease of communication

…and less chance of error

Cheap to produce

Competitive market issues

If rates are too high, competitors can undercut the rate and still make a profit…

…leading to loss of customers and profit

If rates are too low, the company will lose money

Therefore the rate should be unbiased (not too high or too low)…

…and accurate (as low an error variance as possible)

Regulatory issues

Should have an explainable relationship to the loss cost of the class

May need some level of approval from regulator

Classic regulatory law requires that rates be "not inadequate, not excessive and not unfairly discriminatory"

Statistical issues

Must consider all types of error that make up the prediction error…

…i.e. the squared difference between the credibility weighted prediction and actual results

Errors in the type of model used (model error)

Errors in the specific parameters selected (parameter error)

Independence from the base statistic

The responses to this question were mixed. Parts (i) and (ii) were generally poorly answered with only the better prepared candidates demonstrating a good understanding of the differences between Classical and Bayesian credibility. In part (iii) most candidates generated a good number of the desirable properties.

10 (i) Location of property, e.g. postcode, or individual address point

Distance from water

Height above water

Claims history of historical flooding…

Type of historical floods (cloud burst vs. river basin vs. coastal flood risk)

Flood defence precautions taken at the property

Flood defence precautions taken in the local area

Drainage system quality in the area

Number of floors, or which floor the property is on

Type of property (e.g. house, flat)

Construction materials

Rebuild cost

Value of contents

Cost of alternative accommodation

Post event inflation / demand surge

Output from a flood cat model

Restrictions imposed by regulatory requirement (e.g. excess levels, cover levels etc.)

(ii) Factors affecting outgo from the fund

Precise definition of "extreme risk"

Number of properties that are at extreme risk

Distribution of claim costs

Average claim frequency

Expenses and management costs for setting up the scheme

Cost of capital required to be held by the fund

Improvements to flood defences

Inflation

Demand surge

Projection of weather patterns

Progress of coastal erosion

Who handles/settles claims attributable to fund (outgo may differ depending upon whether the claims are handled directly by the fund or by the primary insurers)

Other running costs, for example IT systems

Factors affecting income to the fund

Number of household insurance contracts sold

Investment income on the fund's assets (linked to size of fund)

Reduced sales in low-premium areas due to additional levy to subsidise the high flood risk properties

Other factors

Time required for the fund to be operational

How claims will be dealt with in the period until the fund has built up sufficient funds

Levy may change over time when sufficient funds exist

Availability and cost of reinsurance

Building up a buffer for future claim events

Public reaction as the cost of the levy will be passed onto all policyholders but not all of them are exposed to flood risk.

Introduction of the scheme may change the behaviour of people and companies, e.g. less caution over moving to properties, or building properties in high flood risk areas.

Part (i) was generally well answered, but part (ii) saw lower marks. In part (i) many gave points about insurance in general but not flood in particular. In part (ii) few mentioned the practicalities of setting up and running such a fund, missing out on many of the available marks.

11 (i) Event Module – location and frequency

In the last ten years, new research will have improved understanding of how earthquakes are triggered.

The last ten years may also have produced earthquake events that have never been witnessed before (either in size or location or both) and these should be added to the event set.

…these may change the risks of recurrence

Measurement sophistication is always improving and model parameters can now be estimated more accurately.

The improvements in computing power mean that stochastic models can now be run more efficiently meaning more simulations and therefore better estimation.

Digital terrain mapping is always evolving at ever higher resolutions, thus improving the location intelligence of events.

Hazard Module – magnitude

Research into rock formations or soil type at earthquake prone locations will have improved, …

… as well as the understanding of how they are affected by different sized earthquakes.

There will also be improved understanding of where fault lines lie and in particular their depth, and how this affects the magnitude of an earthquake.

Research will also have developed in terms of size, location and frequency of aftershocks.

Vulnerability Module – structural damage

In the last ten years it is likely that much work will have been done to improve building techniques and construction materials…

…hence newly built properties should be resilient to all but the most extreme earthquakes…

Older properties may also benefit from new construction techniques and materials that may help provide support to buildings.

Improved awareness/education of the public including better warning systems…

…which may lead to speedier disaster recovery, and thus limit consequential loss.

Improved understanding of the impact of aftershocks

Improved understanding of quality of construction by location.

(ii) Create an inventory module – the insurer will have to list all its exposures in as much detail as the model can utilise.

This is likely to include:

a measure of location (postcode, cresta zone)
property type/use (shop, warehouse, manufacturing plant, hotel)
Property construction

Property age
sum insured or EML

Any significant expected changes to the portfolio mix should be factored in.

Parameterise the financial module.

This is likely to include:
Excesses/deductibles
Limits
Exclusions
Business interruption or consequential loss
Reinsurance treaties in place
Demand surge

Run the proprietary model to determine the expected annual loss cost for the portfolio.

Or use the OEP/AEP outputs in a stochastic frequency severity model to simulate losses in a year

This could be pro-rated per policy in some way:

e.g. by sum insured;

Or more accurately by a combination of the drivers of earthquake risk cost, such as sum insured and location and construction type.

It is important that the user reads the model's user manual.

This question was poorly answered, demonstrating a lack of understanding of catastrophe models in practice. Many candidates believed that the vulnerability module needs to be modified for changes to the insurer's exposure. However, the question relates to a proprietary catastrophe model and the inventory module is where exposure is specified. In part (ii) most recognised the need to update the inventory module and parameterise the financial module, but few gave sufficient details about what this actually involved.

12 Preliminary checks

Carry out data checks, such as cleansing and reconciliation

Check that the claims and policy data correspond correctly

Obtaining base values

Group the exposure/policy data by major risk type/type of cover

Data in "policy section" could be used for this.

Group the exposure/policy data by policy year

provided that there is sufficient data.

It is assumed in that each outlet has the same policy sections

For each class, obtain:

Reported loss count/number of claims (from the loss data given)
Exposure measure
Individual loss costs

Suitable exposure measures would be:

Sum insured for property-related risks
Turnover for public liability
Number of employees for employers' liability

…each multiplied by the proportion of the year on risk (use "days on risk" for this)

<u>Developing losses</u>

Develop the reported loss counts to obtain ultimate loss numbers.

This involves estimating the reporting delays and IBNR

Deal with catastrophe losses separately:

Remove them from the analysis
Estimate them using a specialist model
Add an allowance back into the overall analysis

Develop individual loss amounts to obtain ultimate loss costs.

Claims can be developed using case estimate development factors on open claims only (or other valid method).

Ideally, the development factors would be based on the insurer's own experience.

However, if these are not available or credible, it may use a benchmark pattern.

Allow for any changes in reporting and settlement delays.

When developing the losses, bear in mind the deductibles and limits that apply for each sales outlet for each policy year.

Estimate the ultimate costs for any IBNR losses.

For new/unknown attritional losses, use other similar developed losses for the insured.

Deal with large losses by truncating them at a certain level

…and adding back a separately modelled adjustment.

Frequency = (ultimate number of losses) / (exposure measure)

Average severity = (ultimate cost of losses) / (ultimate number of losses)

Trending

Inflate the historical estimates to current values

and then project them to the mid-point of the future exposure period (or period of claims payment).

Include a further allowance for trends on top of inflation.

Do this separately for frequency and severity.

The observed pattern of historical experience for the risk can be used as an indication of the trend to apply, but it is more common to apply a standard trend.

This may be based on the insurer's whole portfolio or publicly available sources such as industry or statistical bodies.

Inflate the turnover and sum insured exposure measures because these are monetary.

Adjusting to new policy Ts&Cs

Historical losses must be adjusted if they arose under different terms & conditions from those that will apply in the forthcoming period of exposure.

One approach is to develop standard curves to adjust frequency and severity for deductibles, limits etc.

Limits and deductibles may need to be adjusted for inflation.

Exclude losses that would not be covered in future loss years (e.g. due to an additional exclusion).

Add an allowance for any new types of loss likely to become evident over time.

Fitting the model

Choose the base period to use for fitting.

Older years will be more developed (less error introduced by estimating development)

Recent years are more relevant (less error introduced by adjusting to prospective Ts&Cs and trending/inflation).

The extent of this will depend on the cover type

For example, stock is shorter tailed than liability (or other valid example)

So the company must decide which years to down-weight or exclude.

Base period should be longer for long-tailed classes like EL

Fit distributions to frequency and severity using statistical techniques,

combined with expert judgement/"sanity checks"/external benchmarks.

Common distributions for frequency include Poisson and negative binomial.

Common distributions for severity include log-normal, Weibull, Pareto, gamma.

Different severity distributions may be used for different parts of the loss range.

Catastrophe losses would come directly from the cat model and bypass the fitting process.

It is likely that a simulation (/Monte Carlo) approach would be needed…

…to deal with the combination of individual and aggregate deductibles and limits

Applying to the prospective period

Combine frequency and severity to obtain the overall loss cost.

Express the final premium as a rate per unit of exposure…

…so that it is adjustable if the exposure changes.

The candidates who scored highest in this question structured their answer in the way they might approach this in practice (such as in the solution above). A disappointing number of candidates used a scatter-gun approach, thereby failing to generate a sufficient number of distinct and valid points. In many cases answers also lacked detail – for example most identified the need to estimate IBNR losses but few explained that, as a frequency/severity model was used, it would be necessary to estimate the number and the value of these losses.

END OF EXAMINERS' REPORT