Institute of Actuaries of India

Subject ST8 – General Insurance: Pricing

March 2017 Examination

INDICATIVE SOLUTION

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.

Solution 1:

Following aspects of the business would be monitored to keep the performance under check:

- Being an internet only company, the premium rates are expected to be low as compare to competitors. Need to continuously monitor the premium rates with competitors
- The premium rate change with respect to own business and competitors rate (only online business) need to be monitored.
- Persistency/renewal ratio is an important component for the profitability of the company. We need to constantly monitor the renewal rates and compare with the expected number as per business planning. This may not be applicable for travel policies as they are generally short term, non-renewable policies.
- Need to monitor the desired business mix of two lines of business done by the company. As two lines of business are expected to have different loss and expenses ratio, keeping the business mix at check is important.
- Business mix within the product is very important. e.g. in motor insurance, mix of private vehicles and commercial vehicles. In travel, mix of domestic and overseas travel policies. One time versus annual multi-trip policies
- Other aspects that are important to monitor are:
  - Conversion rate
  - Policy Endorsements; financial and non-financial
  - Mid-term Cancellations

[5 Marks]

Solution 2:

i) Return commission: The direct writer (the cedant in the reinsurance arrangement) will have suffered expenses in order to sell the original policies (for example, commission to brokers). The reinsurer will reimburse the direct writer with some percentage of the premium to help cover the acquisition expenses.

      Override commission: To compensate the direct writer for the extra work that the direct writer will have carried out in attracting and administering the business, the reinsurer may pay a further commission payment to the direct writer. The commission over and above the return commission is sometimes called override commission.

(2)

ii) In a quota share contract, the loss ratio of the ceded business will be the same as the loss ratio of the underlying business.

      From the loss ratio distribution, the probability of loss ratio more than 60% is less than 20%.

      Therefore the maximum ceding commission which can be charged = 100% - 60%- 5%- 2%- 3%= 30%.

(4)
[6 Marks]

Solution 3:

i)

     a. The proposal will lead to increased level of business; both renewal and new business

     b. It might lead to risk concentration if windscreen damages are more prominent in certain geography of the country

     c. It will reduce the premium income and thus hence the profitability of the company

     d. It might lead to change in behavior of the policyholder. Policyholders will start claiming for this damage even if they were not doing this earlier because of prospective increase in premium due to loss in NCB. This will further lead to reduction in profitability

     e. Geographies or segment of vehicles, where these type of claims are uncommon, may not find any value in the proposal, thus not giving the required benefit

     f. Cost of marketing this feature has to be compared with expected increase in the premium

     g. If the company decides to remove this feature in future, it will lead to adverse publicity

(4)

ii)   Possible Consequences:

     a. Increase the rates for all customers:

          i. Lead to adverse selection

          ii. Higher premium will result in loss of business

     b. Offering this feature as an optional cover:

          i. May be offered by competitors, thus not giving any advantage to the company

          ii. May be opted by those policyholders who are more susceptible to such claims.

     c. Increasing rates for segments that are more prone to windscreen damage:

     Model windscreen damage as a separate peril thus avoiding cross-subsidies; thus charging high rate to only that cohort of policyholders who are more susceptible to such risk.

(3)

[7 Marks]

Solution 4:

i) 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 and hazard modules are based on seismological and meteorological assessment.

The vulnerability module is based on engineering assessment.

(2)

ii) Primarily, it will be mainly Event and Hazard Modules which will need to be revisited because of global climate change.

Event Module: Since due to global climate change, the frequency of extreme events is expected to increase and therefore the assumptions in this module need to be revisited.

Hazard Module: The hazard is the consequence of the event that causes damage. So if impacts of climate change on event module are incorporated, the hazard module may not require further changes. However, some further adjustments may still be needed. For example: the wind storm of the same

intensity could lead to bigger storm surges due to rising sea levels, wild fires may travel faster and cover greater areas etc.

(4)

iii)

At the return periods 100, 200, 250 and 500 year, the corresponding exceedance probability is 0.50 %(=1/200).

Therefore the reinsurance purchase limit for EQ in the proposed CAT XL should be 295.

(2)
[8 Marks]

Solution 5:

i)   Important factors will usually include:
- the type and value of the craft
- the scope of the voyages
- the areas covered or the destination
- the number and experience of the crew
- previous claims experience.

(2)

ii)   Solution: Calculating the trend rate for Sum Insured:
Inflation was up to 31st December 2014 and expected is for 2017. We need to trend the SI to Dec 2017 level

Policy Year	Period	SI	Annual Trend	Trend Factor	Trended SI PY 2016 Level	PY 2017 Level
2012	Jan - Dec	29	5.00%	1.1576	33.57	35.25
2013	Jan - Dec	31	5.00%	1.1025	34.18	35.89
2014	Jan - Dec	33	5.00%	1.0500	34.65	36.38
2015	Jan - Dec	36	0.00%	1.0000	36.00	37.80
2016	Jan - Dec	35	0.00%	1.0000	35.00	36.75

Assumptions:

- SI is written evenly throughout the policy year (or other sensible assumption, provided calculations are consistent).
- SI is at midpoint of year for inflation purposes.
- SI is a good exposure measure.

Year	Trended SI (1)	Reported Claims count (2)	Development % (3)	Projected Ultimate Claim Count (4)	Ultimate Claim Frequency (5)
2012	35.25	302	90%	336	9.5
2013	35.89	219	80%	274	7.6
2014	36.38	279	60%	465	12.8
2015	37.80	45	35%	129	3.4
2016	36.75	30	15%	200	5.4
2017	42				
APPROACH 1: Average of Ultimate Claim Frequency over the years, weighted by trended SI { [Sum of (4) across all years] / [Sum of (1) across all years] }					7.7
APPROACH 2: Average of Total Reported Claim Count to Total 'Used-Up' trended SI { [Sum of (2) across all years] / [Sum of (1)*(3) across all years] }					8.7

2017 Exposure: 42

2017 Claim Count: 42*7.7 = 324 (APPROACH 1) or 42*8.7 = 364 (APPROACH 2)

Justifications / Assumptions:
- The more recent data is more representative. Older claims data are more certain (no IBNR).
- But exposure is less certain, due to trend assumptions.
- Generally put more weight to recent data but try to understand shift.
- Latest year is very uncertain due to large development. (under Approach 1)
- 2014, or even 2015, may be anomalous, so could put less weight on this.
- No explicit additional allowance for large claim/cat experience is needed.
- Completely experience-rated (past is a good guide to future).

(6)
[8 Marks]

Solution 6:

i)

(a) Bonus Hunger: the reluctance of policyholders under a no claim discount system to notify claims or claim amounts when faced with a potential increase in premiums.

(1)

(b) Profit Testing: A term used for estimating the economic value of contracts using net present value techniques; i.e. proposed premium rates are tested by projecting possible levels of future business, claims, expenses, investment experience and profit.

(1)

(c) Swing Rated: A system by which the premium of each individual risk depends, at least in part, on the actual claims experience of that risk in the period covered.

(1)

ii)

  (a) Components:

      i.

Error Distribution: Error should be Poisson for frequency

$$P(x = k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

Link Function: Link function should be Log Link for Multiplicative model

$$g(x) = \ln(x)$$

$$g^{-1}(x) = e^x$$

      ii.

Vector of responses: $\begin{bmatrix} 1.5 \\ 2.5 \\ 4 \\ 6 \end{bmatrix}$

Vector of Model Parameters: $\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix}$

      iii.   Design Matrix: $\begin{matrix} x_1 & x_2 \\ \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} \end{matrix}$

      iv.   Weights: $\begin{bmatrix} 1000 \\ 1500 \\ 800 \\ 500 \end{bmatrix}$

                                                                                (4)

  (b) Missing data can be problematic. If you put "unknown" as a level for each factor, for example, they may be correlated with each other and cause aliasing. To solve, you can eliminate the level from one of the factors so there are no linear dependencies. If there are linear dependencies, there will be no unique solution in beta parameters and any arbitrary amount can be added to one parameter and subtracted from the other.

                                                                                    (2)

                                                                                  [9 Marks]

Solution 7:

i)   Loadings to be done on risk premium:

              Reinsurance Cost Loading: Can be incorporated as the net cost of reinsurance in a premium rate based on gross risk premium

              Expense Loading: Need to allow for both direct/indirect expenses and fixed/variable expenses. Can be incorporated as a percentage loading on risk premium

              Profit Margin Loading: Can be incorporated as loading on risk premium basis the target return on capital.

              Investment Income: Can be allowed in the premium by discounting the projected claims and expense cashflows at a suitable rate of interest.

              Other loadings can be

              Catastrophe/ Large Claim loading

              Contingency margin loading

                                                                      (3)

ii)

(a) Claim frequency under Model A varies from 12% in first decile to 50% in 10th decile whereas the same varies from 15% to 33% for Model B.

Under Model A, the claim frequency in first 4 deciles is increasing gradually but it makes a swift shift from 5th decile onwards. Whereas in Model B, the claims frequency is increasing gradually from 1st to 10th decile, thus not creating a huge difference in the characteristics while moving from one decile to another.

Observing the variation in claims frequency for both the models, using a lift curve or otherwise, it is apparent that Model A has better predictor on the out-of-sample data.

                                                                             (3)

(b) Multiplying results of Model A with 1.1 and that of Model B with 0.95 will lead to the projection of total 25000 claims from both the models.

However, this will not change the actual values by decile used for the lift curve, since the relative ordering of observations by model score would be unchanged after multiplying by a constant factor. (1 mark)

Thus, there is no change in the predictive power of bot the models from part (a).

Ideally, to test the model using lift-curve or otherwise, out-of-sample data has to be used. So the adjusted models ideally have to be tested on some other data since the models have already used the data through those 'adjustment factors'.

                                                                             (3)

                                                                                 [9 Marks]

Solution 8:

i) The relative loss size distribution Y (=X/M) is independent of the size of the risk. **(1)**

ii) Property class of business is the most suitable class since the policy limit in property business gives an indication of the size of the loss. **(1)**

iii) The primary sources of heterogeneity are
- Wide range of SI limits
- Different Perils
- Differences in jurisdiction and claims environment
- Different sub-classes (e.g. retail vs manufacturing vs warehouse)
- Different coverages (buildings only, contents and degree of business interruption cover).

(2)

iv)
The relative loss size
At the attachment point is $1/10 = 0.1$
At the limit point is $(1+5)/10 = 0.6$
Therefore from the relative loss size distribution, the loss cost to the layer is

$30\% * 300 * [G(0.6)- G (0.1)] = 90* (95\%- 66\%] = 26.1$ Cr. **(2)**

v)

A company would like to use exposure curve based on industry data under the following conditions
- when the company experience is like industry or like any other company.
- when the company experience is insufficient due to new lines of business and low volume.
- when the company experience is not credible due to changing mix of business and changing risk profiles.

A company would like to use exposure curve not based on industry data under the following conditions
- Company experience is very different to the industry
- No industry data

(3)

vi)
In residential property business
- No. of total losses is huge although we will have lots of partial losses also.
In commercial property business
- No. of partial losses is huge compared to a very small total losses.
Therefore the exposure curves would be different for these two classes of business.

In commercial property business, the percentage of total expected losses at a lower relative loss size limits would be considerably higher compared to that in residential property business because of the large number of partial losses present in the commercial lines.

(2)
[11 Marks]

Solution 9:

i)   Requirements for a rating Factor:
- Define the risk clearly
- Do not correlate too closely with other rating factors
- Practical to obtain and record
- Objective
- Verifiable and factual
- Acceptable to the policyholder
- Non-manipulable

(3)

ii)

The other company's data could be of poor quality, e.g. missing, or containing lots of errors.

It might not be detailed enough. For example:

• Insufficient data fields or too grouped

• Other insurer might be using different rating factors

• The other insurer might capture different data items to us – for example, cattle type group rather than exact cattle.

The other company might have outsourced administration of policies and/or claims to the distribution channels. In this case, the data might be less detailed.

If the other company uses more than one distribution channel then the data might come in lots of different formats depending on the channel.

The data might be in a very different format from ours, e.g. policy numbers might have a different format.

The definition of a claim might be different. For example, for ongoing health problems where a cattle needs treatment every month, are the monthly claims treated as separate claims or linked together as one?

There could be different treatment of expenses & fees or excesses.

Inconsistent claims estimate methods underlying the data.

Policies may have features that can't be accommodated in our system.

So we either have to build it in or change the policy, which either costs IT money or risks attrition.

The two systems may be incompatible i.e. not able to link up for the purposes of transferring data.

There may be "pipeline" problems with transferring records that are partway through a transaction, such as a purchase, renewal or claim.

In these cases the transfer may omit historical information that is needed to close the transaction properly.

Payment processing to customers, refunds, commissions, aggregator fees etc: we need to ensure these are not missed or duplicated.

Currency treatment might be inconsistent.

If the imported policy is for a customer we already have (with a different type of policy), then we will need to synchronize the customer record.

Similarly with claims supplier records.

The consequences of the above may be incorrect payments to customers or suppliers; poor customer service and loss of reputation.

(5)

iii)
- Less detailed data could create a need to contact the policyholder prior to renewal, to get the required information, or a need to make assumptions when calculating premium rates.
- Different claim definition for the two insurers will make the comparison of calculated frequencies and severities difficult.
- Different expense and fees estimate and inconsistent claim estimation method could lead to:
  - Incorrect information on performance of the book, leading to incorrect management decisions.
  - Loss of profits through pricing too low
  - Loss of profitable volume through pricing too high.
  - Anti-Selection through using an incorrect rating structure.
  - Inappropriate reserving.
  - Incorrect capital held, leading to possible solvency problems or regulatory intervention.
  - Failure to make recoveries from reinsurers.
- We may need to maintain two different sets of systems, leading to extra ongoing costs, or spend time and money finding a suitable IT solution, or manually transfer data, which could be open to errors. Data volumes may overload the system.
- Customer data may be subject to data protection laws, which may limit the use of data.

Contravening these laws could lead to criminal prosecution and unfavorable publicity, so permission may need to be obtained for use of personal data when a policy is issued or renewed.

(4)
[12 marks]

Solution 10:

i)
   (a) Benefits: Loss of money upto the limit covered
   (b) Insured perils
   - Hacking/phishing
   - Loss or Theft of mobile phone
   (c) Basis for cover: Losses occurring
   (d) Measures of exposures to which premiums are related
   - SI limit which will be linked to the E Wallet limit
   - E-wallet limit at the time of purchase of insurance
   (e) Claim characteristics
   - Frequency may be high due to fraud, stealing, hacking, etc
   - Small ticket claim size limited to the limit of E wallet
   - Faster claim reporting as most of the consumers will be well educated and aware of insurance
   - Claim settlement may be slower due to court and consumer forum cases.
   - Loss assessment may take some time and effort. This will be based on the amount spent out of the wallet before the mobile wallet company could block it.
     Also due to the fact that the moral hazard may be very high and admission of a claim may take longer by the insurer.

(f) Risk factors and rating factors
- Number and type of Security software/apps installed in the mobile
- Security and type of Wallet application installed in itself

(8)

ii)

- Individual risk events should be independent of each other.
  But in such an offering, multiple claim events may be triggered by a single cause e.g. cyber attack, etc.
  - o Moral hazards may be very high and quite difficult to eliminate in such offerings
  - o Also, customer may not be incentivized to inform the mobile wallet to deactivate the wallet after the loss/theft of mobile
- Lack of sufficient statistical data to estimate a reasonable amount of expected claims from a portfolio of policies.
- Insurable Interest: Some customers may use very small amounts (Rs. 2000 or so) just for small transactions such as cab fare etc.

(4)
[12 Marks]

Solution 11:

i) The three main reinsurance coverage bases are
- **(a)** Policies incepting basis
- **(b)** Claims made basis
- **(c)** Losses occurring basis

(1)

ii) For policies incepting basis, proportional reinsurance arrangement is commonly used.
For Claims Made basis, non-proportional reinsurance arrangement is commonly used.
For Losses Occurring basis, non-proportional reinsurance arrangement is commonly used.

(2)

iii) Surplus Treaty is suitable to
- Property lines of business
- Where the risks are very heterogeneous
- Where the risks are too large to retain by the insurer

Quota Treaty is suitable to
- Motor and Health classes of business
- Where the risks are very homogeneous
- Where the risks are small in size.

(2)

iv) The options the direct insurer has to place reinsurance for this risk are
- **(1)** Facultative reinsurance arrangement to operate before this surplus treaty to cap the losses at 11 crore. 11 crore is the maximum capacity provided by this surplus treaty. [11= (1+10)*1]

(2) Arrange a second surplus treaty with 9 lines (or more) to operate in parallel with the first surplus treaty with the same retention per line.

(3) Cede the maximum number of lines into the surplus treaty and pay the remaining share of any claims itself. (subject to the terms and conditions of the treaty)

(4) Decline the risk.

(4)

v)

In surplus treaty arrangement, the ceding percentage varies from risk to risk which is flat percentage in case of quota share reinsurance arrangement. In this case, it is most probable that the large limit risks have disproportionately heavy large loss experience. This means that the cedant is simply passing the larger proportions of the more hazardous risks to the reinsurer and keeping the less hazardous risks themselves.

Therefore the reinsurer has the following options to manage the same

- Cession flexibility has to be reduced i.e. now the cession has to be based on some strict underwriting rule like hazard category/score. High hazard means lesser cession and vice versa etc.
- Surplus capacity can be reduced by reducing the number of lines, etc. and instead the reduced capacity can be provided through non- proportional treaties.
- Surplus treaty can be completely replaced by non-proportional treaties like Gross excess of loss treaties, etc.

(4)

[13 Marks]

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