Institute of Actuaries of India

Subject ST8 – General Insurance : Pricing

May 2014 Examination

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.

Solution 1 :

The main reasons for monitoring the business written, covered in this section, are to:

- Assessing performance against the organization's goals: A general insurance company will monitor the business it has written 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 (for example, 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' strategies. It can also allow the company to compare itself with the market and assess the underwriting cycle.
- Market regulators may require periodic monitoring and reporting of written business.
- A company may be able to influence the market by publishing the results of its monitoring exercises.
- Assist with reserving: The outputs of any monitoring exercise can be used for other purposes such as an input into the reserving process.
- Validate assumptions as part of the actuarial control cycle.

[3 Marks]

Solution 2 :

  i. 100,000 less 10% = 90,000 as all the risk is in second quarter of the financial year i.e. July to Sep, UPR as on 31 March 2014 is zero. **[1]**

  ii. 150,000 less 5% = 142,500 as the risk starts at zero, and increases daily by a constant linear amount over the policy year the UPR as on 31 March 2014 is 75% of 142,500 = 106,875 106,875.

Working for 75%: As on 31st March 2014, 182 day's risk is expired and 183 day's risk is still with the company. As the risk starts at zero, and increases daily by a constant linear amount over the policy year the total risk can be calculated as follows:

Total Risk $= \frac{365*366}{2}\ units = 66{,}795\ units$

Expired Risk $= \frac{182*183}{2}\ units = 16{,}653\ units$

Therefore unexpired risk = 50,142 units i.e. 75% of the total risk

Note: Please allocate full marks if students use two decimals i.e. 75.07%.

[3]
[Total Marks-4]

Solution 3 :

Assume that the relativities given are exact i.e. there is no random variation and/or they are truly representative of the risk.

Car Group	Driver's Age	Exposure	Predicted Value	Total Response
Low	Old	8000	0.36	2880
Low	Young	20,000	0.6	12000
Medium	Old	10,000	0.6	6000
Medium	Young	10,000	1	10000
High	Old	12,000	1.44	17280
High	Young	200	2.4	480

One Way Tables:

Car Group	Exposure	Total Response	Predicted Value
Low	28000	14880	0.53
Medium	20000	16000	0.80
High	12200	17760	1.46

Driver's Age	Exposure	Total Response	Predicted Value
Old	30000	26160	0.87
Young	30200	22480	0.74

[5 Marks]

Solution 4 :

i. The substitution of one party for another as creditor, with a transfer of rights and responsibilities. It applies within insurance when an insurer accepts a claim by an insured, thus assuming the responsibility for any liabilities or recoveries relating to the claim.

ii. Moral hazard is the risk that an insured may act differently because of being insured, ie the policyholder may become less risk averse. For example, a policyholder may start to leave spare keys under the doormat after taking out household contents insurance because they feel less concerned about possible adverse consequences.

iii. A time limit, usually defined in the policy wording or through legislative precedent, placed on the period within which claims must be reported. It generally applies to classes of business where several years may elapse between the occurrence of the event or the awareness of the condition that may give rise to a claim and the reporting of the claim to the insurer, for example, employers' liability or professional indemnity.

iv. A policy clause that permits the insurer to raise automatically the level of benefits or sum insured (and therefore the premium) in line with some form of inflation index.

[6 Marks]

Solution 5:

Following are the risk factors:

    a. type of cover (whether only RTO requirement or more than RTO limits)
    b. excess
    c. the number of miles driven
    d. the density of the traffic where the car is driven
    e. the ability of the driver
    f. the speed at which the vehicle is usually driven and its general level of performance
    g. weight of the vehicle
    h. fire risk
    i. the use to which the vehicle is put (eg for business use)
    j. the age of the vehicle
    k. the occupation, gender & age of the policyholder and other drivers
    l. whether or not driving is restricted to certain named drivers
    m. make and model of vehicle
    n. the extent of any modification to the engine or body
    o. past experience.

Following risk factors can be used as the rating factors:

    a. type of cover
    b. excess
    c. the number of miles driven
    d. weight
    e. age
    f. engine capacity
    g. number of seats

Shall not to mention the following in risk factors:
a. the ease with which the vehicle can be damaged and the cost of repairing it
b. the theft risk

Shall not to mention the following in rating factors:
a. value of the car and its contents

[6 Marks]

Solution 6 :

The data published by the regulator in the given case has following issues due to which the same cannot be directly used for calculation of premium rates for the new product:

1. There is potential for distortions within industry-wide data, particularly owing to heterogeneity.

The possible reasons for distortions could be that companies operate in different geographical or socio-economic sections of the market and the policies sold by different companies' are not identical.

Also, as stated, the data relates to products which are covering 12 to 18 CIs and therefore the data supplied by different companies may not be precisely comparable in this case and cannot be used directly either for 12 CIs or 18 CIs.

2. The available data is much less detailed and less flexible and hence it will be more difficult to manipulate.

   The proposed entry age in the product is set to zero whereas the data covers ages starting from 18 only.

   In addition the proposed product has indemnity benefit whereas the data relates to life insurance business which works on fixed benefit and therefore the severity of the claims might not be easily available for which we need to look for some other source.

3. The data is out of date as the same relates to 2002-04.

Other general problems with using industry-wide data may be:
- The data quality will depend on the quality of the data systems of all its contributors.
- The companies will have different practices; for example, underwriting, claim settlement and outstanding claim reserving policies

[6 Marks]

Solution 7 :

Possible reinsurance arrangements

i. Quota share
   a. As a newly started company, it may need technical expertise in pricing, claim handling etc
   b. In such a case, the reinsurer may like to cede the product on quota share basis.
   c. For a newly started company, involving a reinsurer on proportional basis will provide confidence of correctness of premium rates
   d. Both insurer and reinsurer will share the fortune of profit or loss in this arrangement
   e. However, the insurer will be exposed be potential high claims from one risk (due to high sum insured up to Rs 10 Crore) and potential accumulation of risks which will need further reinsurance protection

ii. Surplus share
   a. Surplus share will help in protecting the claims from high sum insured lives above a certain retention level.
   b. If there is inuring QS, surplus will cover the net retained sum insured for every risk

iii. Risk XL
   a. Risk XL may also be bought. However as the SI for each risk is well defined, surplus will be better in this case

        b. Otherwise, there is a risk that the portfolio mix in terms of sum insured may not be as projected and hence will bring in an element of risk for both the insurer and reinsurer for incorrect pricing or reinsurance

  iv. CAT / Event XL

        a. This will be required to protect the insurer from large claims resulting due to accumulation of lives which get impacted from any one event – natural catastrophe or otherwise.

        b. The retention of the cover should be based on the risk appetite

        c. The limit should be based on potential accumulation of lives in any one group or in any one location

  v. Stop loss

        a. Stop loss cover may also be considered to cover the insurer from high claim ratio

  vi. Facultative

        a. The reinsurer may not agree to cede risks above a certain limit under the treaty. In such a case, all risks above the limit will need to be covered on facultative basis.

        b. Facultative may be both on proportional (surplus will be more appropriate in such case) and non-proportional basis.

[6 Marks]

Solution 8 :

Expected pure risk premium = 0.20 * 20000 = 4000

Expected number of claims = 1000 * 0.20 = 200

At 90% (P) probability of the actual pure risk premium to be within 10% (K) of the true mean, the number of claims for full credibility is

$$= \left(\frac{y}{k}\right)^2 * (1 + CV_X{}^2), where \ y = \Phi^{-1}(\frac{(1+P)}{2})$$

$$= \left[\frac{\Phi^{-1}(\frac{(1+0.9)}{2})}{0.1}\right]^2 * 1$$

$$= 271$$

So, credibility factor is = $(200 / 271)^{0.5} = 0.86$

The credibility weighted pure risk premium = 0.86 * 3500 + 0.14 * 4000 = 3570

Assumptions:

- Estimated number for claims for IBNR has been included in the actual number of claims reported.

- Any open claim at time of submitting the data has been assumed to be finally settled at the same amount.
- It is assumed that mix of vehicles will not chance in the next coverage year
- No loading for unusually large claims or a catastrophic event has been done.
- No inflation adjustment is required on the past year pure risk premium

[6 Marks]

Solution 9 :

For the given reinsurance arrangement the average cost per claim for the reinsurer can be calculated as follows:

$$\int_1^2 (100{,}000x - 100{,}000) * \frac{1}{8} * (4 - x)\, dx + \int_2^4 (100{,}000) * \frac{1}{8} * (4 - x)\, dx$$

$$= \frac{1}{8}\left(100{,}000 * \left[\frac{5x^2}{2} - \frac{x^3}{3} - 4x\right]_1^2 + 100{,}000 * \left[4x - \frac{x^2}{2}\right]_2^4\right)$$

$$= \frac{100{,}000}{8} * \left\{\left(\frac{15}{2} - \frac{7}{3} - 4\right) + (8 - 6)\right\}$$

$$= 39{,}583.33$$

The expected number of claims is 75; as the portfolio of 10,000 policies is expected to follow Poi (75). The reinsurer requires an expenses margin of 15% and a contingency margin of 10% of the premium.

The reinsurance premium is therefore given by:

$$= \frac{39{,}583.33 * 75}{1 - 0.15 - 0.10} = 3{,}958{,}333.33$$

The required assumptions are:
- claim inflation can be ignored
- reinsurer also agrees with the number of claims distribution and the claim amount distribution
- no further profit loading is required (assumed to be covered by the contingency loading)
- this reinsurance premium is before any profit commission arrangements.

[7 Marks]

Solution 10 :

Only motor policy is expected to be sold through online channel as complexities involved in selling fire insurance might result into lower take up rate for fire insurance through online channel. Therefore the fire insurance business might continue to be significantly sold through broking channel whereas significant portion of motor insurance business might come through online channel.

The mix of motor business might increase as only motor policy is expected to be sold through online channel.

The overall contribution from both agency and broking business is expected to come down to 50% as the target for online channel is set to 50% of the overall business.

New set of premium rates might be required for online channel to allow for following:
- The different level of expense and commission loading in online channel
- Different rating structure: Greater flexibility in data collection will enable potential new rating factors to be collected and tested.
- It should be easier and more cost effective to update these periodically to take account of new experience and more frequent updates will become possible.
- More extensive policyholder information can possible be captured via this medium by developing easy to use system.

There might be negative impact on the agency relationship as the premium rates might be lower for the online channel for the reasons mentioned above. This might result into difficulty for the agency channel in selling the similar product at higher premium rates offline.

The mix of business will change as those purchasing insurance via the internet will have different characteristics and the online customers are likely to be more sophisticated.

This might also result into different geographical spread as internet access is easily available in metro cities as compared to tier II or tier III cities.

Possibly increased proportion of policyholders in the age bracket of 20 to 40; thus an increase in the concentration of risk is likely.

Renewal rates may increase due to the ease of renewal via this medium and also due to the reason that the policy was being bought by the customer at first place rather than sold by a distributor.

[7 Marks]

Solution 11 :

(i) Risk Premium Calculation

FY	Number of Employees	Notified claims	Inflation Index	Inflation Adjusted Claim	% Development	Inflated Ultimate	Inflated Ultimate/Employee
2009-10	1,680	890	1.75	1,557	85%	1,831	1.090067
2010-11	600	400	1.52	608	75%	811	1.351889
2011-12	2,500	1,240	1.32	1,640	60%	2,733	1.093267
2012-13	2,800	750	1.15	863	30%	2,875	1.026786

Average Risk Premium/Employee (in '000): 1.14 and

Weighted Average Risk Premium/Employee (in '000): 1.09

Risk Premium for 2013-14   = No of Employees * Risk Premium/Employee
                                                  = 3,500 * 1,090
                                                  =3,815,000

[6]

(ii) Assumptions that are made in the above calculation:
- The data provided is correct particularly the estimated development factors are reasonable
- There is no significant change in the structure of company and in safety procedures/substances handled by the employees
- The employee count definition remains constant and there are no unusual losses in the data
- No change in the terms and conditions of the policy e.g. limits, deductible.
- Future risk profile is same as historic risk profile (age distribution, salary distribution, gender, occupation, geographical spread etc)
- Claim occur evenly throughout the year (all claims occurred in the middle on experience years and will occur in the middle of estimation year)
- The effect of unusually high claim year of 2010-11 has been spread evenly over the experience period (such years are expected to occur once in 4 years)

[3]

(iii) Limitations
- Use of Frequency-severity approach would provide greater accuracy and more information
- Only number of employees may not be the ideal exposure measure as the coverage is linked to the basic salary of the employees. Therefore wage-roll might be a better exposure measure for average claim and number of employees for frequency of claims.
- Any of the assumptions identified in (ii) may be incorrect; specially the assumption of "no significant change in the structure of company". The data shows that in FY 2010-11, there is significant reduction in the employee count which requires further investigation.

- Insufficient data to give full credibility.
- It is unlikely that the data is sufficient to give reasonable allowance for future large losses or may have heavy experience in the data e.g. unusual large losses
- The approach doesn't allow for trends in the data.

[3]
[Total Marks-12]

Solution 12 :

   i. Sources of risk and uncertainty

      c. Data errors
- May be of poor quality with not all fields captured and poor fill-rates of captured fields or with erroneous records
- Data may be inconsistent over time if there have been changes in claim processing for example
- Data for some benefits may not be available at all for which a judgment may need to be applied for parameters selection
- Data for certain perils and extreme events may not be available

      d. Modeling errors
- modeling error
- Parameter errors – inaccuracy of assumptions, statistical distributions, correlations etc
- Simulation errors

      e. Process uncertainty – specific to company
- Claim processing may change in future
- Claim reserving method may change leading to change in incurred claim experience during the year
- Large claims
- Catastrophic events
- Latent claims – a new court ruling may change the way claims are reported / settled
- Frequency / severity assumptions for a new benefit priced may not be as expected
- New tie-up with repair centers
- Change in fees of surveyors, lawyers etc will lead to change in allocated loss adjustment expenses

      f. Process uncertainty – systematic
- Claim inflation not as expected
- Economic environment may change significantly impacting the claim frequency / severity
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      g. External environment
- New buying behavior of customers – role of aggregators, brokers etc
- New court ruling for liability claims
- New technology for repairs of damaged cars

    h. Others
- o The actual product mix, customer segment mix etc may be different than expected leading to a different experience at portfolio level

[7]

ii. How to deal with the risks and uncertainty

    i. Loading for uncertainty

    j. Reinsurance

    k. Detailed discussions with claim personnel for future claim processing changes likely

    l. Do a reasonability check of the parameter estimates with market benchmarks and prior experience studies

    m. Get a peer review of the pricing done by an external actuary

    n. Try to get data externally for the ones not available

    o. Take help from reinsurers for pricing

    p. Have detailed discussions with sales, product and strategy teams for likely mix of business. Perform elasticity tests on the premium rates for likely change in mix due to premium rate changes

    q. Appropriate modeling techniques should be used to reduce modeling errors for example testing and validation of the model on a test data.

    r. Sensitivity and scenario tests should be done to check the most sensitive parameters and use commensurate resources to accurately estimate those parameters

[8]
[Total Marks-15]

Solution 13 :

i. Basis of cover: This insurance is most likely to be written on loss occurring basis as it is easy to determine with a loss event due to an insured peril occurred. **[1]**

ii. Vehicle-years **[1]**

iii. Claim characteristics:
- Reporting delay is expected to be small as the customers buy insurance themselves and would like to get compensation for the loss as soon as they come to know about it…
- The defects also are not expected to emerge over a long period of time. It is easy to establish as to when the defect occurred and whether it was within or outside the warranty period.
- After reporting, most cases are expected to be settled soon as there will not be much disputes in establishing the admissibility of the claim and the claim amount.

- Some disputes may arise in establishing if the warranty applies or not (for example if the damage is due to accident or if a repair was done by 'non-authorized' service center).
- The amount of claim is expected to be homogeneous with similar types of vehicles as there will not be 'large claims' such as a total loss in car theft or fire. However, if there are multiple faults, the overall cost of claim may be high.
- There may be some instances of accumulation of claims if a particular type of vehicle turns out to be prone to faults, giving rise to very high frequency of claims.
- Overall the delay and settlement pattern is expected to be short-tailed with most claims reported and paid within one year.

[4]

iv.   Risk and rating factors

a. Vehicle make and model

b. Age of the vehicle

c. Mileage

d. Number of drivers for the vehicle

e. Prior claims in the vehicle

f. Location (a proxy for weather conditions)

g. Sum insured

h. Deductible / excess

i. Number of years of manufacturer's warranty

j. Number of years of cover

k. Type of use of the vehicle

[4]

v.   Exclusions

- Accidental damage (likely to be covered in normal motor insurance)
- Wear and tear
- Defects due to misuse of the vehicle
- Some specified parts
- Manufacturer's warranty

[2]

vi.   Solution

The traditional motor policy is for one year while this policy will be from one to three year term

In the traditional motor policy the risk commences from day one of the policy, while in extended warranty, the risk commences after the manufacturer's warranty is over. If the manufacturer's warranty is over at the time of buying the policy then risk commencement is at the policy start date.

[2]

vii. Consideration while pricing and reserving
- Pricing:
  - o With sufficient amount of data available, frequency-severity method could be used for pricing
  - o However, due to up to three year cover, the expected pure risk premium will need to be estimated for all three years
  - o And possibly discount it to account for investment income
- Reserving
  - o IBNR can be estimated in traditional way by looking at the delay pattern and settlement pattern

UPR will need to be estimated for the remaining period of cover. This may be done in a similar manner as for life insurance products

[3]
[Total Marks-17]

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