

# **Institute of Actuaries of India**

**Subject ST7 – General Insurance:  
Reserving & Capital Modeling**

**October 2015 Examination**

**INDICATIVE SOLUTION**

**Solution 1:**

The claims experience could be analyzed by:

- Accident Year
- Year of Reporting
- Underwriting Year

**Accident Year**

- Claims are grouped by the time period during which they occurred.
- All claims in a cohort belong to the same period of exposure.
- They will all therefore be subject to the same risk environment.
- Even though they may have been written under different rating and policy conditions.
- IBNR claims will be included (eventually) in the time period in which they Occurred as will recoveries and re-opened claims.

**Year of Reporting**

- Claims are grouped by the time period in which they are reported to the company, irrespective of when they occurred.
- An apparent advantage is that no further claims will be added after the end of the time period.
- The method does not allow for the cost of IBNR and reopened claims.
- Claims will arise from different exposure periods which may have different volumes of business, cover applying and claims settlement patterns.
- Hence any claims patterns derived may not represent the current position.

**Underwriting Year**

- Claims are assigned to the calendar year in which the policy was written
- Irrespective of whether the claim occurred in the first or second calendar year of the policy. i.e. claims occurring on two consecutive calendar years will be assigned to the same claim year.
- The method follows the way in which funded accounts are divided and follows the total outcome of all policies written in each year.
- It takes up to two calendar years before all claims have occurred and an additional period before all are reported.
- Each cohort of claims will have occurred over a wider risk period than an accident year cohort.
- IBNR claims included (eventually)

**[9 Marks]**

**Solution 2:**

i) The technical reserves that might be required in respect of this product are:

- outstanding claims reserve
- IBNR reserve - Incurred but not reported reserve
- claims expense reserve
- unearned premium reserve

**Outstanding Claims reserve**

- For each known claim, it can be determined the exact number of monthly payments are remaining.
- If the remaining no of months is t, then for each unit of the policy we should reserve INR  $2,000t + 1,00,000$ .
- Additional reserve needs to be set up in respect of any unpaid payments between the date of death and the valuation date if payment has not yet started, for example if it is still not proved who is entitled to claim the benefit.
- Further for disputed claim, for example if it is not clear whether or not a death was a result of an accident, then a proportion of a full reserve might be set up.

**IBNR reserve**

- To estimate IBNR, one needs to estimate the expected number of future claims and the expected average amount for each of the claims.
- To estimate the expected number of future claims, the time taken to report claims should be investigated.
- A delay table constructed from the record of past claims by month of occurrence and by number of months delay until reporting can be used.
- This may be used to give the proportion of claims being reported by the nth calendar month end after the accident ( $n = 1, 2, 3, \dots$ ). Let this be  $p_n$ .
- The expected average claim amount for an IBNR claim can be estimated similar to outstanding claims reserve.
- Calculate the claim amounts of all policies if they had become claims in each previous month, in the same way as outstanding claims, and get an average value across all policies for each year. Let this be  $S_n$ .
- Thus if the number of claims reported in the nth month prior to the valuation is  $N_n$ , then the IBNR is equal to:

$$\sum_{n=1}^{\infty} (1 - p_n) N_n S_n / p_n$$

### Claims expense reserve

- Claims expense reserve would most likely be a percentage of the claims cost or premium.
- This expected percentage figure can be estimated using historical experience or based on industry data.

### Unearned Premium reserve

- Assume the acquisition cost for the business is a% of the premium charged for the product i.e. INR 5,000 \* a%.
- Unearned Premium reserve in respect of policies already claiming is zero.
- The usual methods or formulae e.g. 365ths method, 24ths method etc. cannot be used to calculate the unearned premium reserve as the term is not one year and the risk is not constant throughout.
- If a policyholder should die accidentally in the first month of the policy, the total benefit per unit would be INR 2,000 × 120 + INR 1,00,000 = INR 3,40,000.
- On the other hand, if he should die accidentally during the last month it would be INR 1,02,000.
- In general, if he dies in month n (n = 0,1,2, ... 119), the benefit will be INR 2,000 × (120 – n) + INR 1,00,000 = INR 3,40,000 – INR 2,000n.
- The probability of a person dying accidentally each month should not vary unless some extremes of age are included.
- If the most dangerous ages for young male accidental death are included then assuming a level probability will be slightly conservative, and might be acceptable. If older ages are included some adjustment to this assumption may be needed
- The earned premium calculated each month should be proportional to the risk, or to 170 - n (n = 0,1,2, ... 119).
- The sum of these weights is  $120 \times 170 - 120 \times 119 / 2 = 4200 - 1770 = 13,260$ . Thus for after x complete months of the policy the proportion of risk remaining will be:

$$\sum_{n=x}^{119} (170 - n) \div 13,260$$

$$= ((120 - x) * 170 - (119 + x) / 2 * (120 - x)) / 13,260$$

$$= (20,400 - 170x - (14,280 + x - x^2)/2) / 13,260$$

$$= (13,260 - \frac{341x}{2} + \frac{x^2}{2}) / 13,260$$

$$= 1 - \frac{341x}{26,520} + \frac{x^2}{26,520}$$

- Hence the unearned premium per unit of policy for a unit taken out exactly x months ago is  $\text{INR } 5,000 * (1 - 341x / 26,520 + x^2 / 26,520)$ .
- To hold this for a policy that had a curtate elapsed duration of x months would be slightly conservative. The correct value could be approximated by adding on half a month to get  $\text{INR } 5,000 * (1 - 341x / 26,520 + x^2 / 26,520 - (170 - x) / 26,520)$ .
- The exactly correct value for a policy that had had d days since its last monthly anniversary is, in a 30-day month,  $\text{INR } 5,000 * (1 - 341x / 26,520 + x^2 / 26,520 - (170 - x) / 13,260 \times d / 30)$ .
- From this, a% may be deducted to allow for deferred acquisition costs.

[16]

ii) Company is small and region focused and may consider the following reinsurance options:

- With all types of reinsurance the value for money should be considered, i.e. the protection it brings, including security status of reinsurer compared to the cost.

#### Quota Share

- Company may use quota share to allow more risks to be written, giving a more balanced risk profile for each of the products.
- In particular company may use reciprocity arrangement for Household and Motor book as they are regional focused.
- Quota share reduces net written premium compared to free reserves, thereby helping the solvency position and might help the company to satisfy the statutory solvency requirement.
- Commissions may assist the company cash flow which could be important given that they are a relatively small insurer.
- Quota Share could be the preferred reinsurance arrangement for the new long term personal accident product as they can get technical assistance and help with product design.

#### Surplus

- Surplus reinsurance would be mainly used for Commercial property risks.
- Company can use surplus reinsurance to choose, within limits, the size risks that it will retain for the commercial risks.
- Company can also write larger risks, which might otherwise be beyond its writing capacity.
- Also allows to fine-tune exposure by ceding more of the risk in areas where already have some properties on risk i.e. spread risks.
- Commissions may assist the company cash flow which could be important given that they are a relatively small insurer.

### **Risk XL/CAT XL/Aggregate XL**

- Company might consider Risk XL cover to protect itself against any potential large risk losses affecting its commercial property or motor portfolio. e.g. subsidence or motor liability claims etc.
- In respect of Personal accident cover, company might look to buy Risk XL cover if it expects a single individual to buy a large number of units.
- Company is regional focused covering property and motor insurance and hence could look at cat XL to protect against insolvency in the event of a catastrophe occurring.
- Given that company wishes to sell Personal Accident policies via a large bank, company might have potential aggregation and wish to cover it via Aggregate XL or CAT XL.
- E.g. Employer arranging PA cover for its employees etc.
- The need for both these types of reinsurance will be exacerbated as the company is small.
- XL can help the company stabilize the technical results by smoothing out claim fluctuations.
- Further, it helps make more efficient use of the capital by reducing the variance of the claim payments.

### **Stop Loss**

- Stop loss reinsurance could be purchased to protect solvency margin.
- Often it isn't available and certainly not at a reasonable price..

### **Financial Reinsurance**

- Financial reinsurance to protect balance sheet/transfer risk to reinsurer
- Any regulatory requirements must be complied with including those that affect the choice of reinsurer / reinsurance structure.

[10]

[26 Marks]

### **Solution 3:**

- i) risk definition and details of cover
  - class of business
  - case reserve estimates and paid amounts
  - current status
  - loss occurrence date and claim reported date
  - start/end date of policies (or another date example)
  - relevant amounts and currencies (exposure, sums insured, premiums, claims payments, etc.)
  - currencies of claims

history of past policy and claims records  
 link to relevant policy record  
 reinsurance recoveries triggered  
 type of claim and cause of claim  
 administrative details

any other relevant details

[3]

ii)

- Information could be entered onto the wrong claim record
- Information could be entered against the wrong policy record
- A claim may be entered for an incorrect claim date
- A payment may be entered for an incorrect date
- Incorrect amounts may be entered, or correct amounts in the wrong currency
- A claim may be entered for an incorrect claim type
- A claim may be entered for an incorrect case estimate
- Information may be missed out

Any other reasonable suggestion

[4]

iii) **Data Limitations/Errors**

- Company does not have any internal data in respect of liability book except motor third party liability business.
- Further, the acquired liability book has limited experience as it has been written only for four years.
- Overall company has limited experience from existing business operations.
- There may be distortions or omissions in the data, particularly changes in claim recording procedures or other external environmental factors e.g. legislation or customer behavior.

#### **Uncertainty at Extreme Values**

- Liability business can give rise to very large losses that occur rarely so will be limited data to fit the tails of the distribution.
- Further certain events might not have yet occurred within the data i.e. latent claims.

#### **Process Error**

- Given the model is stochastic, the future outcome will be uncertain even if the model chosen is perfect.

- e.g. change in business mix, government legislation, economic conditions, claim payment patterns, third party behaviors etc.

### **Model Error**

- The model may have been structured incorrectly so doesn't represent the underlying risks.
- Choice of model for a particular risk can be very subjective, particularly due to the change in legislation.

### **Simulation Error**

- 5,000 simulations might not be adequate given we are modeling liability class of business.
- The severity distributions of liability class of business usually have highly skewed distributions with no theoretical upper limit, such as lognormal or Pareto.
- Ideally at least 10,000 simulations should be run so as to allow the distributions to converge.

### **Programming Error**

Mistakes may be made when constructing the model particularly as the process is new to the company.

### **Parameter Error**

- There will always be a certain degree of uncertainty that the parameters reflect real life.
- Therefore there will be significant subjectivity in parameter selection
- e.g. future court award inflation, frequency and severity of large claims, catastrophic and latent claims etc.

### **Incorrect Dependencies**

- The correlations between the different components of the model may not be estimated correctly or completely missing.

### **Other reasonable error (e.g. systemic)**

- Reasonable description

[8]

[15 Marks]



**Solution 4:****i) Different regulatory regimes:**— **Unregulated markets**

It has been argued that the costs of regulation in some markets, especially those where only professionals operate, outweigh the benefits.

— **Voluntary codes of conduct**

These operate effectively in many circumstances but are vulnerable to a lack of public confidence or to a few “rogue” operators refusing to co-operate, leading to a breakdown of the system.

— **Self-regulation**

A self-regulatory system is organized and operated by the participants in a particular market without government intervention. The incentive to do so is the fact that regulation is an economic good that consumers of financial services are willing to pay for and which will benefit all participants. An alternative incentive is the threat by government to impose statutory regulation if a satisfactory self-regulatory system isn't implemented.

— **Statutory regulation**

In statutory regulation the government sets out the rules and polices them.

— **Mixed Regimes**

In practice many regulatory regimes are a mixture of all of the systems described above [4]

**ii) Possible objectives that could be considered are:**

- a) promote efficient, fair, safe and stable insurance markets for the benefit and protection of policyholders.
- b) to help growth and competition in the insurance sector and contribute to economic growth
- c) enhance the overall efficiency of the financial system
- d) manage risk and mobilise long-term savings.
- e) Any other suitable objective [2]

**iii) Two objectives I would recommend along with its benefits are:**

- a) Promote efficient, fair, safe and stable insurance markets for the benefit and protection of policyholders.

b) to help growth and competition in the insurance sector and contribute to economic growth

+ Policyholder confidence is very important for the growth of insurance market and will lead to increased revenue and profitability of the insurer. This will help to attract more players in the market.

+ more competition will lead to more innovation in insurance product leading to better fulfilment of citizens and businesses needs

+ since the insurance market is still not very developed, policies by the regulator to help growth in this sector along with competition will help other agents in the economy to manage their risk better allowing them to be more entrepreneurial

+ bigger insurance sector can help to channelize long term savings into productive assets boosting capital output ratio. [4]

#### iv) Costs associated with regulations

##### Direct costs

- administering the regulation
- compliance for the regulated firms

##### Indirect costs

- alteration in consumer behaviour
- undermining of the sense of professional responsibility amongst intermediaries and advisors
- reduction in self-regulation by the market
- 
- reduced product innovation
- reduced competition

[4]

[14 Marks]

#### **Solution 5:**

##### i) a) Principle of Indemnity

The principle whereby the insured is restored to the same financial position after a loss as before the loss.

[1]

**b) 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. [2]

**ii) Moral hazard**

Moral hazard refers to the action of a party who behaves differently from the way that they would behave if they were fully exposed to the circumstances of that action. The party behaves inappropriately or less carefully than they would otherwise, leaving the organization to bear some of the consequences of the action. Moral hazard is related to information asymmetry, with the party causing the action generally having more information than the organization that bears the consequences.

Or any other relevant description.

[2]

**[5 Marks]****Solution 6:****i)**

Arrangements	PML Basis	Risk %	Premium	SI Exposure	Loss Amount
Obligatory	28.47	10.0%	9.49	94.90	20.00
Company's Net Retn.	12.50	4.4%	4.17	41.67	8.78
1st Surplus	125.00	43.9%	41.67	416.67	87.81
2nd Surplus	118.73	41.7%	39.58	395.77	83.41
<b>Total</b>	285	100%	94.90	949.00	200.00

[6]

**ii)**

The full sum insured is very unlikely to be paid out in the event of a claim under a large risk, especially if the sum insured is spread over several sites. For such classes the PML is used as the measure of the risk.

Consider two different risks:

Risk 1: 30 individual buildings spread around a site. Total sum insured of INR 150 crore.

Risk 2: One large office block. Total sum insured of INR 100 crore.

A single insurer could conceivably insure all 30 buildings, but decline the office block on the grounds that it was too big. The office block is bigger risk, in that there is a much more concentrated risk.

The possible loss from one incident with Risk 2 may be much greater than the possible loss from one incident involving Risk 1, which might typically involve a loss of about INR 5 crore.

[3]

[9 Marks]

### **Solution 7:**

#### **i) Advantages and disadvantages of a deterministic model**

- + It is easy to explain to a non-technical audience, since it does not involve the explanation of probability distributions, particularly because the scenarios tested may have been developed in conjunction with this audience.
- + It is clear which economic scenarios have been examined.
- + The model is usually simpler than a stochastic model, and therefore less time consuming to build and run.
- ... and therefore less costly.
- + It is easier to introduce more (subjective) detail, such as descriptions of reinsurance programme or the treatment of underlying risks.
- + It helps to ensure that the scenarios modeled are chosen intelligently, rather than included somewhere amongst a myriad of other scenarios (as is the case with a stochastic model).
- + It is easy to link the model with the risk register, i.e. to integrate capital and risk management.
- + Scenarios can be used to aid scenario planning.
- + It is easier to consider interdependencies between risks without having to estimate statistical correlations.
- It is more difficult to determine which economic scenarios to test ...
- ... and the testing may not cover a sufficient range of scenarios.
- Some important scenarios may be missed.
- It is not a good model for valuing options and guarantees (although these are rare in general insurance) as it is difficult to model the variability in take up rates or the guarantee biting.

#### **Advantages and disadvantages of a stochastic model**

- + Using a stochastic model, a large number of simulations can be run to identify which eventualities are acceptable.

- + A stochastic model may, due to its random nature, identify a potentially poor scenario that would not have been thought of as a specific scenario to test under a deterministic model.
- + A stochastic model takes into account the variability of the model parameters and the covariance between them.
- + The output of a stochastic model forms a distribution of values from which statistics such as the mean and the variance of the output and a number of different risk measures can be calculated.
- + Confidence levels can also be calculated if required.
- + Such information is useful in understanding the risks inherent in the product design.
- + It is easier to assess the knock-on consequences of particular scenario overtime.
- + Simulation under a stochastic model will explore many possible combinations and rank them against the chosen risk measure.
- + A stochastic model is useful for modeling any options and guarantees (although these are rare in general insurance) embedded in the contract design, since the likelihood of option take up, or of guarantees biting, can be explicitly allowed for.
- A stochastic model can be longer and more expensive to run.
- A stochastic model is likely to be more complex to design and test; leading to potentially increased operational risk.
- The output from a stochastic model may be difficult to interpret and to communicate to senior management.
- The model output is only as good as the input and depends on the choice of probability distribution and its parameters for the stochastically modeled variables.
- Whilst a stochastic model is a useful tool for making sure that all eventualities have been tested, there is no substitute for experience.
- The best course of action is often for the actuary to consult as many people as possible about possible eventualities and to think the unthinkable!
- In practice, it will be impossible to find a capital level that is acceptable under all eventualities, as the cost would be prohibitively high making the product unmarketable.

[9]

ii) Factors that I would consider while selecting the modeling approach are:

- a) time availability for the exercise; stochastic model generally takes longer to set up and the company may not have that much time to raise capital.
- b) approach followed by the rating agency – if the rating agency uses a deterministic model with a specified capital charge factors for different risks, it would be advisable to use a deterministic model similar to rating agency.
- c) Intended users of the results will also determine which approach to use between stochastic and deterministic, as non-technical audience may be more comfortable with deterministic model, since it does not involve the

explanation of probability distributions, particularly because the scenarios tested may have been developed in conjunction with this audience.

- d) Budget available for the project; stochastic model generally involves more time building and parameterizing. [4]

iii) Capital allocation methods that can be used are

— **Marginal capital method (a “last in” method):** We allocate the capital with reference to the marginal capital requirements of each segment.

— **The Shapley method:** This is an extension to the marginal capital method based on game theory. We allocate the capital with reference to an average of the marginal capital requirements, assuming that the class/risk under consideration is added to the overall portfolio first, second, third and so on.

— Any other relevant allocation method

[3]

iv) Different steps which company could take to lower its capital requirement are:

- De-risk its asset portfolio by divesting high risk assets like property & equity and investing it in lower risk assets like bonds
- Reduce its reserve risk by purchasing reinsurance like adverse development cover
- Lowering its future credit risk by purchasing reinsurance with better security
- Lowering premium risk by reducing its future business or re-allocating its portfolio towards lower risk line of business.
- Any other valid suggestion

[4]

v) Sources of capital

- Rights issue
- Preference share
- Initial public offer
- Follow on offer
- Private equity
- Reinsurance capital through ceding more risk
- Financial reinsurance
- Long term debt e.g. perpetual debt

[2]

[22 Marks]

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