

# **Institute of Actuaries of India**

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

**September 2017 Examination**

**INDICATIVE SOLUTION**

**Solution 1:**

i)

Certain lines of business may have recently started or yet to start. For some lines, no claim might have been reported. The underwriting risk for these lines can't be determined using company's data. Market benchmarks need to be used for these lines of business.

The data available would be at actual time horizon and actual policy conditions. This needs to be adjusted with expected trends, rates and conditions for future projections.

Even though the company may have sufficient data to estimate the mean values, the data may not be sufficient to measure the tail risk. Eg. Company may not have faced a large risk which could potentially happen. For fitting distribution to these lines, scenarios of worst possible outcome should be created and checked against the distribution selected. Also, market benchmarks could be looked at.

The data may not be sufficient to estimate the correlation between lines of business and between various risks. Scenarios for joint movement can be constructed which can be used for estimating the correlation.

Data may not be available for future legislative and economic scenario. Market yield curves and third party economic scenario generators could be used.

Risk registers may have been maintained by the company to measure the operational risks. But these are usually at expected level, and little data is available to fit a distribution for these risks. Parameterization for these risks should be carried out in discussion with various stakeholders.

The default probabilities for credit risk may not be available. For Reinsurance credit risk, one can use the probabilities suggested by external rating agencies.

The historic catastrophic risk data of the company will usually be insufficient to measure the risk. There are external cat modeling companies, which do such analysis and provide risk details after mapping company's exposure to the cat scenarios.

The details for the possible latent claims are unlikely to be available. For these risks, subjective loading may be used.

Data for other risks like group risk, strategic risk, political risk, etc is unlikely to be available. These risk need to be measured with appropriate stress and scenario testing.

All the expenses and assets might not be allocated to a line of business. This allocation would be required to estimate the capital at a line of business level. Appropriate methodology can be adopted to allocate these at line of business, eg. Proportion of premium, or count of policies.

(10)

ii)

Stress testing: It quantifies the effect of varying single parameter. It is useful to understand the potential impact of individual risk in isolation.

Scenario testing: It quantifies the effect of varying combination of parameters. It is useful to consider the combined effect of number of risks.

Sensitivity analysis: It is the process of testing the extent to which the results of capital model vary by making a small change in the assumption.

Back testing: It is the process of comparing actual output with model output. It tests how well the model predicts the range of outcomes that actually occur.

Alternate method of capital calculation: The output can be compared against other methods of capital estimation, like deterministic stress and scenario tests on key risks.

Past model: The output can be compared with output from any previous model and differences could be understood to check whether they are in line with model changes or not.

Breakdown of model into sufficient level of detail: The breakdown of model output into various risk categories helps in understanding the risk individually and the results could be cross-verified by discussing with corresponding business team.

(7)

[17 marks]

**Solution 2:**

i)

Both these approaches are simple to understand.

Modeling gross claim triangles is better than modeling net triangles:

The data in net triangles is capped for non-proportional treaties. If these capping have changed over time, then the development would not be appropriate for future projection.

A short tailed triangle is usually better predictable. The net triangles may have a bigger tail due to delay in recoveries. The variation in timing of recoveries may also distort the net development.

The net earned premium is at times also not smooth due to adjustment entries. This causes issues looking at net results.

Modeling gross separately gives a clearer picture of underlying severity trends which could be vetted by claims team. Severity for net losses is reduced for proportional reinsurance and capped for XoL.

Modeling gross separately gives a clear picture of performance of gross underwriting and reinsurance. This is usually helpful for various business reporting.

If the reinsurance ceding is very high, the net data may be very little to model appropriately.

Modeling net claim triangles is better than modeling gross triangles:

Large and cat losses are usually capped in net triangles (if appropriate XoL/Cat covers are taken) which help in smoothening the development. In gross modeling, one would need to model attritional, large and Cat separately.

Using the ratios to net down is difficult for non-proportional reinsurance contracts as the losses will not be in line with the net to gross premium ratio and only past net to gross claims ratio could be used.

For stochastic reserve modeling and complex Reinsurance contracts, none of these approaches may be suitable to model the net claims.

**(8)**

**ii)**

Alternate approach could be:

Using reinsurance triangles to model the reinsurance recoveries and then subtract them from gross results to get the net results.

Modeling reinsurance on case by case basis and then subtracting from gross results.

Develop individual loss to ultimate and then pass through reinsurance contracts. Then subtract from the gross results to obtain the net results.

**(3)**

**[11 Marks]**

**Solution 3:**

**i)**

The business lines involving legal aspects will be affected. The biggest one is likely to be motor Third party claims.

With digitization, the notification is expected to be quicker as the insurance company can get instant mail/message once a claim is reported where the insurance company is one of the parties.

Digitization will also help in faster settlement as clearer details about the case would be available and comparison with other similar cases could be made. Also, delay in finding the records would reduce.

Reduction in reporting and settlement delay is likely to reduce the claim reserves.

Digitization is likely to bring more accuracy on the recorded data, thereby reducing volatility in the claim reserves.

With a central database available, fraud claims involving multiple locations or inconsistent data are likely to reduce. This could reduce the claim frequency and free up the reserves.

(5)

ii)

a) Earning of premium

Traditionally earned premium has been estimated assuming uniform risk throughout the year. With the high inflation in TP claims, this assumption doesn't seem to hold for long term contracts.

So, if the expected inflation in claims is 12% pa, then the earning should happen as:

EP,  $1.12EP$  and  $1.12^2EP$ , where EP is the earned premium. The sum of the three years earned premium can be equated to total written premium to get each year's earning. This still assumes risk to be uniformly distributed throughout the year.

(2)

b) Investment strategy

Increase in the duration of assets would be needed as the reporting & settlement of these contracts would take longer as compared to 1 year contracts. This is because 3- year policy would cover the claims happening in 3<sup>rd</sup> year as well.

Assets closely matching the claims inflation would be required to match the liability outgo. Thus real assets like govt. and corporate bonds may be used for the purpose. However, they may not be able to match the claims inflation. In such case or to achieve higher return, depending on the solvency level of the company, investment in riskier asset classes like property/equity could be made to achieve higher returns.

(3)

[10 marks]

**Solution 4:**

- i) For a pre-defined Sum Insured, the product is likely to cover the loss of declared jewelry by means of theft, robbery, fire, collapse, earthquake, flood, etc. Condition of average is likely to apply in case of under-insurance.

(2)

- ii) Location, SI, Type of residence-Villa vs flat, Safety measures, Travel days, Type of jewelry-Chain, rings, etc., Family profile – members, working hours, age, gender, etc., Historic theft records (2)
- iii) Various measures include:
- Invoice copy/pictures required at the time of insurance.
  - Detailed list of jewelry items and value to be provided at the time of taking out insurance
  - Latest valuation report for getting correct sum insured.
  - Compulsory requirement of FIR at the time of claim.
  - Deductible can be imposed.
  - Policy wording should have clauses clearly stating that gross negligence is not covered.
  - Compulsion to report the claim within a stipulated time period from the date of loss. (3)
- iv) If the company is not confident about pricing, it should share a major portion of risk via proportional contract. Also, proportional RI allows diversification benefit.  
If similar product is not available, stop loss treaty is unlikely to be available in the market due to lack of experience or will be available at a very high cost.  
The company should get protection against cat losses by means of Cat RI treaty.  
Risk XoL treaty can be considered if the company plans to underwrite high SI as this may lead to large losses. (3)
- v) Initially there will be business strain as volumes would be low and setup expenses would be high. Also, there will be expenses for training and hiring of skilled resources.  
If the volumes are low in initial years, the performance is likely to be volatile.  
Gradually as the experience unfolds and volumes increase, the product is likely to yield returns based on the underwriting cycle. (2)
- [12 marks]**

**Solution 5:**

i)

			1 year - Q1 policy		6 month - Q2 policy	
Quarter	frequency	severity	risk rate (units xy)	Cumulative UPR	risk rate (units xy)	Cumulative UPR
1	x	2y	2	100%		
2	0.75x	2y	1.5	53%		
3	0.5x	y	0.5	18%	0.5	100%
4	0.25x	y	0.25	6%	0.25	33%
			4.25		0.75	
		Answer	18% * 4.25xy = 0.75xy		33% * 0.75xy = 0.25xy	

(a+b) (4)

ii)

- 1) Profits are made up of operating ratio plus any investment income on technical and free reserves. The investment income could be significant especially for long-tailed lines.
- 2) We don't know how expenses and depreciation have been dealt with in the accounts.
- 3) If it is a new company with high expenses, the operating ratio may be expected to be above 100%.
- 4) Any decision regarding closure to new business should be based on the expected probability of future business, not the size of past losses.
- 5) The operating ratio can still be above 100% without it relating to the current business being written, since the loss ratio includes an element adjusting past reserve estimates.
- 6) We should consider the strength of the reserving basis; the operating ratio may be much lower if the reserves are calculated on a realistic basis.
- 7) Same argument holds if the allowance for DAC or other parts of the accounting basis are unrealistic.
- 8) The difference is high if the business is expanding and reserving is cautious
- 9) This would also be true if past reserving had been less cautious than at present
- 10) Also, the operating ratio is made up of expenses/written premiums. Strictly speaking, it should be incurred expenses and earned premiums.
- 11) We should look at the figures over many years, not just one year in isolation.
- 12) One year's results may be distorted for a number of reasons including –
  - a. Catastrophes
  - b. A court award leading to a new latent claim
  - c. A jump in inflation
  - d. Failure of a reinsurer
- 13) Even if one year's business is unprofitable, there are more appropriate courses of action than closure, for example increasing the premium rates.

(6)

[10 marks]

**Solution 6:**

i) Insurer's appetite for offsetting risks through reinsurance depend on -

- a) The size of the insurer
- b) The insurer's experience in the marketplace
- c) The insurer's available free assets
- d) The size of the insurer's portfolio
- e) The range within which the business outcome (or profit) can be forecast with confidence

(3)

**ii) Fronting**

- a. Fronting occurs when an insurer, acting as a mere conduit, underwrites a risk and cedes all (or nearly all) of the risk to another insurer which is technically acting as a reinsurer.
- b. The ceding or “fronting” insurer will typically receive a fee for its involvement to cover its expenses and profit.
- c. Although the fronting insurer is not generally concerned with the profitability of the underlying business it does remain legally liable to the original insured.
- d. The fronting insurer should assess the credit risk of the assuming insurer before entering into the fronting agreement

## Reasons for choosing fronting

- 1) Assuming insurer may not be licensed to write a specific line of business
- 2) It’s credit rating may be inadequate
- 3) There may be a tax advantage

**(3)****iii) Facultative Reinsurance and its advantages and disadvantages**

- e. Facultative reinsurance is the insurance of a single risk
- f. There is no obligation for the ceding company to offer the business nor is the reinsurer obliged to accept it.
- g. Each case is considered on its own merits and the reinsurer is free to quote whatever terms and conditions it sees fit to impose for the risk

## Advantages

- a. Flexibility that both parties have

## Disadvantages

- a. It is a time-consuming and costly exercise to place such risks
- b. There is no certainty that the required cover will be available when needed
- c. Even if cover is available, the price and terms may be unacceptable
- d. The primary insurer may be unable to accept a large risk until it has been able to find the required reinsurance cover. This means the insurer cannot accept business automatically when it is offered, and consequently its standing in the market may be reduced.

**(3)****[9 marks]**



**Solution 7:****i) Link Ratios**

	12	24	36	48	60
2012		3.17	1.38	1.24	1.12
2013		3.15	1.34	1.23	
2014		3.10	1.32		
2015		3.00			
2016					
ATAF		3.107955	1.351288	1.234568	1.115385

**Unpaid Liability**

Cumulative Paid Losses (INR Crores)						
	12	24	36	48	60	Reserve
2012	2400	7600	10500	13000	14500	
2013	2300	7250	9750	12000	13384.62	1384.615
2014	2100	6500	8600	10617.28	11842.36	3242.355
2015	2000	6000	8107.728	10009.54	11164.49	5164.488
2016	1900	5905.114	7979.51	9851.246	10987.93	9087.929
						<b>18879.39</b>

**(3)****ii) Claim disposal ratios**

Ult. Reported Claims							
			12	24	36	48	60
	2012		0.52	0.84	0.91	0.97	1.00
	2013		0.51	0.82	0.89	0.96	
	2014		0.49	0.79	0.87		
	2015		0.47	0.76			
	2016		0.45				
	Selected Disposal Rate		0.45	0.76	0.87	0.96	1.00

Clear slow-down

**(3)****iii) Restated closed claims = Selected Disposal Rate \* Ult. Reported Claims**

Restated Closed Claims					
	12	24	36	48	60
2012	3510	5928	6786	7488	7792
2013	3870	6536	7482	8256	
2014	4455	7524	8613		
2015	4320	7296			
2016	4050				

(2)

iv) Adjusted Paid Triangle =  $a \cdot \exp(b \cdot \text{restated closed claims})$ , where a and b changes by year.

	12	24	36	48	60
2012	1831.624	5891.523	8918.046	12519.21	14500
2013	1827.367	5736.536	8608.789	12000	
2014	1805.657	5714.298	8600		
2015	1854.056	6000			
2016	1900				

(4)

v) Berquist-Sherman reserve = chain-ladder on restated paid loss triangle

	12	24	36	48	60	Reserve
2012	1831.624	5891.523	8918.046	12519.21	14500	
2013	1827.367	5736.536	8608.789	12000	13898.64	1898.642
2014	1805.657	5714.298	8600	12030.99	13934.54	5334.537
2015	1854.056	6000	9039.199	12645.41	14646.17	8646.168
2016	1900	6059.882	9129.412	12771.61	14792.34	12892.34
						<b>28771.69</b>
ATAF		3.189411	1.506533	1.398952	1.15822	

(3)

vi) Yes, the range of reserves is 18,879 to 28,772 due to the full impact of settlement slow-down and is therefore material enough to be disclosed.

(1)

[16 marks]

**Solution 8:**

i)

Let T = Aggregate Total Losses, I = payout of insurer, R = payout of reinsurer.

The distributions of T, I and R is given in the tables below

	P
P(T = 0)	60.0%
P(T=10000)	16.0%
P(T=20000)	12.8%
P(T=100000)	4.0%
P(T=110000)	3.2%
P(T=200000)	4.0%

Insurer	P	Reinsurer	P
P(I = 0)	60.0%	P(R = 0)	88.8%
P(I=10000)	16.0%	P(R=50000)	4.0%
P(I=20000)	12.8%	P(R=60000)	3.2%
P(I=50000)	11.2%	P(R=150000)	4.0%

The joint distribution of I and R is given by –

	Joint	P	F(I)	F(R)
	P(I=0,R=0)	60.0%	60.0%	88.8%
	P(I=10000,R=0)	16.0%	16.0%	88.8%
	P(I=20000,R=0)	12.8%	12.8%	88.8%
	P(I=50000,R=50000)	4.0%	11.2%	4.0%
	P(I=50000,R=60000)	3.2%	11.2%	3.2%
	P(I=50000,R=150000)	4.0%	11.2%	4.0%

$P = F(I,R)$  and the marginals are  $F(I)$  and  $F(R)$ .

One can see that  $F(I,R) = C(F(I),F(R)) = \min(F(I), F(R))$ .

(5)

ii)

a) Best estimate plus 10%

- 1) The rationale here is that the extra 10% will provide a cushion in case claims exceed the best estimate.
- 2) The 10% appears to be an arbitrary figure that has been chosen because it is easy to understand and calculate.
- 3) No assumption about the shape of the loss distribution is required for this method.
- 4) So this method can be considered to be less subjective than other methods
- 5) However, this method is indiscriminate in that it doesn't take into account differences in the nature of the risks covered, the size of the portfolio or the levels of reinsurance being used.
- 6) Theoretical arguments suggest that the size of the cushion should be linked to the standard deviation or the percentiles of the distribution, not a fixed percentage.

- 7) According to a Poisson model, the variation in the claims amount, as measured by the standard deviation, should be proportional to the square root of the mean, rather than being a fixed percentage.
- 8) A margin of 10% is likely to be inadequate for a small portfolio where the variation will tend to be large relative to the mean, but may be excessively cautious for a more stable portfolio.
- 9) This method encourages better use of reinsurance.

**b) 75<sup>th</sup> percentile**

- 1) The rationale here is that a reserve based on the upper quartile, rather than the median will provide a cushion in case claims exceed the best estimate.
- 2) This method is consistent with a value-at-risk approach. The reserve calculated using this method can expect to be exceeded one year in four.
- 3) Using the 75<sup>th</sup> percentile links the reserve amount directly to the loss distribution.
- 4) It will therefore take into account differences in the nature of the risks covered and the size of the portfolio.
- 5) This method requires a good knowledge of, or an assumption to be made about, the form of loss distribution.
- 6) The method can allow for reduction in claim volatility due to reinsurance by basing the reserve on the net claims distribution.

**c) Best estimate plus 1 s.d**

- 1) The rationale here is that the extra s.d. will provide a cushion in case claims exceed the best estimate.
- 2) Theoretical arguments suggest that the size of the cushion should be linked to the s.d. or the percentiles of the distribution.
- 3) However, using 1 s.d. appears to be an arbitrary choice that has been made because it is easy to understand and describe.
- 4) 1 s.d above the mean may correspond to very different percentiles, depending on the actual shape of the underlying distribution.
- 5) So the method does not, in general, conform directly to a VAR approach.
- 6) However, if claims have a normal distribution, this method is consistent with a VAR approach corresponding to a confidence level of  $\text{PHI}(1) = 84\%$ .
- 7) This method requires a good knowledge of, or an assumption to be made about, the form of the loss distribution.
- 8) The method can allow for reduction in claim volatility due to reinsurance by basing the reserve on the net claims distribution.

**(10)**

**[15 marks]**

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