

Institute of Actuaries of India

November 2010 EXAMINATION

Subject ST8 — General Insurance: Pricing

Indicative Solution

Q 1

(i) Uncertainty is the inability to predict the future with confidence. Because of the presence of uncertainty, we need to consider the effects of possible deviations from the projected figures.

Risk is the possibility of adverse variations in financial results.

It is important that a general insurer is able to identify the risks that it faces and assess the suitability of methods available for managing those risks.

The greater the uncertainty, the greater is the risk.

(ii) Any pricing analysis would be dependent on the quality of data used in the analysis. The major areas of risk and uncertainty in data may relate to the following

- data availability
- data quality
- data manipulation

Data availability

Typical data problems might include:

- Data does not exist: It may be a new product, or the company may be entering an existing market for the first time.
- Data is small or incomplete: For large, unique, risks the data might be limited to the history of the insured or to a small number of similar risks.
- The data may not include sufficient number of claims to produce a reliable model of the risk.
- The data may not have been gathered accurately; for example, brokers or agents may not enter all details into a database in a consistent manner.

Data quality

Typical issues might include:

- Missing data or incorrect data entry: New rating factors may not have been gathered, or information not originally used may have been incorrectly entered.
- Useful information not recorded: Policy and claim information may not allow desired analysis, for example, if we cannot tie claims back to individual policies because accident date is not recorded. To enable us to match claims to policies, it is also necessary to record a unique link within both the policy and claims data, ie some information that tells us which policy a particular claim relates to.

Following changes in claims settlement, it may be necessary to analyse separately costs previously analysed together. If the details are not recorded, this will not be possible.

- Fraud: Data may be deliberately entered incorrectly.

- Claims data may not be adequately developed e.g. doesn't include IBNR / estimates of outstanding claims inaccurate

Data manipulation

- Errors in data processing stage: Generally some work is done to the data before the analysis can commence. The work may include, for example, attaching external data, linking policy and claims data or applying inflation factors to the claims. It is possible that errors might be introduced at this point. [1/2]
- To mitigate these problems, we can carry out detailed checks on data manipulation to reduce the chance that errors have been introduced.

[8]

Q2.

(i) Market Cycle : The market cycle is a period in which a given class of insurance business moves from a period of profitability to a period of losses and then back to profitability. Historically, in different markets all over the world there has been a surprisingly clear cyclical pattern of insurance profits in the past. Despite this clear pattern the cycle is quite difficult to predict.

The phases under market cycle include:

Phase 1: high profits

When insurance premiums are high, insurance companies enjoy good profitability.

When business is profitable, more insurers enter the market and existing companies are likely to attempt to expand, attracted by the prospect of good returns.

Phase 2: greater competition

As more companies join the market, competition increases. Premium rates will become soft as insurers compete for market share. "Soft" premiums are low, relatively less profitable rates.

Phase 3: losses

This will lead to reduced profits or to losses, and the cycle will go into depression. The position may be accentuated by catastrophes or by the economic climate.

At the bottom of the cycle, insurers will leave that market or reduce their involvement in the classes concerned.

Phase 4: reduced competition and the start of the upswing

As insurers contract and withdraw from the market, competition reduces and premium rates can start to harden (ie increase) again. Eventually premium rates will increase to cover the losses being incurred. The speed with which this occurs will depend on the position adopted by the leading insurers in that business, and insurers' continuing demand for market share.

The effects of phase 4 lead back to Phase 1.

(ii) Price optimization In order to cope with the effects of the cycle, companies would attempt to use price optimization.

The premium charged should ideally cover the costs and allow for a profit to be made. However, the exact amount of profit depends on the market phase,

And, indeed at some points of the cycle it may be hard to keep the contribution to profit positive.

In the long term, however, companies would attempt to even out the pattern of profits and losses.

Since different classes will be at different points of the cycle at different times, in the short term, profitable classes may be able to cross-subsidise losses in other classes.

And companies would attempt to optimize between growth or retention of business and profit over a medium to long term despite short term fluctuations in overall profit.

[7]

Q 3.

(i) Age of policyholder as a new rating factor:

- Age of policyholder is likely to be an indicator of future claims experience.
- Use of this additional rating factor should remove some residual heterogeneity.
- Age of the policyholder is objective, easily measurable and verifiable.
- older people may be more likely to stay at home for longer hours during the day, and this reduces the opportunity for theft claims
- there may be lower moral hazard with older policyholders, *eg* they may be more careful not to leave windows open or leave the house without securing the doors.
- Age of the policyholder may also be an indicator of future persistency.
- For example, older policyholders may be more “loyal” and likely to renew policies (leading to lower per-policy expenses).
- Charging premium according to this risk factor will encourage more of the lower risks (*ie* older policyholders) to take out policies with the insurer ...
- similarly, fewer of the higher risks (*ie* younger policyholders) will take out the policy.
- This should lead to better experience overall, and hence cheaper premiums generally, or likely higher profitability for the insurer.
- If some other companies are already rating by age of policyholder, this company will not be subject to anti-selection.
- If premiums get cheaper as a policyholder gets older, this should result in lower premiums on renewal, which will improve persistency levels.

(ii) Further aspects:

The company will need to calculate the extent to which the age of the policyholder will affect the premium charged.

Data on the age of the policyholder could have already been collected as part of “Know Your Customer” norms; then the likely impact could be calculated from the insurer’s own data

Calculation of premium rates from such data may be for each age or age-band.

The appropriateness of the existing rating structure and the weights for the levels of current rating factors may be tested as a part of the analysis.

However, suitable adjustments to calculated crude rates may be needed to allow for changes in expected age profile due to introduction of age as a rating factor and any suspected inaccuracies/ deficiencies in existing data. Before finalising the premium rates by age of policyholder comparison of age based claim frequencies and/ or claim severities with external data may be needed.

Where current experience analysis does not appear to give credible results some allowance for a subjective view may be needed but this may introduce bias.

If the new set of premium rates allowing for age as a rating factor is incorrect, this may result in anti-selection.

Information collected at the proposal stage may need to be amended in order to ensure collection of correct date of birth of the policyholder or age for all future new business.

In households with more than one occupant, the age of the policyholder will only make a crude allowance for the ages of all the people in the household.

The addition of one more rating factor may be seen to over-complicate the product.

The rating factor may not be liked by sellers (*eg* if it is seen to make the product more difficult to sell), and some sellers may be less willing to sell this insurer's products.

Further aspects needing the company's consideration are:

- the need to smooth rates from one age (or age band) to the next
- the need for a simple rating structure, *eg* using 10-year age bands.
- Rating manuals (or quotation software) will need to be redesigned, and sellers may need to be trained to explain the effect of policyholders' age on the premiums charged.
- The company may need regulatory approval to allow for the additional rating factor – *eg* it may need to provide statistical evidence that age of policyholder does have an impact on claims experience.
- The proposed change could make a significant difference to the premium paid by existing policyholders on renewal, which may adversely affect renewal rates. For example, a younger policyholder might see a significant premium increase when the new rating factor is introduced.

Reinsurance arrangements may need to be reviewed following the proposal.

[13]

Q 4.

The factors relate to:

- i. Existing reinsurance arrangements
- ii. Classes of business sold
- iii. Company specific features
- iv. Reasons for obtaining reinsurance
- v. Possible impact on business due to the changes in reinsurance arrangements

These are dealt with in brief detail below:

Existing reinsurance arrangements-

- types of reinsurance, retention levels, reinstatement terms, *etc*
- appropriateness of existing reinsurance arrangements

Classes of business -

- nature of risks in each class of business written
- the range of size of the risks
- the volatility of claims experience

- the geographical spread of risks
- possible accumulations of risk
- the risk of catastrophes
- the predictability of the business written, which will depend on:
 - the extent of past claims experience, say 5–10 years
 - the goodness of fit of statistical distributions to past claims experience.

Company specific features-

- the structure of the company and in particular any support from a parent or group to which it belongs
- the solvency margin / free assets
- the company's appetite for risk.

Reasons for obtaining reinsurance-

- the limitation of exposure to risk / need to spread risks
- the need to stabilise results
- the need for financial support
- the need for technical assistance.

Possible impact on the business of the change-

- the effect on profitability due to higher retention levels
- the effect on business volumes
- the effect on the investment freedom of the insurer
- the possible reduction in administrative costs if there is less contact with reinsurers.

[10]

Q 5.

- (i) In an insurance context, properties in neighbouring geographical areas will be subject to similar risk.

Postcode is a risk factor often used in property insurances; however postcode often has many levels such as in millions.

Spatial smoothing allows the model to fit many values to the postcode factor, and then removes the random element of past experience from the predictions by adjusting the relativity to take into account neighbouring values.

The method thus improves the predicted values by taking into account the credibility (or lack of it) for the response in a single location.

This also helps in rating postcodes for which no exposure and claims data is available.

- (ii) Two main forms of spatial smoothing typically employed:

- distance-based smoothing
- adjacency-based smoothing.

Distance-based smoothing incorporates information about nearby location codes based on the distance between the location codes: the further away a location code, the less influence (or weight) is given to its experience. This is true regardless of whether an area is urban or rural, and whether natural or artificial boundaries (such as rivers) exist between location codes.

Risks such as theft risk and density of occupancy may not be correctly reflected in such an approach.

Distance-based smoothing methods are often employed for weather-related perils where there is less danger of over- or under-smoothing urban and rural areas.

Distance-based smoothing methods have the advantage of being easy to understand and easy to implement, as no distributional assumptions are required in the algorithm.

Distance-based methods can also be enhanced by amending the distance metric to include “dimensions” other than latitude and longitude.

For example, including urban density in the distance metric would allow urban areas to be more influenced by experience in nearby urban areas than by nearby rural areas, which may be appropriate.

Adjacency-based smoothing incorporates information about directly neighbouring location codes.

Each location code is influenced by its direct neighbours, each of which is in turn influenced by its direct neighbours.

Prior knowledge of the claims processes can be incorporated in the technique.

An iterative method can be adopted while building the model (although complex to implement).

Natural or artificial boundaries (*eg* rivers or motorways) can be reflected in the smoothing process.

Location codes tend to be smaller in urban regions and larger in rural areas, so adjacency-based smoothing can sometimes handle urban and rural differences more appropriately for non-weather-related perils.

Adjacency-based smoothing methods can be used for non-weather-related claim types because the boundaries can be reflected and because of the urban/rural issue.

Examples of non-weather-related claim types are theft or malicious damage.

(iii) Degree of smoothing

Employing too low a level of spatial smoothing would mean that near or neighbouring location codes have little influence on the location code in question.

This can result in some of the random noise element being captured together with the true underlying residual variation.

This causes distortions and reduces the predictive efficiency of the model.

Conversely, employing too high a level of spatial smoothing can result in the blurring of experience so that some of the true underlying residual variation is lost, again causing distortions.

Appropriate diagnostics (*eg* based on residual analyses) should therefore be used to assess the level of smoothing required.

[11]

Q 6.

Assessing performance against the company's goals

Assessment of growth targets achieved in each of the classes of business and a review of the levels of underwriting profit, insurance profit and change in solvency margin, if any.

Whether the solvency level itself is optimum for the growth rate targeted is another exercise.

Higher growth rates are often associated with a greater probability of deterioration in selection standards. This will be reflected in lower underwriting profit/ higher loss ratio and sometimes higher proportion of large claims.

This will need examination.

The reasons for deviations, (whether plus or minus), from the targets and in particular the linkages between such deviations and factors like productivity, rate changes or changes in business mix.

An assessment based on results of the above two of the likelihood of achieving the overall goals, if performance is short of targets and likelihood of taking up revised higher targets is required

Further, if expectations are not being met, data on areas where shortfalls have arisen in order that decisions can be made to put the business back on target such as by re-pricing products or reorienting target sales profiles may be gathered.

A comparison of the business profile up to last financial year and at the end of the recent financial year subdivided by segments of distribution channel, geographical region and policyholder demographic profile, would indicate the degree of success achieved on growth and introduction of new rating factors.

Similarly, a comparison of volumes of business during the year under the new benefits introduced with that expected would indicate the degree of success and policyholder preferences on the nature of benefits.

Review of rating structure and premium rates against actual experience

The company would have had some data prior to the introduction of the new rating factors on policies falling under these factors and the rates would have been based partly on such information. The company would now have one year's additional data of claims, which may be used to find out how the actual claims, particularly by the new rating factors, compare with that expected on the pricing basis.

To what extent changes in claim experience have been the result of introduction of new benefits needs study by analysing data of claims by nature of loss/ damage.

A review of how the actual fixed costs and variable costs (other than commission) compare with expense assumptions in pricing and whether growth and introduction of additional benefits have helped reduction in fixed costs may be made.

Similarly, it is also time to review how the persistency has changed, particularly because of the new rating factors. While examining IBNR, it has to be remembered that experience for the new benefits may still be emerging.

Managing risk

Monitoring written business allows the company to assess how much risk is inherent in the portfolio (for example, accumulations). High growth combined with introduction of new rating factors could change the picture on accumulations; this will need study

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

Change in mix and profile of written business can provide useful information about how far the company has been able to cope with competitors' strategies. It can also allow the company to compare itself with the market and assess the position of the underwriting cycle.

[13]

Q 7. (i)

UW year	Inflation Index	Premium Index	Inflated Losses	Level Premium	Loss Ratio
2009	1.05	0.95	438.31	440.63	99.5%
2008	1.10	0.95	355.73	383.16	92.8%
2007	1.16	1.00	385.07	414.76	92.8%
2006	1.22	1.10	505.41	414.76	121.9%
2005	1.28	1.65	357.36	576.06	62.0%
			2041.89	2229.37	91.6%

Available from question

Claims inflation = 5%

Rate change for 2010 = 5%

Assumptions

Average loss ratio = 91.6% ; weighted average loss ratio 94.5%

No change in policy terms and conditions

Incurred loss include IBNR & IBNER

No change in business mix

(ii) More information about rate changes for 2010

Projected volumes of business in 2010 (Written Premium)

Information on large or unusual exposures

Information of large loss experience especially for 2006

Any IBNR, particularly for 2009.

Commissions including profit commissions, brokerage, override etc.

Loads for internal expenses both fixed and variable.

Taxes and any other levies.

Any costs of retrocession.

Investment income.

For this we need to know payout pattern and premium receipt pattern as well as investment yields on suitable assets.

(iii) The past 5 years may be too short a time frame to capture the extremes of the loss experience.

For example, if this portfolio of business has had unusually heavy claims experience in the last 5 years, then the average loss ratio over a longer time period may be lower.

There will be differences of opinion from the buyer s and seller s perspectives.

Errors in data supplied or errors in calculation

Oversimplification or differences in calculation/method used

Claims expenses/reinsurance coverage changes of direct insurer.

Difference in definition of premiums and claims (i.e. gross/net of commission)

Changes in the mix of business over time.

There may be difference in opinion of:

Coverage provided in 2010 vs historic years.

Type of claims incurred.

Claims inflation.

Legislation or regulation that affects claims.

Propensity to claim.

This means that the future experience may be very different from the past.

The company may be planning to target a particular segment of the portfolio and hence increase its exposure to that part.

There may be changes in underlying economic conditions / crime rates that affect the claims experience.

[16]

Q 8.

(i) There are 5 modules as follows:

An event module which is a database of events with each event defined by its physical parameters, location and annual frequency of occurrence.

A hazard module which determines the consequence of an event such as hurricane, causing damage.

An inventory module which is a database of insured systems and structures with details such as age, occupancy and type of construction.

A vulnerability module which enables determination of the degree of loss, often expressed as a percentage of sum insured, how much damage each insured property is likely to sustain due to a defined peril.

A financial database module, which converts a physical damage loss into an insured recovery amount using database of policy conditions such as limits, excesses and coverage terms

(ii) The components of the existing event module and hazard module will no longer be appropriate and every component has to be modified using the recently published information.

If the existing model did not set up a database for some parts of the country, as they were not falling under the existing definitions of risk proneness, they will have to be brought into the model with the recent information

The revised model may also consider building in a flexible feature for any future changes in the event and hazard module databases. The flexibility has also to enable, if needed, a history of changes (including effective dates of the changes) so that links to the other 3 modules would help generate a history of financial assessments and help review the nature of fluctuations on reserves.

Since the published information appears to be linked only to the earthquake peril, there is a need to consider whether a change in the parameters for other perils is also required. This would be decided based on the notes published by the department along with their maps and peril related information available generally through any scientific organisations or otherwise.

If the existing model has links to a reinsurance model, then there is a need to consider how changes are to be made on the relationships to the reinsurance model.

The financial analysis model would indicate the overall impact due to all perils. The results of this model before revision and after revision, as and when completed, would need careful study and judgment to see if any of the parameters of the vulnerability and financial model will need amendment.

If, as a result of the published information, the pricing on some products needs a change and if the company finally decides to implement such changes, there could eventually be a change in the inventory model; if such changes are not automatically built in, efforts to incorporate the changes are required.

If the existing model has any links to other publicly available catastrophe models used by the insurance industry in general, then revisions to be made by the company may be compared with any changes in such external models.

[13]

Q 9.

Building Coverage Limit (Rs)	Direct Premium (Rs)	Ceding Co retention as % of Building coverage limit	Allocation from Cumulative Loss cost distribution table	Ceding Co. retention plus reinsurance limit as a percent of building coverage limit	Percentage allocation of total premium from Cum Loss Dist Table	Exposure Factor	Exposure Premium
1	2	3	4	5	6	7	8
1250000	10000000	400%	100%	800%	100%	0%	0
2500000	10000000	200%	100%	400%	100%	0%	0
3750000	10000000	133%	100%	267%	100%	0%	0
5000000	10000000	100%	100%	200%	100%	0%	0
10000000	10000000	50%	89%	100%	100%	11%	1100000
	50000000						

Assumptions

Direct Insurance company expense	0.60
Reinsurance sharing of direct insurers expense	0.10
Reinsurer's target loss ratio	0.80
Rate Adequacy factor	1.00

$$\text{Exposure Rate} = ((1100000 * 0.6 * 1.1) / 50000000) * 1 * (100/80) = 1.82\%$$

$$\text{Col 3} = \text{Col 1} / 5000000$$

$$\text{Col 5} = \text{Col 2} / \text{Col 1}$$

$$\text{Col 7} = \text{Col 6} - \text{Col 4}$$

$$\text{Col 8} = \text{Col 7} * \text{Col 2}$$

One marks for correctly inserting values from the Cumulative Loss Cost distribution table

[9]

[Total Marks 100]
