

Institute of Actuaries of India

Subject SA3 – General Insurance

May 2011 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

Q1.]

i)

The usefulness of a commercial package policy is the ability to deliver value to large risks and generate premium volume at a lower production cost for the insurer. The insurer benefits from the consolidation of claim management processes and will be able to provide risk management services to the insured, thereby reducing the loss costs.

The covers should be chosen on the basis of their capacity to generate premium volume. For state Transport organizations, these are Motor TP, Motor OD, (Motor Comprehensive will be counted as two depending on how the answer is structured) Health cover for employees and their families, and Workers Compensation.

The candidate is expected to provide a simple calculation of total premium that can be generated from a single account based on reasonable assumptions about exposures and rates.

For example, an assumption of around 1,000 buses will translate to around 1200 drivers, 1200 conductors, 300 mechanics, etc to say around 3,000 employees. At around 5,000 to 6,000 per bus, 3,000 per employee healthcare exposure, and augmented by WC premium, the total premium volume that can be generated from such an account can easily exceed 2 crores.

Candidates were not able to provide such an analysis. Partial credit was awarded for naming any four covers needed by a state transport corporation and describing their characteristics.

ii)

The answer to this question should be consistent with the covers identified for 1.i above.

Motor TP: Number of trips and number of passengers per trip are two key exposures to price this cover. Historical data should be available on number of trips and total number of tickets sold. However, tickets by route/trip combination may not be available. Here, proxies will have to be worked out based on average collection per trip, average ticket price in a trip, etc. In theory, the underlying "amount collected" data should be audited and accurate. However, the actuary should focus on setting up reconciliation checks. Such exposure data will be best suited to estimate frequency parameters.

Motor OD: Number of bus trips by bus class and age of bus will be the best exposure measure to price this cover. Again, an audited data set should be available on the number of busses by bus class and age. What is unlikely to be available is the number of trips by a bus. A proxy may be needed to estimate this number -- one such proxy will be revenue per trip obtained from aggregates. This exposure is best suited to estimate the frequency parameter.

Note: The above two answers required an "outside the box" response from the candidates. Credit was awarded as long as the answers were consistent.

Employee Healthcare: Persons covered by age, sex, and pre-conditions will be the best exposure measure. The information on the employee will be relatively accurate because they

can be cross-verified per the corporation's HR records. However, the same cannot be said about "dependant information". Hence, population averages should be used to verify the reasonableness of the dependant data. Frequency measures by age/sex can be estimated from this exposure data.

Workers Compensation: Payroll and number of employees by employment class will be the best exposure. This information should be relatively accurate from the corporation's payroll information. Payroll data will be useful for estimating the characteristics of the benefit payments while employee numbers will be useful in estimating the frequency of accident parameters.

Note: Credit was awarded to similar analyses for the selected covers.

iii)

Rajasthan and Kerala

Rajasthan is a large state with low to scanty rainfall and a low population density. There will be many more rural trips than urban trips. Given the low population density, the average ridership in a trip is likely to be lower. Primary weather effects will be in the summer due to the desert winds. Monsoon can create problems but that will be a rare event. Most likely, the accidents will be due to excess speeding in the desert and in such cases, the potential for death claims and total destruction of the vehicle is higher.

In contrast, Kerala is a small state with a very high population density, heavy traffic, high bus usage. Kerala also faces a heavy monsoon season and has a mountainous region. Given the traffic density, we are likely to see more frequent but low level accidents -- dents on the buses and minor injuries.

Thus the two states complement each other in terms of loss exposure -- low freq/high severity in Rajasthan and high freq/lower severity in Kerala. This exposure mix should smoothen the overall loss experience.

Note: Credit was awarded to answers that were consistent with the conditions in the chosen states

iv)

The insurer should consider quota share insurance and per occurrence excess insurance.

The Q/S contract would reduce the total risk carried, provide a commission income that will add to the profitability of the book (given the low production cost), and reduce the capital requirement.

The excess cover will provide protection against large losses -- for example when a loaded bus crashes into a speeding train in an unmanned level -- crossing. The optimality of an excess cover is well-known.

[25 Marks]

Q2.]

i)

Frequency and severity have to be estimated to price this product.

Per problem statement, this product will provide cover only in a select chain of hospitals. This condition implies that the insurer will have access to the chain's cost and patient characteristics records. Note that patient identity is not needed for this analysis and hence patient privacy laws will not be violated. In turn, the necessary information needed to estimate the cost of the procedures, the cost of stay, the cost of medication, etc and relate the costs to patient characteristics (age/sex/pre-conditions, etc) will be available. In other words, the severity function can be derived from hospital data.

Frequency estimation will be far more complex. The underlying pre-conditions provide an insight to the frequency. For example, high Blood Pressure and Diabetes will be good predictors of heart surgery. Relating these causal variables to their incidence in the population will be a way to estimate frequency. Hence, population health data is another major source that should be tapped to price this product.

ii)

This cover's experience will exhibit a "low frequency" and a "high severity" loss structure. In addition, multiple factors will impinge as causative factors. The same factors can act differently on frequency and on severity. For example, frequency can be expected to increase uniformly with age whereas severity can exhibit a "U" shape – because the procedures can lead to more complications in the "very young" and the old. Hence, multivariate methods should be preferred over single variable methods.

In addition, the traditional triangle method of estimating ultimate losses will not be stable.

GLM procedures offer a good option to estimate the price.

iii)

Candidates should have identified a discrete distribution for modeling frequency and a continuous distribution for modeling severity. Both distributions should belong to the exponential family so that GLM methods can be applied. The discussion should be specific to the distributions selected by the candidates. Care should be taken to explain how the distribution chosen for frequency will model the low frequency and the almost non-existence of a second claim during a policy period. Similarly, the properties of the severity distribution should be discussed with respect to the potential of very large losses.

Typical Frequency Distributions:

Binomial -- needed to have explained reasonable values of the parameter.

Poisson -- needed to have evaluated the likelihood of more than one claim per exposure period

Negative Binomial -- Needed to have explained the validity of this selection

ODP -- Needed to have explained the benefit of modeling variance in a normal Poisson

Severity Distributions:

Any of Gamma, Log-Normal, Beta could have been selected. The role of the skew in the distribution should be explained.

iv)

The answer to this section should be consistent with the chosen distributions -- one for frequency and one for severity. The candidate should demonstrate the ability to handle link functions appropriately. The structural equation used in the estimation process should be presented. The role of the predictors should be explained.

The frequency distribution is a discrete distribution and can be effectively modeled in most situations with a single parameter. For example, if the Binomial distribution had been chosen, then the link function would have been the "Logit" function: $g(m) = \log \{m/(1-m)\}$ etc. If the Poisson distribution had been chosen, then the link function could have been the "log" function: $g(m) = \log(m)$.

The severity distribution would be a continuous distribution. The "Inverse" function would have been the link function for the Gamma distribution: $g(m) = 1/m$. If a "lognormal" had been chosen, then one should observe that the lognormal can be generated by transforming the dependant variable values into their appropriate logarithms and assuming a normal distribution. In this case, the identity function would have served as the link function.

The linear predictors should be specified. For example, age, male, female, HBP (high blood pressure), D (Diabetic), HBP/D interaction can be used as predictors. In this selection, age would be a continuous variable, whereas all the other variables are categorical variables. For example, the combination (40,1,0,1,0,0) would represent a male aged 40 who suffers from high blood pressure. In this example, the person is not marked as a diabetic and hence the interaction indicator is also set to zero. The candidate should have explained how to interpret categorical variables and how they effectively represent classes.

[25 Marks]

Q3.]

i)

Financial condition report is supposed to give an over view of the current financial condition of the GI company and also project its financial condition and viability in to the future.

The analysis to be included in the report should aim to help the Appointed Actuary come to an independent opinion of the financial 'health' of the company at present and also in the future time period as required by the regulator.

The financial condition report analysis can be segmented into five broad analysis

- i) Adequacy of premium
- ii) Adequacy of reserves
- iii) Risk management system
- iv) Cash flow condition and investment strategy
- v) Adequacy of Capital and Scenario testing of various stress scenarios

1. Adequacy of Premium

Loss Ratios:

- Loss ratios to be analyzed for each line of business.
- The loss ratios for the past years and the immediate year on review to be checked for trends.
- Loss ratios may be affected by large losses / CAT events, hence normalization of the large losses has to be done to check for premium adequacy across the years.
- The premium should also be able to support large losses across the years, for this loss ratios across the years may be summed up and studied for adequacy. This may also be checked with the assumption used in pricing of the product to cover for large loss.
- The loss ratios may need to be studied product wise and across the various rating factors to understand if there is any cross subsidization and / or to what extent the loss ratio is dependent on the mix of business.
- For commercial lines of business the loss ratios may also be studied along with rate plan movement and hence a check on accuracy of premium rates be carried out.

Commission Ratios:

- Product wise / channel wise commission ratios : to be checked for consistency with the pricing assumptions.
- Commission ratios to be checked for compliance with regulatory guidelines.

Expense Ratios:

- Detailed expense analysis to be done including activity based allocation of expenses.
- Analysis of the past expenses including any significant abnormal expenses and expectations regarding future expenses

Pricing Process:

- Detailed analysis of the pricing process – frequency of price revisions, monitoring of the experience and feedback into the pricing of the products
- Targets for profit margin and capital growth assumed in the pricing of the products and the monitoring of the same from the product performance.

Pricing Sophistication:

- Availability and accuracy of technical premiums based on GLMS and / or other technical foundations

- Implementation of technical price across products / channels and impact of profitability. Source of data for the above analysis would be the premium data base, claims data base and the commission and expense data bases. The data may be extracted from the centralized database through queries appropriately written by the IT team.

2. Adequacy of Reserves :

- It would also help to study the claims philosophy and the claims reserving policy of the company to understand if there has been any fundamental changes to the company's claims settlement process.
- Analysis of the outstanding claims utilization to check the adequacy of the claims liability at various reporting periods.
- Loss development triangle to study the adequacy of the past claims reserve including case reserves and IBNR claims reserves
- Standard claims reserve amount , number of claims under standard claims reserve and the adequacy of the standard claims provision for each class of business.
- Closure of claims with nil payment and subsequent reopening of the claims for each line of business.
- For long tail classes like motor TP claims adequacy of claims reserves and IBNR reserves to be done with the help of industry data, where ever applicable.
- Claims inflation analysis both on short tail and long tail claims will give an indication about the robustness of the claims reserves.

Majority of the data for the analysis in this section would be provided by the Appointed Actuary's report on IBNR claims reserves, which is submitted every year to IRDA. Any further information may be collected from the

3. Risk Management system:

Risk Management System

- We may like to study in detail the risk management system and philosophy which the company follows
- The risk matrix and the methods of quantification of the risks
- The various risk mitigation strategies followed by the company.

Reinsurance

- Analysis of the reinsurance program is also a critical area. The maximum retention in cases of large loss and / or CAT loss to be studied to check for capital adequacy status of the company.
- Analysis of the reinsurance retentions over the years would help us in getting greater insights into the business philosophy of the company.
- Analysis of the gross and net loss ratios line of business wise also throws light on the performance of the company and its future prospects in getting favorable reinsurance treaties.

4. Cash flow and investment strategy

Cash Flow:

- The cash flow statement for each line of business would help us analyse the cash flow generated by each line of business and if there exists any cross subsidization across products which may lead to a potential problem in future.

Investment Strategy:

- Any mismatch of the investments with liability with respect to term and currency could result in a adverse financial condition of the company. Hence we have to study the duration of the portfolio in line with the duration of the liabilities.
- Though there is regulatory control on the investment portfolio, it is still important to do an independent evaluation of the investment portfolio and to ensure that the regulatory prescription is followed.

5. Adequacy of Capital and Scenario testing of various stress scenarios

- Statutory capital position of the company in the last two years and the consistency of applications of various statutory guidelines across the years to be studied.
- However, it would also help if economic capital for the company is worked out based on internal capital modeling work. This would ensure that the actual capital position of the company is understood by the stakeholders and appropriate actions may be taken.
- Based on future business plan, various scenario tests can be carried out to test the adequacy of the capital. In cases the analysis throws up large capital requirements on occurrence of certain events, we have to bring it to the notice of the shareholders and ensure that they understand that there could be events leading to increased capital requirement.

Conclusion:

- The financial condition report is for the whole company, hence the final view has to be a collated view across all the five analysis that is described above.
- Over and above the broad areas mentioned, many times, it helps to study the external environment e.g competitors, underwriting cycle and emerging regulatory environments to understand the uncertainties that lie ahead for the business.
- The financial condition report is dynamic in nature and hence, it is to be left to the Appointed Actuary to update the report every quarter with his / her latest view on the financial health of the organization.

The Board has also asked you to develop a non-parametric 'Early Warning System' to help the Board and Senior Management detect financial weakness of the company before it actually happens.

- ii) Outline the analysis you would include in the Early Warning System and the ranges of value outside which the Warning System will be triggered

Analysis to be included

1. Profitability Tests :

- a. **Combined Ratio** : measures the UW profitability. A combined ratio below 100% indicates that the company has made UW profits. However combined ratio can only partially measure the profitability of the business since it ignores the investment income.
- b. **Operating Ratio** : Takes into account the investment income. It is calculated as the difference between the combined ratio and investment income.

2. Leverage tests

- a. **Net Leverage** : The sum of a company's net premium written to policyholder surplus and net liabilities to policyholder surplus. This ratio measures the combination of a company's net exposure to pricing errors in its current book of business and errors of estimation in its net liabilities after reinsurance, in relation to policyholder surplus.
- b. **Ceded Reinsurance Leverage** : The ratio of the reinsurance premiums ceded, plus net ceded reinsurance balances from non-US affiliates for paid losses, unpaid losses, incurred but not reported (IBNR), unearned premiums and commissions, less funds held from reinsurers, plus ceded reinsurance balances payable, to policyholders' surplus. This ratio measures the company's dependence upon the security provided by its reinsurers and its potential exposure to adjustment on such reinsurance.
- c. **Gross Leverage** : The sum of net leverage and ceded reinsurance leverage. This ratio measures a company's gross exposure to pricing errors in its current book of business, to errors of estimating its liabilities, and exposure to its reinsurers.

3. LiquidityTests:

- a. Overall liquidity ratio indicates that the ability of the company to cover liabilities by its total assets. This ratio, however, does not include the not invested assets, the marketability and the quality of the premium balances as well as the affiliated investments.
- b. Another form of a liquidity ratio is the current ratio. This is described as the relationship between the current liabilities and the current assets
- c. On the other hand, quick ratio, which is referred to be a better short-term solvency indicator, subtracts the current assets to the inventory to determine the percentage in relation to cash equivalents and cash to the current liabilities.

4. Loss Reserve Tests :

May include

- a. Loss development triangles,
- b. Projected to reported claims,
- c. Estimated reserve deficiency to surplus

5. Cash Flow Tests

- a. Tests may include Net cashflow,
- b. Net cash flow to quick assets,
- c. Quick liquidity

iii)

Any valuation work would depend on the purpose of valuation of the company.

Since the Board is looking to acquire a general insurance company the actuary needs to clarify whether the valuation is based on company's current organization and plans or whether the synergies are to be considered.

The valuation would look at the following three board areas

- Adjusted Net Asset Value
- Other Value arising from Past business
- The value arising from future business

1. Adjusted Net Asset Value

- a. Taken from the balance sheet at the valuation date.
- b. Adjustments required – any asset not stated at market value or generating a higher or lower investment yield than market yield
- c. For certain assets the actuary may have to decide on stream of future earnings, net of tax and discount this at an appropriate risk discount rate
- d. Assets such as good will or past research and development costs are normally given a nil value and their value is considered as a part of future written business.
- e. Earnings streams which are not capitalized in to the balance sheet have to be valued e.g where premises are sub let the rental earnings are not capitalized.
- f. Generally the valuation of a company is done on a going concern basis but it is possible to consider the value of a company on a break-up basis. It should also be realised that companies can have a greater value on a break-up basis than on a going-concern basis. Usually, in these circumstances, management is not doing a good job and unless the situation can be turned around serious consideration should be given to break-up or run-off.

2. Other Value arising from Past Written Business

- a. This includes any surplus or deficit in insurance reserves and requires an assessment on a prospective basis of all claims reserves, premium reserves and insurance funds covering all reserves for both past and future exposure periods representing business written in the past.
- b. It also includes the value of future investment income attributable, based on the insurance assets and how they may change as the reserves run off.
- c. Any expenses not reserved for but attributable to the administration of the payment of net claims, and other expense items arising from the run-off of the balance sheet.

In making the above assessment we need to carry out the following

- A thorough claims reserve review – including run off of statutory reserve and claims settlement patterns
- Assessment of
 - other reserves e.g IBNR
 - appropriate investment yield
 - expense allocation

3. The Value arising from Future Written Business

- a. The additional value arising from future written business is based on the expected additional net earnings arising from future written business, usually including renewal business discounted at appropriate risk discount rates.
- b. The projection of net earnings takes account of each of the elements of profitability, including premium, commission, other expenses, claims, investment income attributable, reinsurance and any other item of revenue.
- c. Each element is allowed to vary for short-term structural changes and underwriting cycles.
- d. The longer term view of profitability and growth takes account of the company in the context of the market in which it operates and averaging of cyclical profitability.
- e. Typically, the calculations are performed for each main class of business separately and taken net of tax.
- f. The timing of the emergence of profit is allowed for, as are the current levels of production and future potential growth. The resultant net earnings stream is discounted at the selected risk discount rates for the insurance operations.
- g. Reductions from this value should be made for the cost of any restrictions to investment policy and the return needed to cover capital allocated to the insurance operation, if judged appropriate.
- h. In addition, reductions for undercapitalization and the risk of adverse catastrophic experience, not incorporated in the projection of earnings above, should also be deducted.
- i. If the general insurance company which is being valued is a part of a group, then these synergies and conflicts must be identified wherever possible. If there are any synergies or conflicts following the purchase then that has to be also considered.

Other points to consider in valuation of a general insurance company are

4. Choice of risk discount rates
5. Allocation of capital across different lines of business
6. Deterministic / stochastic evaluation

[50 Marks]

[Total Marks – 100]
