Institute of Actuaries of India

ST8 – General Insurance - Pricing

November 2012 Examinations

INDICATIVE SOLUTIONS

Introduction

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable.

1)

a) A peril is a type of event that may cause a loss that may or may not be covered by an insurance policy. An insured peril is one for which insurance cover is provided.

b) Rating factor is a factor used to determine the premium rate for a policy, which is measureable in an objective way and relates to the intensity of risk. It must, therefore, be a risk factor or a proxy for a risk factor or risk factors.

c) **Perils**
Accidental damage to insured vehicle
Malicious damage to insured vehicle
Fire of insured vehicle
Theft of insured vehicle

Rating factors
Type of cover
Value of car and its contents
Policy excess
The use to which the vehicle is put
The age of the vehicle
Occupation of policyholder and other drivers
Whether there are additional drivers of the vehicle as well as the policyholder
Gender of driver
Age of policyholder and main drivers
Whether or not driving is restricted to certain named drivers
Make and model of vehicle
The extent of any modification to the engine or body
Location of policyholder
Where the vehicle is kept overnight
Past experience

[7 Marks]

2)

a) Risk classification / segmentation for more accurate pricing
Attract favourable risks
Influencing risk by providing feedback on customer behaviour
A more informed claims process
Reducing frauds
Other value additions like theft detection, driver feedback, emergency services etc
Reduced loss ratios
More satisfied customers – better retention

b) larger volume of policy and claims data to process
manifold increase in per policy number of records
current systems might be inadequate to handle such volumes
due to this it might take longer to process the data
concerns of insurers' access to sensitive policyholder data

[6 Marks]

3)

+ lower price as compared to buying the covers in separate policies

+ some covers might not be available individually

+ simple to have single policy instead of several different policies

+ simple to deal with single insurer instead of several insurers

- some covers may be lower priced from different insurers

- concentration risk of having to deal with single insurer for all covers

- if customer service found unsatisfactory, exposed to it for all covers in package

- if claims settlement found unsatisfactory, exposed to it for all covers in package

- exposed to fortunes of single insurance company

[4 Marks]

4)

Committed (or contingent) capital – This is based on a contractual commitment to provide capital to an insurer after a specific adverse event occurs causing financial distress. The insurer purchases an option to issue its securities at a predetermined price in the case that the defined situation occurs, on the understanding that the price would be much higher after such an event. For example, securities might have a current market value of Rs.100. the insurer might fix the predetermined price at Rs.100. Following the adverse event, the market value of securities might fall to below Rs.100, however the insurer will still be able to issue such securities at the higher price of Rs.100.

Securitisation – this provides a mechanism for risk and capital management. Three examples of securitisation:

Insurance-linked securities – These enable an insurer to increase insurance capacity. For example, catastrophe bonds have been used by insurers to transfer catastrophic risks to the capital markets via a bond issue. If the specified catastrophic risk is triggered, the bondholders forfeit the interest and principal on the bond to the insurer.

Credit securitisation – These may enhance the creditworthiness of debt instruments and provide capital relief to banks and credit protection to companies.

Motor securitisation – These enable a motor insurer to pass on certain aspects of the portfolio risks to the investment market.

Weather derivatives – Standard derivative techniques are used to make derivative contracts based on weather.

[6 Marks]

5)

    a) Soft premium rates are premium rates with significantly reduced margins due to the competitive state of the market.

    b)

        a. Risk segmentation – less scope since the range of premiums will be low

        b. Demand for insurance – will be increased, since insurance is available at low cost

        c. Loss ratios - high

        d. Any premium deficiency reserves – there may be an element of this since premiums are low

        e. Capital required – depending on required provisions, capital may be required

        f. Reinsurance support – reinsurers might not be willing to quote favourably

        g. Number of insurers offering cover – this might gradually reduce as insurers start experiencing losses

[8 Marks]

6)

    a) Latent claims are those claims that result from perils or causes that the insurer is unaware of at the time of writing a policy, and for which the potential for claims to be made many years later has not been appreciated.

    b)

- Number of claims – the number of claims depends on how many parties were affected and the number of separate incidences caused by the perils.
- Claim cost – the cost could be huge depending on the extent of damage proved and the number of parties affected.
- Claim inflation – depends on the period of reporting delay, the settlement delay and the extent of damage. More of the inflation will arise from court awards.
- Delay patterns – depending on the time it takes to establish a claim and to establish an acceptable compensation.
- Variability of experience – the experience from different claims could be significantly different.
- Accumulations – there could be significant accumulations depending on the peril causing a claim
- Fraudulent claims – there are chances of fraudulent claims, depending on the difficulty in establishing independence of a development from an insured peril in the face of a harsh court award

[8 Marks]

7) Changes in claims handling procedures
Incorrect updations in case estimates
Changes in processing delays
Large claims
Return premiums
Insufficient recording of claims inflation

[3 Marks]

8)

a) Currency of claim – this will impact the average severity assumption
Volatility of currency – this will impact the volatility in severity, hence related provisions
Variation in claims cost by country
Moral hazard
selection

b) For 1, 2 and 3 – have specific prices for different countries so differences in treatment costs and exchange rate over short term are less uncertain.
For 4 and 5 – have adequate underwriting at policy issuance stage.

[4 Marks]

9)

a) When the sum insured is less than that required under the terms of the contract. Depending on the policy wordings, where underinsurance is proved to exist, this could render the policy null and void. Alternatively, average may be applied to claim amounts.

b) Under the principle of average, a payment on any claim is reduced in proportion to the extent of proved underinsurance. So insurers effectively pay a claim only in respect of the insured part of the total claimed amount.

[3 Marks]

10)

    i. Expected cost with unlimited free reinstatements with 1,000,000 Annual Aggregate Deductible

        = Expected cost with no limits with 1,000,000 excess - Expected cost with 1,000,000 limit with 1,000,000 excess = 1,110,000 – 700,000 = 410,000

    ii. Expected cost with 1 free reinstatements

        = Expected cost with limit 2,000,000 with 1,000,000 excess = 900,000

    iii. Expected claim cost with 1 free reinstatement and 1,000,000 AAD = Aggregate cost with limit 3,000,000 – Aggregate cost with Limit 1,000,000 = 1,050,000 – 700,000 = 350,000

[4 Marks]

11)

   i.

      a. The first step is to select the base data based on volume, availability, relevance etc.

      b. Suitable adjustments for inflation and other trends are done on the data

      c. The claim costs will need to be adjusted for future inflation to bring it to the level of cost which is suitable based on future coverage period.

      d. If there are any other expected future changes in the environment which may impact the future claim experience, that adjustment should be done.

      e. Divide data into homogeneous groups such as private and commercial vehicles.

      f. Some fields may need to be calculated such as exposures, earned premium, number of claims etc. as they may not be readily available in the data extract.

      g. Data will then need to be summarized in a format in which a GLM analysis can be run for example grouping the exposure and claim data on the rating variables.

      h. Before starting a GLM exercise, One-way and Two-way analyses should be done to understand the data and for a preliminary analysis of effects of rating variables.

      i. Distribution of the exposures for various rating factors should also be studied to understand about the most important customer segments (in terms of size) or if some grouping is required for sparse groups.

      j. Grouping of data may need to be done for levels of rating variables which are very sparse for example certain ages or certain car models.

      k. Preliminary correlation analysis may be run on the rating variables to check for any significant correlations to remove correlated variables.

      l. Error checks will need to be performed to look for missing values, possible data errors (such as dates, age etc.) and apply measured to correct them if possible to apply any other valid solution

      m. Preliminary analysis may be done to find out outliers in the data so that suitable adjustments can be done.

ii.

    a. Study the predictive power of the variables. Based on the how well a predictor the rating variable is, a decision is taken whether to keep or remove a rating variable.

    b. We need to study if a possible interaction effect between two variables is present and if we should include that in the model.

    c. We need to select the final model for an analysis based on statistical test and predictive power of the final model. Every new variable will most likely increase the predictive power but after a certain stage that increase will not be significant.

    d. An analysis of residuals (difference between actual response and the predicted value) needs to be done to be sure that most characteristics of the response has been captured.

    e. Transformation of variables may be required if we observe that the linear variable is not giving a good fit.

    f. Analyses are performed to check for outliers using statistical tools to check if any particular data points are affecting the model significantly. In that some adjustment to the data may be done. Lift curves / outliers

    g. Grouping of levels of rating variables may be done by the model.

    h. Smoothing of the parameter estimates may be required to be done.

    i. There may be certain restrictions on the model such as no claim bonus. The model needs to account for that in estimating the parameters (Offset).

    j. Separate model for frequency, severity may need to fit and then the results of the two models may be combined to get the estimates for pure claim cost.

    k. Different claim types may need to be modelled separately due to very different experience from each other in terms of frequency and severity. Such as:

        1. Own Damage
        2. Third party damage
        3. Third party injury
        4. Fire
        5. Theft
        6. Windscreen

    l. If we build separate models for each claim type, then we need to combine the models to get one pure claim cost model.

    m. At the end, model validation needs to be performed to check the predictive power on the model. For this a random sample is drawn out of the data which is not used for the GLM analysis. After the GLM analysis results are obtained, it is tested on this validation sample to check as to how accurately is the model predicting the response.

    iii. The further considerations in using the results from the GLM exercise

        a. Loading for CAT claims may need to be done on top of pure claim cost based on own data analysis.

        b. Loading for

            1. Expenses

                a. % of premium only or slipt amount % of premium, fixed per policy and claims related.

            2. Acquisition cost

                a. Depending on the business mix from different channels. May be different for new and renewal business.

            3. Profit or capital charge: How much to load, different class of business may hold different level of capital depending on the riskiness and hence may require different profit margin.

            4. Reinsurance cost

                a. If reinsurance cost was not considered in pure claim cost estimation then net of reinsurance cost.

        c. Sophistication of the quote systems. Needs to be looked at if a new rating variable is being introduced.

        d. Cross subsidy may need to be built across rating variables to allow a particular rating structure. In this case, impact of possible change in portfolio mix may need to be studied.

        e. Competitors rates needs to be looked

        f. Our own existing / current premium rates need to be looked at and the rate increase or decrease compared to them for each risk cell needs to be discussed with the sales staff and partners.

        g. The relativity of rates across various risk cells also needs to be checked.

        h. Sales channels – relationship with particular broker, distribution partner

        i. The rates need to be comply with the applicable regulations

        j. No claim discounts may need to be kept in line with the market.

        k. Renewal process needs to be looked at as it will impact the renewal acquisition cost and other expenses.

[20 Marks]

12)   **Advantages**

- This approach mirrors the underlying process – a number of losses are generated, each with its own ultimate value – and so is readily understood by underwriters.

- We can use the approach for complex insurance structures.

- By separately assessing information on loss frequency and severity, we gain additional insight into aggregate loss amounts.

- It helps us to identify trends.

Disadvantages

- Assessing the compound frequency-severity loss distribution has more onerous data requirements than assessing aggregate amounts.

- This approach can be time-consuming for a single risk and requires a high level of expertise.

- More data is required.

[3 Marks]

13)   **Solution**

    i. Let n be the observed number of claims. Using Normal Approximation for N, we need

$$P(\mu - k\mu \leq N \leq \mu + k\mu) = P$$

$$P(-k\frac{\mu}{\sigma} \leq Z \leq k\frac{\mu}{\sigma}) = P$$

$$P(-k\sqrt{n} \leq Z \leq k\sqrt{n}) = P$$

The last equation follows as variance for Poisson is equal to mean and mean is replaced with its estimate n.

$$2\Phi\left(k\sqrt{n}\right) - 1 = P$$

$$n = \left(\frac{\Phi^{-1}\left(\frac{1+P}{2}\right)}{k}\right)^2 = n_0$$

ii. Let $\overline{X}$ be the mean of the observed average claim size. Let μ and σ be the mean and standard deviation of S. We need,

$$P(\mu - k\mu \le \overline{X} \le \mu + k\mu) = P$$

$$P(-k\sqrt{n}\,\frac{\mu}{\sigma} \le Z \le k\sqrt{n}\,\frac{\mu}{\sigma}) = P$$

The last equation follows as variance of $\overline{X}$ is $\dfrac{\sigma}{\sqrt{n}}$

$$2\Phi\left(k\sqrt{n}\,\frac{\mu}{\sigma}\right) - 1 = P$$

$$n\frac{\mu^2}{\sigma^2} = \left(\frac{\Phi^{-1}\left(\frac{1+P}{2}\right)}{k}\right)^2$$

$$n = n_0 \frac{\sigma^2}{\mu^2} = n_0 CV_s^{\;2} = n_s$$

iii. From the above derivation,

$$\frac{\sigma_{PP}^{\;2}}{\mu_{PP}^{\;2}} = \frac{\mu_N \sigma_S^{\;2} + \mu_S^{\;2}\sigma_N^{\;2}}{\mu_N^{\;2}\mu_S^{\;2}}$$

$$= \frac{\sigma_S^{\;2} + \mu_S^{\;2}}{n^2 \mu_S^{\;2}} = \frac{(1 + CV_S^{\;2})}{n^2}$$

$$2\Phi\left(k\,\frac{\mu_{PP}}{\sigma_{PP}}\right) - 1 = P$$

$$\frac{\mu_{PP}}{\sigma_{PP}} = \left(\frac{\Phi^{-1}\left(\frac{1+P}{2}\right)}{k}\right)^2$$

$$n = n_0(1 + CV_s^{\;2}) = n_{PP}$$

iv. For P = 95%, $\Phi^{-1}\left(\dfrac{1+P}{2}\right)$ = 1.96.

So, n_0 = (1.96/.05)^2 = 1536.34. ~ 1537

CV_S^2 = 1/r = 0.2. So N_S = 1536.34*0.2 = 307.33 ~ 308

N_{PP} = 1536.34*1.2 = 1843.97 ~ 1844. We need to pick the next integer if the solution is not an integer.

Alternate for N_{PP} = 1537+308 = 1845

[12 Marks]

14)

i.

$$G(x) = \frac{LEV_X(x)}{E(X)}$$
$$LEV_X(x) = \int_0^x S_X(x)dx$$
$$LEV'_X(x) = S_X(x) = 1 - F(x)$$
$$So, \quad G'(x) = \frac{1 - F(x)}{E(X)}$$

ii. The curve is suitable with the assumption that the Limit and loss amount move up with inflation in the same proportion. This assumption more or less holds true for personal homeowners portfolio.

iii.

Sum Insured		A			C	D	E	F	G	H	I	J
Lower Limit	Upper Limit	Mid-point	Prem	LR	Loss Cost	Tty Attachme nt	Tty Limit	Tty Attach ment %	Tty Limit %	Exp % Attach ment	Exp% Limit	Loss Cost to Layer
0	100	50.0	10,000	60%	6,000	45.5	272.7	90.91%	100.0%	97.41%	100.0%	155.2
100	150	125.0	3,000	60%	1,800	45.5	272.7	36.36%	100.0%	63.01%	100.0%	665.8
150	200	175.0	2,000	60%	1,200	45.5	272.7	25.97%	100.0%	50.01%	100.0%	599.8
200	250	225.0	1000	60%	600	45.5	272.7	20.20%	100.0%	41.33%	100.0%	352.0
250	300	275.0	500	60%	300	45.5	272.7	16.53%	99.17%	35.17%	99.79%	193.8
300	400	350.0	600	60%	360	45.5	272.7	12.99%	77.92%	28.72%	92.64%	230.1
400	500	450.0	400	60%	240	45.5	272.7	10.10%	60.61%	23.06%	83.59%	145.3
500	1,000	750.0	1,000	60%	600	45.5	272.7	6.06%	36.36%	14.47%	63.01%	291.2

3,321.9

A = Average of Upper and Lower limit

C = Premium * Loss Ratio

D = Treaty attachment adjusted for inflation = 50/1.1

E = 300 / 1.1

F = (Minimum of D and A) / A; G = (Minimum of E and A) / A

H = The point on G(x) @ F; I = The point on G(x) @ G

J = (I – H) *C

iv. Using the mid-point as an estimate for sum insured for all risks in the band may result into a lower than correct expected loss cost to the layer. For example, if the first band had been 0 to 90, then using the mid-point of 45, the loss cost to first layer would have been zero, which is incorrect. Therefore, this method is likely to underestimate the loss cost to the layer for the first band.

v. Some possible approaches could be:

   a. Split the band into two – one below 50 and one above 50. Some approximate split of premium may be done in the two bands

   b. Ask the insurer for details of individual risks in the band.

   c. Use the risk profile of another similar personal homeowner portfolio which has narrow bands for below 100 sum insured.

[12 Marks]

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