INSTITUTE OF ACTUARIES OF INDIA

Subject SP8 - General Insurance: Pricing

May 2024 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)

- Property will be subject to fire, lighting, storm, theft, flood and earthquakes. Being rural property, damage caused due to wild / domestic animals may also need to be covered.
- Crop insurance: Damage to disease, fire, storm, flood and drought.
- Health: Illness, injury, disability that may result in hospitalisation. The conditions may worsen due to occupational health hazards and lifestyle diseases.
- Personal Accident: Death, temporary or permanent, partial / total disability
- Any other valid point.

(Max 4)

ii) For a risk to be insurable:

- The policyholder must have an interest in the risk being insured, to distinguish between insurance and gambling.
- The risk must be of a financial and reasonably quantifiable nature.
- Amount payable by the insurance policy in the event of a claim must bear some relationship to the financial loss incurred.
- Individual risk events should be independent of each other.
- The probability of the event should be relatively small. In other words, an event that is nearly certain to occur is not conducive to insurance.
- Large numbers of similar risks should be pooled to reduce the variance and achieve more certainty.
- There should be an overall limit on the liability undertaken by the insurer.
- Moral hazards should be eliminated as far as possible.
- There should not be any anti-selection against the insurer.
- Unfairness in treatment between one policyholder and another to be avoided.
- Any other valid point.

(4)

iii) Being a package policy, each cover needs to be priced separately.

- Property insurance: The sum insured, premiums, claims paid for different perils during the last 5-10 years.
- Data of previous catastrophe events in the region.
- Simulation of catastrophe events for different return periods.
- Crop insurance: Premiums, claims grouped by type of crop, perils, and geographical region for at least previous 5 years.
- Claims experience of crop is likely to be diverse across years and geographical regions.
- Health insurance: Bordereaux of each policyholder with Sum Insured, premiums and claims split by with age, geographical region, grouped by disease / ailment.
- Reasons for hospitalisation with disease codes for at least 5 previous years.
- PA: Premiums and claims by cause of claim, death, permanent / partial / total disability, and reasons for the accident.
- Possible sources of data include internal data, industry data, tariffs available if any or data available with reinsurers.
- Any other valid point

(Max 6)

iv)

- Past data usually contain an element of randomness.
- The claims information in the past data may originate from risks that are likely to be different from those considered in the current pricing model.

- The claims may also be from a geographical region different from the region where the current product is intended to be distributed.
- The available data may not pertain to the base period appropriate for pricing.
- The data may be incomplete especially with respect to the reconciliation of claims and policy details.
- Look for any signs of corruption in data especially caused during extraction or cleaning.
- For internal data, appropriately account the claims department data for the IBNR / IBNER adjustments.
- Ensure the reasonableness of data by comparing with the recent year loss ratios.
- Ensure reconciliation of the raw data with the financial year / balance sheet.
- Need to ensure that appropriate adjustments have been made for any changes in cover.
- There may be a need to exclude large and catastrophic claims and make appropriate allowances for the attritional claims.
- Check if the data includes information for household contents also. If not, then obtain separate data for the same or price the policy on first loss basis if household contents are covered.
- Being a package policy, there are multiple claim causes, ensure the data is suitable for pricing each of the claim causes.
- Need to check for any accumulations in data and appropriate adjustments.
- Check if the data includes loading for expenses and commission.
- Ensure appropriate claims inflation, any changes in premium are correctly applied to the data before using the same for rating.
- Ensure credibility and homogeneity of data in each data cell.
- Ensure sufficient data is available to calculate frequency and severity over time.
- Especially for external data, ensure that the data is not truncated when passing through multiple software packages.
- Compare data with the own experience of the company and previous analyses if any.
- Ensure data is available to allow for different risk / rating factors to account for each of the perils.
- Any other valid point

(Max 6)

v)

- Credibility is an indicator of the accuracy and completeness of the data available for pricing.
- Credibility essentially means how much the actual experience is factored in the available data.
- The Credibility approach is to solve the problem of randomness in data by taking the weighted average of estimate based on past data and an estimate based on the current market data.
- Credibility theory is used to calculate the weightage to be assigned to the past data.
- The Credibility factor, Z is calculated assuming an appropriate probability like Poisson or lognormal. The factor (1-Z) applied to the collateral information is known as complement of credibility.
- Larger the size of data, lower the variability. Classical credibility is another method used to determine how many data points are needed to assign 100% credibility.
- Any other valid point

Method to ascertain the credibility of internal data.

- Using the method of classical credibility, based on certain assumptions, ascertain whether the available data is sufficient to assign 100% credibility. This will help determine the value of credibility factor Z. If the value is 1 then no collateral information may be needed.
- If using a frequency severity model, ascertain the value of Z separately for the frequency of assuming an appropriate distribution. E.g. Poisson.
- Similarly, the full credibility of severity needs to be calculated for the average size of the claims assuming a suitable distribution. E.g. standard normal or lognormal.
- Since the aggregate losses or loss ratios depend on the number and size of claims, the full credibility for the same is usually larger than that of frequency or severity.

- Lower the variability of claims, higher the credibility assigned to the data.
- In case the value of the credibility is less than 1, then supplement the data with external information and arrive at the final estimate as the weighted average of the two estimates.
- More years of data possibly from wider geographical regions may be used for higher credibility but at the cost of relevance of the same for the current product being priced.
- Another method to increase credibility of the estimate is to give more weight to more stable phenomena. E.g. Property damage cost vs bodily injury claims. Medical costs vs death claims etc.
- Any other valid point

(Max 6)

vi)

- Climate change refers to the long-term variation in average temperature and its effect on the weather pattern.
- From an insurance perspective, climate change results in increasing latent claims that will be reported to the insurers in future.
- It is likely to result in higher frequency and intensity of extreme weather events like cloud bursts, heat waves, floods, cyclones, droughts etc.
- The increased hazards are likely to result in increased claim costs.
- Climate change usually affects the insurability of certain types of risks. E.g. uninsurable infrastructure in coastal areas.
- It is likely to affect the demand, availability, and affordability of reinsurance.
- Insurers may face changes in risk profiles and emergence of newer risks that may necessitate newer products, a review of the existing product terms and pricing. E.g. battery-operated vehicles compared to those run on fossil fuels.
- Political / Peer pressure to withdraw cover to companies that contribute to climate change. E.g. Coal, petroleum etc.
- Environmental Social and Governance (ESG) issues in investments especially in those companies that may seem contributing to climate change. E.g. Coal, fossil fuels etc.
- This may constrain the investment options, thereby achieving lower than optimum investment returns and hence the insurance P&L.
- Emergence of newer liability risks like litigations related to contribution, mitigation, or disclosure of climate risks faced by companies.
- Unavailability of data to price and reserve for the risks due to the impending latent claims.
- There may not be enough long-term investment options available to match the tail of impending latent claims resulting in Asset Liability mismatch.
- Sophisticated simulation software packages like catastrophe models may be needed to price standard covers like Property. Procurement of the same may result in higher expense ratios.
- Any other valid point

(Max 8)

vii)

- Higher average temperatures may result in heat waves that are likely to increase the fire risk of dwellings. Especially the rural households.
- Higher possibility of floods, downpour and inundation affecting the dwellings, property, and crops.
- Higher probability of droughts affecting the crops.
- Even in the absence of any weather-related events, the yield may be lower than expected due to climate change resulting in higher claim payouts.
- Likely increase in health claims due to weather related illnesses, poor air quality, spread of diseases, pandemics etc
- Higher utilisation of health care infrastructure especially in rural areas that may result in demand surge.
- Higher demand for specialised treatments resulting in higher cost.

- Higher incidence of physical injuries and mental health issues due to weather related events.
- The climate change is likely to affect not only humans but property also as covered under the package policy.
- Any other valid point

(Max 4)

viii)

- Claims inflation is likely to be different to different types of claims. The inflation affecting the rebuilding cost of property may be different than the health care inflation.
- The product is likely to be 'small ticket' with higher volumes. This makes it labour intensive for distribution, claims survey etc if not written as a benefit policy.
- Higher costs of distribution and claims management may affect the profitability of the product thereby affecting the payment of claims.
- Delays in receipt of subsidy from the government may affect timely payment of claims and investment returns.
- Demand surge especially after a weather related or catastrophe event affecting a large geographical area.
- Moral hazards resulting in higher claim payments.
- Underinsurance leading to higher claims payments per unit exposure.
- Unusual weather patterns leading to higher frequency and severity of claims.
- Being a government mandated product distributed across the country, there are likely to be limitations to pure technical pricing.
- Also, there may be political interference resulting in higher-than-expected claim costs.
- Any other valid point

(Max 4)

ix) Actuarial investigation of a product is needed to compare the actual experience with that expected during the launch of the product.

- Being a package product, the experience of each of the parts need to be analysed separately.
- Analysis of each type of claim in the group by risk / rating factors relevant to the cover
- Monitor the volume of business by geographical region, income group, age, band, gender etc.
- Ensure the minimum volume of business is underwritten to ensure breakeven / required profitability.
- Need to analyse the business performance by distribution channels.
- Need to analyse the commissions paid for different distribution channels.
- Analyse the persistency of the product, lapses / renewals.
- Analyse any Mid-term cancellations, reasons for the same.
- Delays in receipt of premiums if any and the related impact on investment income.
- Compare own experience with the competition.
- Actuarial investigations should include the adequacy of premiums, emerging loss ratios and the actual expenses incurred compared to the pricing assumptions.
- Analysis of expenses by type, region, fixed, variable etc.
- Analysis of each cover to understand cross subsidy if any.
- Investigations are needed to validate the risk / rating factors.
- MIS reports on the sustainability of the product.
- Actuarial investigations are needed as feedback for reserving.
- Investigation needed to affect changes in premium rates if any.
- Investigation is needed to assess the impact of this particular portfolio on the overall financial result of the insurer.
- Any other valid point

(Max 8)

[50]

Solution 2:

i)

- Aggregate deductible is the maximum amount that the insured can retain within their deductible when all losses are aggregated.
- Individual deductible is the amount retained by the insured for each loss. This is further divided into three. The ranking deductible that contributes to the aggregate deductible, non-ranking deductible that does not contribute to the aggregate and the trailing deductible.
- Trailing deductible is that retained by the insured for each individual loss once the aggregate deductible is fully eroded.
- Per occurrence limit is the maximum amount that the insurer can retain for each individual loss.
- Annual aggregate limit – This the maximum amount that the insurer can retain when all losses for an annual policy period are aggregated.

(Max 5)

ii) The insured has reported five losses to the insurer amounting to 500 Cr.

Following is the split of the losses between the insured and insurer based on their terms of contract.

							Amount in Lakhs
Loss No	Claim amount reported to the insurer (a)	Individual deductible (ranking) (b)	Trailing deductible (c)	Loss to insurer (d)	Loss to insurer (Limited to per occurance limit) (e)	Net loss to insurer (Subject to annual aggregate limit) (f)	Loss retained by insured (g)
1	56	7		49	49	49	7
2	123	7		116	100	100	23
3	133	7		126	100	100	33
4	156	4		152	100	51	105
5	32		5	27	27	0	32
Total	**500**			**470**	**376**	**300**	**200**

Following is the split of losses between Insured, Insurer, and reinsurer.

Contract between Insured and Insurer	
Total loss amount reported to the insurer (a)	**500**
Loss amount retained by the insured (g)	200
Loss amount payable by the insurer (f)	300
Contract between Insurer and reinsurer	
Loss payable by insurer to insured (f)	300
Obligatory recovery from reinsurer (10%)	-30
Loss reported to reinsurer under XL Treaty	270
Excess of loss recovery (Max of 4 Cr Xs 1Cr)	-170
Net loss to the insurer	100
Overall Result	
Loss payable by the Insurer	100
Loss payable by the reinsurer	200
Loss retained by the Insured	200
Total Loss	**500**

(Max 6)
[11]

Solution 3:

- Original loss curves are a method of exposure rating of General Insurance contracts.
- They are often used to derive premium rates where past claims data is too sparse to derive a credible price estimate using traditional techniques.
- Original loss curves are derived from the probability distributions of the losses underlying similar contracts appropriate to the risk being priced.
- It needs to be ascertained what components of loss are covered in the loss curves. The basic assumption is that, only the pure loss cost or indemnity is included in the curves.
- They help calculate the ratio of pure loss cost at different levels of deductible or excess.
- First loss scales, Increased Limit Factors (ILF) and Excess of loss scales (XL scales) are some of the commonly used forms of original loss curves.
- However, a key challenge is to select the curves that are most appropriate to the risk being priced as the resulting expected claim cost is very sensitive to the selected model.
- Differences in claims environment or jurisdiction or differences in coverage are the common sources of heterogeneity in the curves.
- An ideal method to overcome this difficulty will be to derive separate curves for each peril or coverage.
- However, the same will be challenging due to the unavailability of huge amount of ground up data for preparation of the curves.
- A fair assumption underlying the curves is that the effect of inflation is similar for all loss sizes which may not necessarily be true.
- The premium calculated from for excess of loss layers is often credibility weighted with experience rates wherever available.
- The loss cost for the required layer calculated from the curves is then loaded for expenses and profit to obtain the office premium.
- In addition to the pure loss cost, sometimes allocated loss adjustment expenses (ALAE) and / or unallocated loss adjustment expenses (ULAE) at each limit are also calculated using the curves.
- Any other valid point

[Max 6]

Solution 4:

i)

- The young tech savvy customers may be demanding personalised cover which the standard product is not able to offer.
- In a comparative world, customers are likely to choose the lowest priced product with similar benefits and hence our product may not be the preferred one.
- The traditional insurance pricing uses a cost-plus model that relies on past data suitably adjusted for the emerging trend.
- The rating factors used in calculating the premium are pre-fixed or static. This results in fixed bucketed rates for specific groups of insureds. E.g. The premium may be fixed by age-band and geographical region.
- The competitor products may be specifically designed for sale through the online platform.
- The competitor may be using a dynamic pricing model to arrive at the premium based on the profile of the prospective policyholder.
- The acquisition cost and associated expenses may be specific to the platform for the competitor products while the standard product may have included average costs in pricing.
- The other products may be designed specifically for the target population.
- The pricing of competitive products may be specific to the age band of the target population without any cross subsidy.

- In addition to the indemnity and other benefits structure, there may be wellness and other benefits included in the policy structure.
- The website may be able to compare even minor benefits and rank them based on the needs of the visitors. Hence a standard product may not be preferred.
- The competitor may be using methods to promote the product specifically for the target population.
- Any other valid point

(Max 6)

ii)

- Investment in data infrastructure to collate huge amounts of data about each prospective customer and use the same in pricing.
- As data about each visitor to the online platform is available, you may attempt dynamic pricing.
- But the same will need huge amount of data to calculate the dynamic premium correctly.
- Information like occupation, height, weight, any lifestyle diseases, etc inputs may be used to personalise the premium for each customer.
- Not only physical parameters, but pricing can also be based on the behaviour of the insured.
- Artificial Intelligence (AI) and other self-learning algorithms may be deployed to calculate the dynamic premium.
- Data from smart watches or other wearable devices could be used to provide wellness benefits upon maintaining certain health parameters.
- Based on the ongoing performance of the insured, premium discounts may be provided on renewals.
- This could also help reduce claim ratios of this portfolio thereby helping to reduce the cost further.
- This will help to personalise the health product.
- One of the latest concepts is to offer a price near to customer's willingness to pay thereby achieving higher persistency and creating lifetime value to the customer.
- Even the data collected in respect to 'lost business' or quotes that are not converted may be analysed to understand the reasons for the same.
- Any other valid point.

(Max 6)

iii) The two main approaches to machine learning are.

1. Supervised learning: In this approach the model is trained on examples that are clearly described or 'labelled' data. The model then uses the patterns so learned to make predictions on unlabelled data.

2. Unsupervised learning: In this approach, the model learning takes place on unlabelled data itself. The model itself seeks to find the structure or patterns hidden in the data.

Examples of machine learning models

1. Generalised Linear Model (GLM)
2. Gradient Boosted Models (GBM)
3. Artificial Neural Networks

(Max 4)
[16]

Solution 5: Stop loss is a form of excess of loss reinsurance that indemnifies the cedant against losses that exceed a certain amount or percentage of the premium income during a specific period.

- Stop loss reinsurance is used to smoothen the financial results of an insurer by capping the incurred loss ratio.

- Stop loss cover may be purchased to protect one or more classes of business or for the whole account.
- As stop loss cover responds to aggregate losses that includes attritional, large and CAT losses during the period, it is often risky and challenging to price the same.
- Stop loss covers are often expensive and hence it is preferable to undertake a cost-benefit analysis before purchasing the same.
- The excess point and upper limit are often expressed as a percentage of the cedant's premium income. E.g. an excess point of 120% up to 140% loss ratio.
- In addition, the reinsurer may not cover the entire claim in the layer. E.g. only 80% of the losses in the range 120% to 140% may be paid by the reinsurer.
- Any losses in excess of the upper limit will again fall back to the cedant's net.
- Unlike XL reinsurance, the limits are often expressed in terms of loss ratios to prevent the cedant from writing more business at lower premiums.
- Stop loss is not a preferred mode of coverage as reinsurers have limited control on the underwriting standards of the cedant.
- Hence historically stop loss covers are loss making for the reinsurers.
- Reinsurers often impose higher deductibles on the cover to avoid any moral hazard.
- Hence in the short term, it is preferable to analyse each of the portfolios and purchase other forms of reinsurance like surplus or XL as needed.
- In the medium to long term, the company will need to analyse each of the loss-making portfolios and change the strategy to achieve profitable growth.
- Any other valid point.

[Max 7]

Solution 6:

i)

- Spatial smoothing is a method of grouping of more than one level of a factor based on past experience.
- The assumption underlying spatial smoothing is that the areas physically close to each other will have similar experience.
- Smoothing allows a GLM model to fit multiple values to a factor after removing random element of past experience usually termed as 'noise'.
- Smoothing improves the predicted values by taking to account the credibility of response in a region.
- Any other valid point.

(Max 2)

ii)

- The two forms of spatial smoothing are distance-based and adjacency-based smoothing.
- Distance based smoothing incorporates information from a nearby location based on the distance between them.
- Further the distance, lesser the influence and lower weight is assigned.
- In this type of smoothing only distance is considered.
- Any other feature of the location like the terrain, boundaries etc are ignored.
- For example, while modelling theft in a property portfolio, two nearby areas separated by a river may not be affected in the same way.
- Hence sometimes grouping them together may not sometimes be meaningful even while considering the effect of a peril like flooding.
- Distance based smoothing methods are often employed for weather related perils.
- Distance based smoothing is easy to understand and implement.
- Can be enhanced by amending distance metric to other dimensions like Latitude /Longitude
- As the name indicates, Adjacency based smoothing incorporates information about the nearby locations.

- There is a proximity effect as each location that is affected by its immediate neighbour.
- It is possible to incorporate distributional assumptions and prior knowledge of claims in this technique.
- Hence the algorithms are complex to implement.
- Natural and artificial boundaries are automatically reflected in the smoothing process.
- Any other valid point.

(Max 4)

iii)

- The main perils affecting property portfolio are Fire, theft, flood and subsidence. Postcode may not be a relevant factor for these perils.
- For example, for two adjacent postcodes the level of theft may not be the same if separated by a river.
- Similarly, while using different levels of a factor like Postcode, it needs to be borne in mind that the areas coved by a postcode are not uniform across the country. Urban postcodes tend to be smaller than rural ones.
- The area under a postcode may not have the same terrain in the country and hence the effect of the same peril may be different at different areas.
- The same postcode may have entirely different experience at two extreme ends. Flood in one and drought in other.
- May be suitable for non-weather-related perils.
- For large rural postcodes, the effect of weather may be different. Say flood in one area may not affect the other.
- Similarly for subsidence, the soil quality may be different for the same postcode.
- Any other valid point.

(Max 4)
[10]

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