

Institute of Actuaries of India

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

May 2015 Examinations

INDICATIVE SOLUTIONS

Solution 1 :

(i)

Advantages of Quota Share:

- Spread of risk to enable the company to write larger portfolios of risk.
- Encourage reciprocal business which may be useful as the company is growing.
- Enables the company to accept a larger sum insured on individual policies.
- Directly improves the solvency ratio and helps the insurer to satisfy the statutory solvency requirement. This may not be significant for a large company.
- It is administratively simple, but a large company such as this may not consider it such an advantage.
- The commission may help with cash flow.
- Technical assistance may be available from the reinsurer. Although company could also use their brokers for the same and may be of limited use for a large company
- Quota Share can help reduce the cost of XL protection although the impact may not be sufficient enough to justify the cost. [4]

(ii) A domestic insurer may consider using a fronting arrangement to write a risk in another territory rather than underwriting a risk directly for the following reasons:

- The fees payable to cover the expenses of the fronting insurer may be less than the expenses that would have been incurred in writing the business directly.
- The insurer may not be licensed to write a specific line of business in a particular country.
- The current credit rating of the insurer may be inadequate to satisfy the insured's minimum requirements.
- There may be tax advantages in issuing the policy via the fronting insurer.
- Obtain a quick entry to the market where it has an insufficient presence or standing in the market or gain experience in the market. [2]

(iii) **Proportional: Quota share suitability for new business**

- If the new US book of business is much larger as compared with the existing book.
- To ensure that there is not too much exposure to one area, i.e. diversification.

Non-Proportional Risk XOL suitability for new business

- Unlikely to be used for personal property as not a major risk
- ... unless there are individual high risk properties or high sum insured properties of high net worth individuals.

The new business is personal property class of business and similar to those being currently covered under existing treaties. However, current treaty may have scope restrictions and leader might have concerns or may not be comfortable with extension of geographical scope in particular US territory. [3]

(iv) Proportional: Surplus

- Might not be used as it is unnecessary for personal property.
-unless there are individual large and high risk properties.

Non-Proportional: Aggregate and catastrophe XL

- Would definitely be used to cover exposure from natural catastrophes which in US include Earthquake, Windstorm, Tornadoes, Typhoons, winter storms etc.

Non-Proportional: Stop Loss

- If available at an affordable price to cover natural catastrophes

Financial Reinsurance

- Providing financial support or improving the balance sheet
- ...although not a consideration here

[4]

[13 Marks]

Solution 2 :**Possible disadvantages of regulation:**

- The cost in terms of resource and finance to comply with, supervise and interpret the rules
- in particular for changes to the rules.
- The loss of business opportunities that arise from any restraint on a free market e.g. minimum/maximum premium rates, file and use policy.
- The inability to maximize investment returns when there are controls on the investment decision.
- The quantum of regulatory bureaucracy deterring new entrants.

- The difficulties and hence potential inaccuracies in complying with complex (risk based) liability and capital calculations.
- The increased premium cost to the public arising from levies and the general increase in insurer expenses.
- The inability of companies to benefit from economies of scale and cost reduction due to anti-competitive legislation.
- The failure of insurance to reach certain sectors of the population due to the increased cost of and restrictions on methods of distribution.
- Inflexibility of rules: one size fits all
- Check list mentality/ false sense of security if all boxes are ticked
- Rules may act against the principles of insurance: e.g. no sex discrimination on premium rates which also increases overall premium rates. **[4 Marks]**

Solution 3 :

(i) Sources of uncertainty in establishing the ultimate claim reserves are as follows:

- Occurrence and severity of claims.
- the notification delays on individual claims
- legal changes that affect the size of awards
- legal changes that affect the heads of damage awarded
- changes in the litigiousness of society
- levels of claims inflation (which in turn is related to levels of price inflation and wage inflation in the economy)
- court rulings on liability or quantum of individual claims not foreseen by claims handlers or not in the historic data
- changes in the mix of claim types, either caused by an underlying change in claim type experience or by changes in the mix of business written
- changes in claims handling, either because of policy changes or because of external events (such as a catastrophe leading to claims handlers being over-stretched)
- the historic data only provides a limited sample
- the quality of data may have varied over time
- there are many ways of deriving an estimate of the claims reserve, and many judgments required within each method - the uncertainty introduced by this is known as "model error" or "model uncertainty" **[5]**

(ii) The key assumptions when bootstrapping the ODP method are:

- the run-off pattern is the same for each origin period (as for the chain-ladder)
- incremental claim amounts are stochastically independent
- the variance of the incremental claim amounts is proportional to the mean
- incremental claims are positive for all development periods

[2]

- (iii) The process used to bootstrap reserve estimates consists of the following stages (repeated many times) for each class of business:
- Group claims by property damage and bodily injury/death in respect of Motor class of business.
 - Fit a model (e.g. chain ladder) to the past claims data to determine expected ultimate claims reserves for each past origin and development year.
 - Calculate what the past claim amounts "should" have been if they had conformed precisely to the model with no random errors.
 - The difference between the actual values and fitted value then give the residuals.
 - The residuals are used to calculate a large number of possible alternative sets of past data using simulation methods and incorporating the randomness present in the residuals.
 - Bootstrapping can be applied with varying levels of sophistication e.g. assuming that all the residuals follow the same distribution or alternatively distribution can be varied by origin year and development year, which would involve sampling each year separately in the bootstrapping stage
 - The fitted model or same method (e.g. chain ladder) are applied to carry out projections for each of the sets of alternative past data.
 - This gives us a distribution of the possible reserve estimates incorporating the randomness in the residuals.
 - A suitable assumption pertaining to correlation between each class of business is made and also between property damage and bodily injury/death claims of motor class. This dependency can be modeled using copulas and correlation matrix.
 - The claims reserves from individual groups are added for each simulation to determine the total claims reserves and those corresponding to 70% are selected.

[5]

- (iv) The issues surrounding stochastic reserving are:

Model Forms:

- There can be mismatches between the type of model and the data to be used.
- e.g. log-normal models applied to incurred claims triangles/data often does not work well as there are likely to be more instances of negative increments i.e. hump-shaped patterns which are typically applicable for Motor class of business.
- The more flexible over-dispersed Poisson model or Mack model can be used. The former can be applied to individual negative increments for any development period as long as the development factor across the development period as a whole is greater than one whereas the latter can be applied in case where development factor is less than one across a whole is greater than one.

- The stochastic methods described above tend not to be suitable for certain types of claim, in particular latent claims, since they are only able to reflect the variability in the claims data available.

Latent Claims:

- The stochastic methods described above tend not to be suitable for certain types of claim, in particular latent claims, since they are only able to reflect the variability in the claims data available.
- In respect of Motor Third Party liability and Professional indemnity, there is always potential for latent claims which have not been allowed during the pricing of the product.
- A possible approach around this is to use an exposure-based method whereby assumptions concerning the volatility around the number of future claims, and the average cost of future claims, are made.

Sparse data and data peculiarities:

- In case of bodily injury/death claims for motor class of business and professional indemnity claims, the available data maybe quite sparse or missing to determine the overall claims distribution.
- Further, few very large claims might have significant influence in the overall claims reserves. In particular, small changes in numbers can lead to significant changes in the distribution of outcomes, and the results can be quite sensitive to individual points.
- Coping with individual data peculiarities is a matter of individual actuarial judgment; judgment forms as important a part of stochastic reserving as best estimate reserving.

Extremes of tail

- For some purposes, stochastic reserving is used extensively for determining the extreme tail of the distribution of possible outcomes. However, the distribution is parameterized on a finite amount of historic data, which may not be representative of the tail.
- In addition, most stochastic methods make some simplifying assumptions, which may be approximately correct for the bulk of the distribution of outcomes, but which may significantly break down at the extremes. It follows that great care needs to be taken when estimating the tail of a claims distribution.

Under-estimation of variability

- Many of the stochastic reserving methods may possibly underestimate the true variability of reserves due to the assumptions. e.g. the Mack method underestimates the reserve variability due to the central assumption of unchanged development pattern for different origin periods.

- Thus it's imperative that judgment is used while using the stochastic reserving methods and not to accept the results of any one method without question.

[7]

[19 Marks]

Solution 4 :**(i) Assumptions**

All yearly business
 No reinsurance
 Risks written uniformly across year
 Risk is uniform across policy year

Company	A	B
Assets		
Total investments	60,178	93,090
Current Assets	14,354	38,050
Deferred Acquisition	4,178	7,267
Total Assets	78,710	138,407
Liabilities		
O/S claims reserves	27,337	54,105
Additional URR	1,165	3,807
UPR	22,583	34,280
Current Liabilities	12,085	26,855
Free Reserves	15,540	19,360
Total Liabilities	78,710	138,407

$$\text{Deferred Acquisition} = \text{GWP} * \text{Acquisition cost (\% to GWP)} * 0.5$$

$$\text{UPR} = \text{GWP} * 0.5$$

[4]

(ii) Assumptions

- Assume GWP = GEP (i.e. business written in 2013 = business written in 2014)
- Assume AURR as at 31/12/2014 = AURR at 31/12/2013
- Assume o/s claims reserve include IBNR
- No reinsurance

Loss Ratio = Claims Incurred/GEP

$$\text{Company A} = (18,645 + 27,337 - 23,964)/45,165 = 48.75\%$$

$$\text{Company B} = (37,248 + 54,105 - 47,121)/68,560 = 64.52\%$$

Expense Ratio = Acquisition Expense Ratio + Non Acquisition Expenses/GWP

$$\text{Company A} = 18.5\% + 8,362/45,165 = 37.01\%$$

$$\text{Company B} = 21.2\% + 12,145/68,560 = 38.91\%$$

Underwriting Ratio = Loss Ratio + Expense Ratio

$$\text{Company A} = 48.75\% + 37.01\% = 85.76\%$$

$$\text{Company B} = 64.52\% + 38.91\% = 103.43\%$$

Solvency Ratio = Free Reserves/GWP

$$\text{Company A} = 15,540/45,165 = 34.41\%$$

$$\text{Company B} = 19,360/68,560 = 28.24\%$$

Return on Capital employed = (Earned Premium – Claims Incurred – Expenses + Investment Income) / Free Reserves

$$\text{Company A} = (45,165 - (18,645 + 27,337 - 23,964) - 8,355.53 - 8,362 + 4,700)/15,540 = 71.62\%$$

$$\text{Company B} = (68,560 - (37,248 + 54,105 - 47,121) - 14,534.72 - 12,145 + 6,800)/19,360 = 22.98\%$$

[6]

(iii) Comments

- Company B may have suffered from adverse claims experience either on account e.g. a CAT event or a very large claim due to its higher loss ratio as compared to Company B.
- Given that both companies primarily write motor and property business, it is possible that the mix of business might be different, each at a different point in their respective market cycle.
- Company B's expense ratio is higher due to higher acquisition expense ratio as a percentage of GWP.
- Company B might be spending more money to expand rapidly e.g. broker commissions or agent fees or grow its market share in a particular class of business as compared to Company A.
- Company A's return on capital employed is significantly higher as compared to Company B. This mainly could be on account of good underwriting result experienced by Company A as compared to Company B.
- Company B has a lower solvency ratio than Company B, suggesting that the company is less financed than Company A.
- Or it may have stronger valuation basis for its assets and liabilities.
- Company A and Company B both have high returns on capital employed supported by a good underwriting results.

- Company A's solvency ratio is higher than Company B. Comparing with the high return on capital employed for Company A, it suggests that Company A may be over-capitalized with respect to the business requirements. [4]

[14 Marks]

Solution 5 :

- (i) Long tail means that there is a sizeable proportion of total claim payments that take a long time for the insurer to settle from the time of commencement of the exposure

Factors affecting tail of classes of business are:

- Reporting delay
- Settlement delay
- Term/tenure of the policy (e.g. Engineering classes like CAR/EAR)
- Type of coverage – occurrence vs. claim made
- Other relevant factor

[2]

- (ii) Various coverages provided by the comprehensive motor policy are:

- **Compensation for loss of or damage to the insured's vehicle:** The insurance company will indemnify the insured against loss or damage to the vehicle insured and/or its accessories whilst thereon from perils listed or not excluded . The claims are generally short tailed.
- **Compensation for personal injury to third parties and damage to their property:** The insurance company will indemnify the Insured in the event of an accident caused by or arising out of the use of the vehicle against all sums which the insured shall become legally liable to pay in respect
 - of death of or bodily injury to any person including occupants carried in the vehicle
 - damage to property other than property belonging to the .
 - This death or bodily injury claims are generally long tail while third property damage are relatively short tailed.
- **Fixed benefits in the event of defined categories of personal accident to the insured:** The insurance company will pay predefined compensation for bodily injury/death sustained by insured for accident caused in connection to the vehicle insured. Claims are short tailed.
- Any other valid coverage

[6]

- (iii) The policy conditions that may be considered for limiting the tail of the claims from the product under-design could be:

- **Exclusions for difficult to verify claims:** this will help to reduce settlement delays
- **Basis of coverage:** claims made verses occurrence
- **Discovery period:** A time limit, defined in the policy wording, placed on the period within which claims must be reported. This will reduce the risk of reporting delay for claims where several years may elapse between the occurrence of the event and its reporting due to unawareness of the condition that may give rise to a claim : for example employers' liability or professional indemnity. [2]

[10 Marks]

Solution 6 :

The general coverages that could be there are:

- Protection for office equipment and furniture against theft, damage from fire, flood, lightning, hold up or malicious persons.
- Business Interruption coverage - consequential loss of profits insurance in case the office suffers a major fire or coverage of damages to fulfill consultancy contracts due to fire
- plate glass insurance for the office window
- employers' liability insurance if anyone else is employed in the business
- Professional liability coverage / Errors and Omission coverage – insures actuary's professional negligence and that of his firm whilst performing his professional duty as an actuary
- Cyber Liability Insurance coverage
- personal accident of the employees
- Public Liability - Insures against legal liability to third party for property damage or bodily injury caused by your unintended negligence.
- Coverage for money lost during transit between office premises and banks. Also covers loss of money kept in the office during and after office hours.
- Fidelity guarantee - Insures against fraudulent embezzlement or misappropriation of any money or property belonging to the actuary, committed by any staff member or partner.
- Others relevant coverage

[5 Marks]

Solution 7 :

(i) Working of typical securitized reinsurance product:

- An investor purchases a bond from the insurance company and therefore provides a sum of money to the insurer.
- The direct link between the investor and the issuer is broken by a special purpose vehicle (SPV), which is a separate legal entity that sits between the

parties. Where it is a portfolio of business that is being securitized, the securitized assets are transferred into this vehicle.

- The repayment of capital (and possibly of interest) is contingent on:
 - a specified event not happening, e.g. an earthquake measuring 6.5 on the Richter scale not happening, or
 - the portfolio of insurance business (upon which the bond is securitized) producing adequate profits.
- If the event does happen (e.g. the aforementioned earthquake occurs), or inadequate profits are made from the securitized business, the insurer may default on the interest and capital payments due under the bond:
 - in the case of securitizing a particular risk, the insurer can use the sum of money provided from the investor (in purchasing the bond) to cover the cost of claims arising from the earthquake
 - in the case of securitizing a block of business, the poor experience of the business has been passed directly to the investor.
- If the event does not occur or the business makes adequate profits, the investor gets his interest and capital back in the normal way.
- The credit risk is very minimal in cat bonds due to the SPV structure. [5]

(ii) The impact that growth of cat bonds could have on traditional reinsurance market are:

- Increased capital flow through ILS market may lead to softening of rates for catastrophe reinsurance coverage as reinsurers try to retain business
- May lead to increased coverage terms provided by traditional reinsurer for cat perils which are covered by ILS market
- The traditional reinsurer could themselves also think of entering this market through subsidiaries so as to retain their business and continue to provide solutions to its existing clients
- May lead to increase in soft commissions from reinsurers like risk advisory services, researches, technical consultancy, etc to the cedants.
- May lead to innovation in reinsurance product to regain market
- Other valid reasons

[4]

[9 Marks]

Solution 8 :

(i)

Risk profile: The risk profile is defined fundamentally by:

- The risks that have been modeled (including the way that they have been modeled)
- The key outcome used to measure success or failure.

Risks modeled are typically those arising from business that has already been written and a finite period of new business activity.

Typically we use a financial outcome as a measure of success or failure – for example the profit and loss or net cash flows over a selected time horizon or the balance sheet position at the end of a selected time horizon.

Risk measure: We can define the risk measure in terms of the desired impact of the capital on the outcome considered.

For example, we might set capital to achieve a selected probability that the balance sheet at the end of one year shows a surplus no less than zero.

Risk tolerance: The risk tolerance is simply a parameter (or set of parameters) that links the risk measure, as applied to the risk profile, to a single capital amount.

For example, a risk tolerance of 0.5% would set capital such that there is one chance in 200 that the balance sheet position at the end of the year shows a deficit. [6]

(ii) a) Rank by risk types

Scenario	Insurance Risk	Market Risk	Credit Risk	Operational Risk
1	2	10	8	2
2	4	7	10	7
3	3	8	2	2
4	10	6	5	1
5	5	4	3	2
6	9	5	9	6
7	7	2	3	9
8	6	1	6	7
9	1	9	6	9
10	8	3	1	2

VaR (Insurance) = - 65

VaR (Market) = -19

VaR (credit) = -9

$$\text{VaR (operational)} = -6$$

[2]

b) The overall risk profile is

Scenario	Insurance Risk	Market Risk	Credit Risk	Operational Risk	Total Risk	Rank
1	68	-26	-9	0	33	4
2	50	-14	-11	-2	23	6
3	61	-19	-4	0	38	3
4	-177	-6	-6	2	-187	10
5	47	35	-5	0	77	1
6	-73	26	-10	-1	-58	9
7	-59	57	-5	-6	-13	7
8	-28	62	-7	-2	25	5
9	81	-24	-7	-6	44	2
10	-65	39	-3	0	-29	8

$$\text{VaR (70% ile)} = -29$$

[2]

c) Allocated capital by Co-VaR approach is average of individual risk profile where overall risk profile prob > 70%

Scenario	Insurance Risk	Market Risk	Credit Risk	Operational Risk	Total Risk	Rank
1	68	-26	-9	0	33	4
2	50	-14	-11	-2	23	6
3	61	-19	-4	0	38	3
4	-177	-6	-6	2	-187	10
5	47	35	-5	0	77	1

6	-73	26	-10	-1	-58	9
7	-59	57	-5	-6	-13	7
8	-28	62	-7	-2	25	5
9	81	-24	-7	-6	44	2
10	-65	39	-3	0	-29	8

Allocated capital (Insurance Risk) = - (177+73+65)/3 = -105

Allocated capital (Market Risk) = (- 6+ 26+39)/3 = 19.67

Allocated capital (Credit Risk) = - (6+10+3)/3 = -6.33

Allocated capital (Operational Risk) = (2-1+0)/3 = 0.33

[2]

(iii) Modeling of insurance risk

It is normally divided between:

- underwriting risk (also known as premium risk), relating to risks yet to be written / earned, and
- reserving risk, relating to risks already written / earned.

Underwriting Risk

- To determine the capital requirement for the underwriting risk at the chosen level of risk tolerance, we should divide the firm's business into classes / currencies /territories of sufficient granularity (that is, small enough subdivisions) that we can consider distinctive features of the class, but not so fine that statistical methods become invalid (because of insufficient data in the subdivisions).
- We should then assess the variability of its claims and expenses, either by fitting statistical distributions or by simpler approaches such as stress tests.
 - **Modeling of gross premium and commission:** Generally obtained from business plan. Rate changes or underwriting cycle can be stochastically modeled or stress tested.
 - **Modeling attritional claims:** We generally model attritional claims in aggregate. A mildly-skewed distribution such as the lognormal may be appropriate, although we should test this against experience.
 - For classes that are small or not subject to large claims it may be more practical to model loss ratios.
 - **Modeling Large Claims:** Ideally, we should model large claims separately from attritional claims so that we can determine reinsurance recoveries directly. (The dividing line between large and

attritional claims is often the firm's typical retention for policies in the class).

- Generally modeled on frequency and severity basis. Poisson or negative binomial used for frequency modeling. A heavily-skewed distribution such as the Pareto would normally be appropriate for severity, and we should derive it from or test it against historic data revalued to current claims costs.
- **Modeling Catastrophe losses:** Modeled using outputs of third party vendor's proprietary catastrophe models but should be validated before use.
- **Reinsurance:** The losses should be passed through reinsurance programs to derive net underwriting risk profile.

Reserving Risk

As a starting point,

- We can consider the firm's actual reserves if these are prepared on a best estimate basis.
- If the firm includes a significant reserve margin in its published reserves, we should first remove this.
- We should divide the firm's business into classes of sufficient granularity, but not so fine that statistical methods become invalid. Also principle of proportionality should be applied to determine granularity.
- Claim can be modeled by types separately depending upon its impact of risk measurement
- We should then assess the variability in the firm's claims settling, by statistical techniques such as bootstrapping or the Mack method, applying appropriate distribution around best estimate reserve, or by simpler approaches such as stress tests.
- Reinsurance :
 - Simple net to gross ratio
 - Passing through RI program
 - Combination of above

Dependencies that could be applied in the model are:

- Reserve risk v/s underwriting risk
- Within class – within and across claim type/years
- Between class
- Between classes and market – through underwriting cycle
- Link catastrophe risk and financial market returns
- Reinsurers default and total underwriting risk or cat risk
- Other valid dependency

[8]

(iv)

a) Areas where the model can be used in investment decision making are:

- Investment portfolio risk modeling by asset class , managers, etc
- Putting portfolio constraints based on risk tolerance of the company like constraint on investment by asset classes, by managers, etc
- Cash flow matching
- Asset allocation to optimize capital /profit and /or ROE
- Other valid uses

[2]

b) The prime objective regarding the investment of the assets supporting these liabilities is to maximize investment return, subject to meeting all contractual obligations whilst ensuring the risk against not receiving the return is within the company's tolerance. Factors impacting are:

- Assets should match liabilities by:
 - Term
 - amount
 - nature (fixed or real)
 - currency.
 - Volatility in liability and need of liquidity
- Risk appetite of the insurance company
- Impact of inflation on claims and need to balance that with investment in assets with return positively impacted by inflation
- Impact of free assets on investment – can invest in more risky assets with higher return
- Proportion of Non-investible funds like money held by agent/broker/reinsurers, etc
- Expenses by various asset classes
- External influences
 - tax treatment
 - statutory, legal, ethical or voluntary restrictions
 - statutory valuation requirement
 - solvency requirements
 - rating agency constraints
 - competition
 - regulatory constraints

[4]

[26 Marks]
