

# **Institute of Actuaries of India**

## **Subject SP8 – General Insurance: Pricing**

### **November 2019 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:****i) Underinsurance:**

- In an Insurance contract when the sum insured is less than that required under the terms of the contract.
- Depending on the policy conditions, where underinsurance is proved to exist, insurers may be able to claim that the policy is null and void.
- Alternatively, average may be applied to claim amounts.

[0.5 marks each]

**ii) Subrogation:**

- 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.
- For example, the insurer will be responsible for defending legal disputes and will be entitled to the proceeds from the sale of damaged or recovered property.

[0.5 marks each]

**[3 marks]****Solution 2:****i) Deductible:**

- The amount which, in accordance with the terms of the policy, is deducted from the claim amount that would otherwise have been payable
- ...and will therefore be borne by the policyholder

[0.5 mark each]

**Excess:**

- The amount of a claim, specified in the policy, that the insured must bear
- ...before any liability falls upon the insurer.

[0.5 mark each]

**Franchise:**

- A minimum percentage or amount of loss that must be attained before insurers are liable to meet a claim.
- Once it is attained the insurers must pay the **full** amount of the loss.

[0.5 mark each]

- **Deductible** also reduces a **maximum sum insured** loss where excess doesn't
- Franchise pays out **full** loss or nothing at all

[1]

[1]

**[5 marks]****ii)**

- Franchise would reduce the proportion of claims below a threshold but wouldn't reduce claims that are only marginally above the threshold. [1]
- . . . and wouldn't reduce costs at all for any claims that do happen [1]
- . . . and would also introduce a significant adverse incentive for people to inflate claims to reach the trigger point [1]
- Thus Franchise is clearly inappropriate for product UW objective [0.5]
- Deductibles and excesses are similarly likely to remove the number of smaller claims [0.5]
- . . . deductibles would also reduce the overall sum insured for larger claims which the Product UW could just have set at a lower level if that was their objective [0.5]

- . . . and the difference would only take effect for claims where the sum insured is already insufficient [0.5]
- Overall an excess would seem the most appropriate basis [1]

[Max.4 marks]

[9 Marks]

**Solution 3:** Two types of reinsurance that can be used to reinsure a closed book of business:

**Adverse Development Cover**

- A reinsurance arrangement whereby a reinsurer agrees, in return for a premium, to cover the ultimate settled amount of a specified block of business above a certain pre-agreed amount.
- It protects the cedant from significant reserve deterioration on run-off business.
- Usually it is only possible to reinsure a layer above a specified amount, i.e. there is usually an upper limit to the cover.
- The reinsurer may also insist that the insurer has a small participation in the layer.
- Claims are usually still handled by the insurer and hence there are associated expenses.
- Reserves could be maintained by the insurer as opposed to being transferred to the reinsurer and helps the insurer benefit from the investment income generated from the investments backing these reserves.
- ....reinsurer could also request share on the investment income
- The insurer is exposed to the credit risk of the reinsurer, since the insurer remains liable to the insured parties for all claims within the block reinsured.

**Loss Portfolio Transfer:**

- An arrangement whereby the liability for a specified book of business is passed in its entirety from one insurer to another.
- Policyholders will be informed of this “novation” (the transfer of rights and obligations under a contract from one party to another).
- Novation is not strictly reinsurance since the new insurer is responsible for the liabilities in total from the date of the transfer.
- The original insurer will transfer the reserves and the remaining exposure to the new insurer.
- It is likely that there will be a premium in addition to the existing reserves (to compensate the accepting insurer for taking on the risk and for the cost of the transfer).
- This would normally include a claims handling service.
- Assets may need to be realised to pass across the value of the reserves to the accepting insurer (which is particularly important if there is mismatching or if tax gains / losses would be crystallised).
- If the new insurer defaults, this could damage the reputation of the original insurer.
- The transfer may require the buy-in of reinsurers where there are existing reinsurance arrangements covering the portfolio.

[0.5 mark each including type of RI covers]

[Max. 5 marks]

**Solution 4: Benefits of Spatial smoothing :**

- In a GLM model where a factor has too many levels e.g. Postcode, the model cannot be used effectively for predicting purpose. [0.5]
- Spatial smoothing allows the model to fit many values to the factors and then removes the noise from these predictions by adjusting the relativity to take into account the neighbouring values. [1]
- This improves the predicted values by taking into the credibility for the response in a single location. [0.5]

**Different methods of spatial smoothing are****[0.5 mark for each point]**

- Distance-based Smoothing
- It incorporates information about nearby location codes based on the distance between the location codes.
- The further away a location code, the less influence is given to its experience. This is true regardless of whether an area is urban or rural.
- It is generally used for weather-related perils.
- This method does not require any distributional assumptions in the algorithm.
- Adjacency-based Smoothing:
- It incorporates information about directly neighbouring location codes.
- Each location codes is influenced by its direct neighbours, each of which is in turn influenced by its direct neighbours.
- Distributional assumptions or prior knowledge of the claims processes can be incorporated in the technique.
- The algorithms are iterative and complex to implement.
- Natural or artificial boundaries can be reflected in smoothing process.

**[Max. 6 Marks]****Solution 5:**

- i) The main elements of claims risk and uncertainty are [0.5 mark each]:
- Variability in the size of claims at any time, and from one period to another.
  - The lengths of delays between the incidents giving rise to claims and the reporting and ultimate settlement of the claims.
  - Economic conditions – this class of insurance gives rise to claims that are influenced by economic conditions, whose changes are difficult to predict as regards both timing and extent.
  - Judicial decisions – “Court award inflation” poses great uncertainty to insurers.
  - Attitudes of policyholders to claiming.
  - Reinsurance risks – failure to comprehend the true coverage/limits of a reinsurance arrangement and therefore being exposed to risk in areas that were thought to be reinsured.
  - Accumulation of risk – could be geographical area.
  - Interpretation of wording in the policy document, potentially leading to additional claims needing to be paid.
  - Inflation and the consequential rates of escalation of claims.
  - Other valid reasons
- [Max. 4]**
- ii) The insurer will want to monitor its loss experience [0.5 mark each]
- to allow it to more accurately price its risks through experience rating.
  - In addition, the insurer will want to renew its more profitable policies. The insurer will need to ensure that it offers competitive rates on renewal to those policyholders that it wants to keep.
  - Since the insurer is not writing new business it will be concerned with maintaining adequate business volumes to cover operating costs.
  - If business volumes reduce too much the company will struggle to meet fixed expenses.
  - Monitoring loss experience will also allow the insurer to set up more accurate reserves.
- [Max.2]**
- iii) A policy is said to have lapsed if the policyholder was invited to renew the policy but chose not to do so.

- Hence:
- Lapse Rate = no. of lapses for the period/no. of renewals invited for the period

[1]

The risks faced by the Company in respect of lapses [0.5 mark each]

- As the acquisition of new business is generally more expensive than the renewal of existing business,
- ...new business expenses are usually spread over the expected loyalty period of customers.
- Hence the insurer faces the risk that there are more lapses than expected,
- ...and hence it will fail to recoup initial expenses.
- Higher than expected lapse rates could cause the insurer to struggle to recoup fixed expenses as these are spread over the expected number of policies.
- This is made worse by the fact that the insurer is closed to new business and cannot write new policies to recoup the expenses.

[Max.3]

[9 Marks]

**Solution 6:**

- i) Assuming the frequency and severity are independent, the expected aggregate loss =  $30 \times 200 + 10 \times 200 = 8,000$

The variance of aggregate loss =  $30 \times 40,000 + 30 \times 200^2 + 10 \times 40,000 + 10 \times 200^2 = 3,200,000$  [2]

- ii) As the link function used for both frequency and severity was the Log function, the relativities for the expected values can be obtained by taking exponential of the parameter estimates and base estimates for frequency and severity will be exponential value of the intercept term.

The following table gives the base estimates and the relativities:

	Frequency	Severity
Best Estimates	8.21%	36,315.5

Relativities for rating factors:

Factor	Levels	Frequency	Severity
Age	Below 25	1.65	1.49
Age	25-40	0.70	1.07
Age	41-55	1.00	1.00
Age	Above 55	0.64	1.09
Gender	Female	0.76	1.00
Gender	Male	1.00	1.34
Car Color	White	2.66	1.00
Car Color	Black	1.00	0.58
Area	Metro	1.00	1.00
Area	Non-Metro	2.23	0.46

[0.5 mark each to calculate Base estimates for frequency and severity, 0.25 marks for each correct figure in above grid]

[Max.6]

- iii) Pure Risk premium for female, aged 45 and insuring Black car in non-metro area:

Expected Frequency:  $8.21\% \times 1.00 \times 0.76 \times 1.00 \times 2.23 = 13.8\%$  [0.5]

Expected Severity:  $36,315.5 \times 1.00 \times 1.00 \times 0.58 \times 0.46 = 9,604.6$  [0.5]

So, the pure premium = 1,326.1 [1]

- [2]
- iv) Different components to be considered for determining the office premium: [0.5 mark each]
- Reinsurance cost
  - Expense Loading: Direct + Indirect and Fixed + Variables
  - Profit Loading
  - Investment Income

[2]  
[12 Marks]

**Solution 7:**

- i) **Sources of data the Company can use for pricing appropriately** [0.5 mark each]

- There are two primary sources of data, internal and external data sources.
- Since the Company is underwriting only commercial lines of business and hence it shall not have any internal data available which can be used directly for pricing personal lines of business.
- However, there might be certain part of the portfolio, the experience of which may be relevant for pricing purposes subject to suitable loadings and adjustments for risks associated with personal lines of business.
- Where the insurer has insufficient or unsuitable internal data, external data will need to be used.
- Consideration needs to be given how reliable the external data source is.
- External data may take the form of aggregate market statistics.
- Alternatively, we may obtain data from third parties,
- E.g. reinsurers or brokers.
- The reinsurer, which is providing reinsurance cover for the product, may be prepared to supply data and other information about the market as a whole, without giving away competitive information of any one of their cedants.
- For data obtained from external sources or from third parties, we should compare with the corresponding details for the policies the insurer intends to write, as far as possible:
  - the terms of policy cover offered;
  - levels of risk underwritten;
  - the loadings included for expenses and profit in the premium;
  - socio-economic differences.
- The risk grouping done by various insurers in the market may be different thus making it difficult to compare the experience of different insurers and the industry as a whole.
- We should establish the time period of the data so that we can make an appropriate allowance for inflation. It will be difficult to obtain much of this detail for many products.
- The insurer could also investigate the feasibility of purchasing an existing insurer that sells personal lines property

[Max.5]

- ii) **Challenges due to inadequate data in respect of pricing and sourcing business**

- Use of inadequate data for pricing could result in rates which could be excessive or deficient [1]
- This could result lead to insurer [0.5 mark each]
  - suffer underwriting losses if rates are too low;
  - suffer loss of market share if rates are too high;
  - attract undesirable risks causing deterioration in underwriting experience if rates for such risks are too low.
- Inadequate data could lead to wrong decision on the need for rate review [0.5]

- ...and hence rate to be charged. [0.5]
  - When we carry out the actual projections of the new rating requirements, inadequate data may distort the calculations. [0.5]
  - This may be due to errors in : [0.5 mark each]
    - the apparent size of the business in force, and its value expressed in exposure units and premium;
    - the apparent claims experience and its trends, on which the projected future costs are being based.
  - Moreover, the errors may distort the true distribution of the business between risk groups. [0.5]
  - This could have consequences if we decided to adopt a differential rating increase for each risk group. [0.5]
  - It could also affect the marketing strategy if certain risk groups appeared to be more attractive risks than they actually are. [0.5]
- [Max.6]**

**iii) The Company can mitigate the effects of inadequate or poor quality data**

- A prudent view of the future experience should be taken and this shall reflect appropriately in the pricing structure.
  - e.g. Conservative assumptions in the pricing models
  - explicit loading for uncertainty in the pricing models and full loading of the expenses
- Start with underwriting of the base/standard product until actual experience becomes available
- Use more reinsurance thus reducing the retention and hence risk
- Use scenarios analysis and sensitivity testing of the pricing models to the assumptions.
- Compare the rating reflected by the pricing model with the market rates for similar risks to assess the robustness of the pricing model. A “what if” analysis of rating model can be carried out for this purpose
- Regularly monitor the key statistics like business volume, premiums, business mix, claims causes in an attempt to spot the outlier or the unexpected business outcome and to take action at an early stage.
- The pricing model should be flexible enough to allow the change in rates quickly as the market demands
- ...or it becomes apparent to change the rates basis the regular monitoring rather than reviewing/changing the rates at fixed intervals.
- Consider selling through brokers and using a profit sharing arrangement so that the brokers have a financial interest in the success of the business.

**[Max.5]**  
**[16 Marks]**

**Solution 8:**

i)

Year	Rate Change Index	Inflation Index	Adjusted Premium	Adjusted Attritional claims	Adjusted large claims	Attrititional Claim ratio	Adjusted NAT CAT Claims	Total Claim ratio	RI profit excl. Profit Comm.
2015	100.00	100.00	200.03	113.74	-	56.9%	66.91	90.3%	-12%
2016	95.00	105.00	267.38	140.18	38.23	52.4%	-	66.7%	11%
2017	92.15	111.30	357.56	180.34	60.11	50.4%	120.23	100.9%	-23%
2018	92.15	119.09	425.31	224.72	78.65	52.8%	-	71.3%	7%
2019	94.91	126.24	500.85	286.20	31.80	57.1%	-	63.5%	15%
2020	99.66	133.81	100.00						
Total			1,751.14	945.18	208.80		187.13		

Rate change index for Year X = Rate change index for year (X-1)\*(1+Rate change% for year X). 100 for 2015.

Inflation index for year X = Inflation index for year (X-1)\*(1+inflation for year X). 100 for year 2015.

Adjusted premium for year X = Earned Premium for year X \* (2020 rate change index / rate change index for year X) \* (2020 inflation index / inflation index for year X)

Adjusted claims (both Attritional and Large) for year X = Unadjusted claims for year X \* (2020 inflation index / inflation index for year X)

Average attrititional claim ratio = sum of adjusted attrititional claims (from 2015 to 2019) / sum of adjusted premium (2015 to 2019) = 53.98%

Average large claim ratio = sum of adjusted large claims (from 2015 to 2019) / sum of adjusted premium (2015 to 2019) = 11.92%

CAT Loading = 5%

Expense ratio = 7%

Minimum Profit target = 2%

Maximum ceding commission payable = 1-53.98% - 11.92% - 5% - 7% - 2% = 20%

[8]

ii)

Year	Adjusted NAT CAT Claims	Total Claim Ratio	RI Profit
2015	66.91	90.3%	-12.3%
2016	-	66.7%	11.3%
2017	120.23	100.9%	-22.9%
2018	-	71.3%	6.7%
2019	-	63.5%	14.5%

Total claim ratio above is = sum of adjusted attritional, large and CAT claims over adjusted premium

Profit = 1 – total claim ratio – Expense ratio – Ceding commission

[4]

iii)

Year	Total Claim Ratio	Expense Ratio	Ceding Commission	Profit before Profit Comm.	<u>PC</u> <u>20%</u>	Profit after Profit Comm.
2015	90.3%	7%	5%	-2.3%	0.00%	-2.3%
2016	66.7%	7%	5%	21.3%	4.25%	17.0%
2017	100.9%	7%	5%	-12.9%	0.00%	-12.9%
2018	71.3%	7%	5%	16.7%	3.33%	13.3%
2019	63.5%	7%	5%	24.5%	4.90%	19.6%

Profit before Profit Commission = 1 – total claim ratio – expense ratio – ceding commission

Profit Commission = 20% \* profit, if profit is more than 0%

Profit after Profit Commission = Profit before Profit Commission – Profit commission

[4]

iv) Standard deviation of profits in (b) is 16.2% while it is 14.0% in (c). Hence, (c) will be preferable for costing actuary. Profit commission helps in reducing the volatility of profits for reinsurers.

[2]

[18 marks]

**Solution 9:**

i)

- The (ground-up) loss frequency is independent of the limit purchased
- The (ground-up) severity is independent of the number of losses and of the limit purchased

[2]

ii)

- In the Layer 300-500 with amount of 200 in the layer, the incremental ILF change is 0.25.
- While the incremental change is 0.80 for the layer 500-1000. Ratio of ILF change to layer amount is  $0.25/200$  in layer 300-500 while it is  $0.80/500$  that is more.
- This is inconsistent with the property of ILFs that they increase with increasing limits, but at a decreasing rate.

[3]

**[5 Marks]****Solution 10:**

i)

- Key Risks that the Company is exposed to and Insurance suggestions to cover the risk:
- Risk: Theft/Damage to company owned trucks and Third Party Liability due to usage of trucks  
Insurance Cover: Comprehensive Motor insurance for the fleet to cover both own damage and third party liability
  - Risk: Damage to stocks, both raw material and finished stock  
Insurance Cover: Marine insurance for goods in transit
  - Risk: Damage to workshop and contents of the workshop including the machinery  
Insurance Cover: Fire Insurance for building and content and Machinery breakdown damage cover for machinery
  - Risk: Damage to sales stores  
Insurance Cover: Fire Insurance for building and content
  - Risk: Accident at stores resulting in Injury/death to employees or customers  
Insurance Cover: Workmen Compensation/Employer's Liability cover specially for carpenters and support staff
  - Risk: Injury or accident caused to customers due to faulty manufacturing  
Insurance Cover: Product Liability Insurance for producing faulty furniture
  - Risk: Loss of business revenue  
Insurance Cover: Business Interruption cover in case damage to plant and /or machinery and the company is not able to produce goods  
Any other risk and corresponding Insurance cover

[8]

ii)

- The spread of business around the country will justify a premium discount if the chance of all events happening at the same time is lower than the chance of each risk event occurring.
- This will happen to a certain degree, but accumulations of risk still exist.
- Where spreading/diversification will reduce risk:
- It is unlikely that stock at different stores around the country will be affected at the same time,
- It is unlikely that different trucks will be affected at the same time while on the road.
- However, spreading will not be of benefit in the following situations:
  - Concentration of items at workshop (where most business is centralised), including machinery and stock.
  - If an event such as theft or fire occurs, it is likely that many items will be stolen or damaged in the same incident.

- Furthermore, any business interruption at the workshop will affect the whole business as stores will not get supplies.
- Concentration of vehicles if they are parked in the same place overnight. Similar to above, a fire or theft could affect a number of vehicles simultaneously.
- Greater distances travelled by trucks will result in greater exposure to risk as more time is spent on the roads.
- But while there are still accumulations present in the portfolio, it is more diversified than a single policy on a single property (for the same total value) for example. Thus, some level of discount is appropriate.
- However, the insurer should consider to what extent it has taken account of diversification already. One can argue that in a diversified book, all policies benefit from diversification through pooling, though individually they are not diversified policies.
- If the insurer has a diversified book, then a discount will be less appropriate.

[0.5 each, **Max. 5**]

iii)

- In formula terms, the suggestion is:  

$$P = E * P + C$$
 Where,  
 P = Premium to be charged  
 E = Expense Ratio  
 C = Non-expense item including claim cost
- This is a very simple approach of expense loading.
- However, it will lead to high expense loadings for high premium business and low expense loadings for low premium business
- ...which will lead to cross-subsidies between high and low premium business
- ...and a consequent risk of anti-selection.
- Also, the suggested method does not make allowance for:
  - inflation of expenses
  - changes in volumes of business
  - one-off charges
  - other trends from the base period associated with the statutory returns to the period for which the new premiums are to apply.
- The method makes no allowance for the different costs associated with the processing of new business, renewals, etc within an accounting class.

[0.5 each, **Max. 4**]

**[17 Marks]**

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