

2010 Examinations

SPECIMEN SOLUTIONS

Subject ST8 — General Insurance: Pricing

Specialist Technical

1 (i) Weight / Exposure

- These are the weights used in the model fit to attach an importance to each observation.
- For example in a claim frequency model exposure would be defined as the length of time the policy had been on risk.
- For an average claim size model, the exposure will be the number of claims for that observation.

Response

- This is the value that the model is trying to predict.
- Hence in the claim frequency model it is the number of claims for that observation for an average claim size model it is the total claims cost for that observation.

(ii)

- This is a factor to be used for modelling where the values of each level are distinct and often cannot be given any natural ordering or score.
- An example of this would be Car Manufacturer, which has various values “Ford”, “Vauxhall”, “Toyota”, “Lotus”.
- These could be ordered in a number of ways, alphabetically, sorted by exposure on risk, sorted by estimated risk.
- The ordering can help cosmetically when reviewing the results, but does not affect the calculations.

(iii)

- An interaction term is one where the pattern in the response variable is better modelled by including extra parameters for each combination of two or more factors.
- Each factor has a base level which should not be included in the model,
- for interactions each base level row and column of the interaction parameter matrix should be removed.

- 2 (i)**
- Claim event is usually sudden and easily determinable (e.g. burglary, fire)
Notification is normally prompt
Settlement is usually quick
Often just consists of a single payment
Claim amount can normally be estimated accurately
Claims tend to be fairly consistent in size and distribution
Frequency tends to be high relative to buildings cover
As a class, very exposed to the risk of moral hazard
Frequencies closely linked to the economic cycle,
e.g. theft claims frequencies rise when unemployment rises

- (ii) Assume all policies earn uniformly over the year
 Claim frequency per unit exposure remains constant over the year
 Claims occur on average mid-month
 (In each case, alternative assumptions are valid if correctly applied.)

(1)	(2)	(3)	(4)
<i>Month</i>	<i>Policies written</i>	<i>Earned exposure = policies on risk</i>	<i>(Month – 0.5) × earned exposure</i>
9	1,000	1,000	8,500
10	1,500	2,500	23,750
11	2,000	4,500	47,250
12	2,500	7,000	80,500
	7,000	15,000	160,000

Average accident date = $\text{sum}(4)/\text{sum}(3) = 10.667$, i.e. two-thirds of the way through November 2009

3 Event module

- A database of stochastic events (the event set) with each event defined by its physical parameters, location and annual probability/frequency of occurrence

Hazard module

- This module determines the hazard of each event at each location.
- The hazard is the consequence of the event that causes damage
- for example: in the case of a hurricane, wind speed is the primary cause; for an earthquake, it is ground shaking.
- Defines the potential damage vulnerability to a particular type of structure caused by a specific event.
- The hazard component can be “conditioned” with scenarios from climate model projections to represent, for example, the hazard in 2050 for coastal flood risk in the region of concern.
- Must incorporate at least three variables regarding the source parameters of the hazard, location of future events, frequency of occurrence and their severity.

Inventory (or exposure) module

- A detailed exposure database of the insured systems and structures.
- As well as location this will include further details such as age, occupancy, construction.
- Building inventory is important to estimate potential future losses to structures and assets of elements at risk.
- Also the special distribution should be captured.
- E.g. for earthquake damage estimation, engineered buildings in the inventory should also reflect regional differences in construction practice and building codes.

Vulnerability module

- Vulnerability can be defined as the degree of loss to a particular system or structure resulting from exposure to a given hazard (often expressed as a percentage of sum insured).
- The vulnerability module, which translates hazard into building specific damage based on engineering science and claims data, can be tuned to represent specific adaptation measures.

Financial Analysis module

- Uses a database of policy conditions (limits, excess, sub limits, coverage terms) to translate the total ground-up loss into an insured loss.
- Applies the damages against insurance and reinsurance contract specifications to determine the financial losses from an event.
- The financial module subsequently outputs estimates of annual loss, and return period (i.e. probabilistic) loss.
- The Inventory and Financial Analysis modules rely primarily on data input by the user (an insurer or reinsurer) of the models.
- The data will be specific to the user.
- The Event, Hazard and Vulnerability modules represent the engine of the catastrophe model.
- The Event and Hazard modules are based on seismological and meteorological assessment
- and the Vulnerability module is based on engineering assessment.

4

- Assessing performance against the organisation's goals.
- The ultimate goal for most general insurance companies is to exceed a minimum level of profit or return on equity for a given level of risk.
- However, companies will break this objective down into more specific targets.
- The hope is that if these individual targets are met then so will the overall company objective.
- A general insurance company will monitor the business it has written in order to gauge its performance against these targets.
- This enables informed planning and decision making.
- Managing risk
- Monitoring written business allows the company to assess how much risk is inherent in the portfolio (e.g. accumulations).
- The amount of risk will be a factor in determining how much capital the company should hold and what its reinsurance purchasing strategy should be.
- Gaining market intelligence
- Monitoring written business can provide useful information about competitors' strategy.
- It can also allow the company to compare itself with the market and assess the underwriting cycle.
- Satisfying regulators
- Market regulators may require periodic monitoring and reporting of written business.

- Influencing the market
- A company may be able to influence the market by publishing the results of its monitoring exercises.
- Reserving
- The outputs of any monitoring exercise can be used for other purposes such as an input in to the reserving process.
- Considered in isolation this would not necessarily be a reason to monitor written business.
- The most common example is the use of rate indices (derived from the monitoring exercise) to adjust a-priori loss ratios (often called initial expected loss ratios) in Bornhuetter-Ferguson reserving methods.
- Part of the Actuarial Control Cycle
- Another reason for monitoring would be to validate assumptions in a model.

5 (i) **Aggregate Deductible**

Introduction of the aggregate deductible means that now the sum of the claims to the layer must exceed the deductible before the cedant can make a recovery so for a given amount of exposure, expect the aggregate deductible to reduce the cedant's expected recovery and increase the cedant's retention.

The extent of the impact of the aggregate deductible depends on:

the size of the aggregate deductible (for a given exposure in vehicle years)
the expected number and severity of losses to the layer (for a given exposure in vehicle years)
e.g. large aggregate deductible relative to expected number/size of losses means lower recoveries for the cedant (and vice versa for a small aggregate deductible)

Stability Clause

Before the stability clause applied, the expected value of total losses to the layer would have increased annually (all else being equal) because of:
the effect of TPBI inflation on severity of individual losses to the layer (i.e. the conditional expected value of a loss to the layer increases with inflation)
and the gearing effect of TPBI inflation increasing the frequency of losses to the layer (i.e. probability of a loss to the layer increases with inflation).

A stability clause means the attachment point and layer limit are adjusted in line with some specified index (e.g. fixed x% p.a. or a healthcare cost index) so the layer widens with each application of the index
e.g. £1m xs £1m indexed by 5% is £1.02m xs £1.02m

Adding the stability clause has the following expected impact

The frequency of losses to the layer drops over time e.g. a claim that starts in the layer may settle below the layer.

For a given loss, its actual attachment point depends on the settlement date (i.e. the attachment point will increase in line with the stability clause index until the loss settles).

The actual impact of the stability clause depends on the cedant's actual claims experience and on the inflation in TPBI claims relative to the index applied to the layer.

(ii) **Reinsurer**

- + stability clause ensures alignment of interest by encouraging faster claims settlement (as net retention increases with each year due to the indexation of the attachment point and limit),
- + stability clause gives some protection against expected future inflation in the claims to the layer
- + aggregate deductible reduces exposure to the cedant and allows the reinsurer to use capital elsewhere
- + benefits if the sum of claims to the layer doesn't breach the aggregate deductible or claims settle below the indexed attachment point
- actual claims inflation may outstrip the indexation thereby eroding the benefit of the stability clause over time (likely in practice)
- lower premium income with introduction of aggregate deductible
- more volatility in claims cost to the layer relative to the premium charged

Cedant

- + the aggregate deductible reduces reinsurance spend (especially beneficial if reinsurance rates are hard)
- + can use the aggregate deductible to manage risk appetite
- + the aggregate deductible means higher expected profit as ceding less to the reinsurer generally means ceding less profit
- + cedant can manage total exposure to the reinsurer (reinsurer security impacts capital requirement)
- aggregate deductible delays recoveries (cashflow implications)
- greater loss retention, so alternative source(s) of capital required (alternatives may be more costly).
- greater volatility in the retained losses
- retains some inflation risk i.e. if the TPBI inflation is lower than the indexation, then more likely that a claim estimated to settle in the layer settles below the layer

6

(i)

- Once the £15m aggregate is exhausted, cover reverts to general insurance company, so a single bad year could be very expensive
- Unlimited coverage for motor — potential for large single loss
- Large limit for public liability — potential for large single loss
- Do we have/need reinsurance coverage to protect against this

- Perhaps consider negotiating with customer on a structure with lower exposure
- Need to clarify if the excesses/limits cover e.g. legal expenses

(ii)

- Model the motor and public liability accounts separately, for each one
 - Need to model the frequency and severity separately in order to apply deductible
 - Use client's data as start point (since large dataset)
 - Pick a base period
 - Adjust the claims for inflation
 - Adjust for change in exposure
 - Adjust for trends in data
 - Adjust for any changes in terms and conditions over period considered
 - Compare outcome with any internal portfolio/external benchmark data
 - especially for large loss assumptions
 - Consider credibility weighting to portfolio/benchmark
- Consider any relationship between claims received under motor and public liability
 - Unlikely to be strong so probably model as independent.
- Could use deterministic modelling approach to determine parameter estimates for frequency and severity for each cover
- Determine the mean values for both parameters
- Alternatively could model the outcome of the individual accounts using stochastic modelling approach
- Carry out several thousand simulations and apply the product "rules" to the outcome
- The average outcome to the insurer in the simulations will give the expected loss cost to the insurer
- This would also provide the range of possible claims experience scenarios which could assist in determining suitable reinsurance arrangements

- 7** (i) Project the claims costs and inflate to 2010 levels to derive a burning cost

Assumptions

No further tail factor required after 58 months development for all claim types

Assume claims inflation in 2010 = claims inflation in 2009

Development factors are on the same basis as claims stats

Projected Claims Costs (before claim inflation allowance)

<i>Year</i>	<i>Damage Costs</i>	<i>Third Party Personal Injury Costs</i>
2005	74	58
2006	87	72
2007	77	68
2008	136	64
2009	124	67

Amounts in £000

Claim inflation adjustments to 2010

<i>Year</i>	<i>Damage Costs</i>	<i>Third Party Personal Injury Costs</i>
2005	$1.04^5 = 1.217$	$1.07^2 \times 1.09^3 = 1.483$
2006	$1.04^4 = 1.170$	$1.07 \times 1.09^3 = 1.386$
2007	$1.04^3 = 1.125$	$1.09^3 = 1.295$
2008	$1.04^2 = 1.082$	$1.09^2 = 1.188$
2009	1.04	1.09

Projected Claims Costs (after claim inflation allowance)

<i>Year</i>	<i>Damage Costs</i>	<i>Third Party Personal Injury Costs</i>
2005	90	86
2006	102	99
2007	86	88
2008	147	76
2009	129	73
Total	554	422

Amounts in £000

$$\begin{aligned} \text{Burning Cost per vehicle} &= (554 + 422) \times 1000 / (80 + 88 + 90 + 92 + 98) \\ &= \text{£}2,178 \end{aligned}$$

$$\begin{aligned}\text{Gross Premium to charge client} &= (\text{number of vehicles in 2009} \times \text{burning cost per vehicle} \times \text{claims costs} + \text{policy expenses} + \text{vehicle expenses}) / \\ &= (100 \times 2178 \times 1.07 + 100 + 10 \times 100) / (1 - 0.15 - 0.05) \\ &= \text{£}292,683\end{aligned}$$

Bonus mark for identifying and allowing for any legitimate trends in the data, e.g. improvement in PI peril

(ii) Yearly burning cost observations

$$\begin{aligned}2005: & 175,872/80 = 2,198 \\ 2006: & 201,106/88 = 2,285 \\ 2007: & 174,499/90 = 1,939 \\ 2008: & 222,903/92 = 2,423 \\ 2009: & 201,429/98 = 2,055\end{aligned}$$

$$\mu = (2198 + 2285 + 1939 + 2423 + 2055)/5 = 2,180$$

$$\begin{aligned}\sigma &= \text{Square root of } \{(5 \times (2198^2 + 2285^2 + \dots) - (2198 + 2285 + \dots)^2) / (5 \times 4)\} \\ &= 190\end{aligned}$$

$$\begin{aligned}\text{Therefore } Z &= \min(1, 1 - 190/2180) \\ &= \min(1, 1 - 0.087) \\ &= 0.913\end{aligned}$$

$$\begin{aligned}\text{Therefore revised gross premium} &= Z \times 292,683 + (1 - Z) \times (100 \times 3750) \\ &= \text{£}298,932\end{aligned}$$

Note: alternative approach: one could strip out the claims cost from the average premium and then blend claims costs and reconstruct gross premium from that.

- (iii) the 5 year historical claims experience may be heavier or lighter than is expected in 2010
potential large losses in historical data distorting the calculations
competitors may have different assumptions in calculating the premium, for example lower fixed expenses, reduced acceptance of profit or different projection/inflation assumptions so offering lower quotes
own company may be willing to take a reduced profit or slight loss on this business as the policyholder has other insurance contracts with the company that are highly profitable.
using the company's own heavy goods vehicles experience may be inappropriate, for example the account may have a different business mix to that of the client (e.g. age of drivers, location of vehicles).
cover provided in 2010 differs from that in previous years (e.g. increased own damage excess)
different policy wordings/restrictions expected to reduce claims costs/numbers

expected future external events (e.g. changes in legislation) that may impact claims costs, expenses, commission or profit allowances
per policy expense allowance in main account may be disproportionately higher than that required under a fleet contract
influence of broker/customer (e.g. volume of other business offered by broker/customer)
position in the market cycle

8

(i) Brokers

- A company which acts as an intermediary between the seller and the buyer of the insurance product without being tied to either party.

Banks, Building Societies and other financial institutions

- A company whose main activities include providing financing to small businesses and can therefore cross-sell insurance on the back of loan arrangements.

Trade Associations

- A union whose main activity is to provide support and advice to companies of a similar trade who can provide insurance products tailor-made to their requirements.

Internet

- The insurance company can develop a web-based sales point with the customer entering all the relevant rating information through the internet to obtain a quote for insurance.

Telesales

- A call centre arrangement managed by the insurance company to provide in-calls and out-calls to potential clients.
- In-calls can be through advertising in press or telephone directories whilst out-calls can be through leads generated from commercial tradesmen databases.

Direct mailshot

- The insurance company can directly target potential clients through the posting of literature to small business tradesmen.
Employed staff paid by salary or commission.
- Staff of the insurance company visit the potential clients face to face to discuss their insurance requirements based on their circumstances.

Trade Retailers and other affinity groups

- A company whose main activities are non-insurance related (e.g. a building supplies wholesaler) but whose organisation has a significant Commercial customer database to target sales.

(ii)

- Companies of all sizes (small and large) may use Commercial brokers as they can offer advice on their specific insurance needs.
- Companies of all sizes could be a part of a trade association.
- The remaining distribution methods are more likely to be used mainly by small businesses due to:
 - the relative speed and ease of obtaining low cost insurance
 - the far greater propensity for clients to use the distributor for other non-insurance activities

(iii) **Public Liability**

- The insured is indemnified against legal liability for the death or bodily injury to a third party.
- Or for property damage belonging to a third party.
- Other than those liabilities covered by other liability insurance.

Employers Liability

- The insured is indemnified against legal liability to compensate an employee or temporary employee for the death, disease or bodily injury suffered owing to the negligence of the employer during the course of employment.

Contract Works

- Indemnifies insured against loss of or damage to contract works property being worked on and materials.

Plant insurance (Hired or Own Plant)

- Indemnifies insured against loss or damage to plant whether it is hired or owned by the insured.

Employees Tools All Risks

- Indemnifies insured against loss or damage to tools used in the course of trade.

Personal Accident/Sickness

- Indemnifies all people specified under the cover for loss of earnings in an event of an injury or accident, whether temporarily or permanently out of work.

Professional Indemnity

- Indemnifies insured against legal liability resulting from negligence in the provision of a service (e.g. inaccuracies in architectural building design)
- Vehicle insurance (vans, pickups, goods vehicles, trucks, lorries).
- Property Damage — indemnifies insured against loss or damage to their own vehicles.
- Third Party Liability — indemnifies insured against compensation payable to third parties for damage to their vehicle or property or for personal injury.

END OF SOLUTIONS