Institute of Actuaries of India

Subject ST7 – General Insurance: Reserving & Capital Modeling

March 2017 Examination

INDICATIVE SOLUTION

Solution 1:

i)

a) Coverage Trigger
Claims need to be reported in policy period for claims-made policy. Accident/Event needs to occur in policy period for occurrence policy.

(1)

b) Reporting Lag
No reporting lag in claims-made policy. Present in occurrence.

(1)

c) Settlement Lag
Same.

(1)

d) Sensitivity to inflation
Occurrence is more sensitive to inflation since the reporting period extends into the future.

(1)

e) Investment income
Occurrence will be more since premium is held for reporting + settlement lag vs only settlement lag in claims-made.

(1)

f) Reserving risk
Occurrence is more due to reporting + settlement lag.

(1)

ii) Claims-Made + Extended Reporting
Accident Period Covered = Jan 1st 2017 to Dec 31st 2017
Reporting Period Covered = Jan 1st 2017 and later

Occurrence
Accident Period Covered = Jan 1st 2017 to Dec 31st 2017
Reporting Period Covered = Jan 1st 2017 and later

(1)
[7 Marks]

Solution 2:

i) a)

			Lag (in months)							
		Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**	Ultimate
		2010	180	195	200	215	217	218	218	218
		2011	210	220	225	230	232	233		233
		2012	212	230	235	240	241			242
		2013	160	175	185	190				192
		2014	140	150	160					168
		2015	138	150						163
		2016	110							129
			1.08	1.03	1.08	1.01	1.00	1.00		
			1.048	1.023	1.022	1.009	1.004			
			1.085	1.022	1.021	1.004				
			1.094	1.057	1.027					
			1.071	1.067						
			1.087							
				2015.000	2014.000	2013.000	2012.000	2011.000		
Selected Age-to-age			1.077	1.036	1.036	1.007	1.004	1.000		
Age-to-Ultimate			1.169	1.086	1.048	1.012	1.004	1.000		

Selections with appropriate justifications should be provided.

(3)

b) Tort reform, Mix of business change, fraud, change in incidents, shrinking book, faster reporting, change in claim lodgement procedures

(2)

ii) a) Claim closure rates

0.20	0.25	0.30	0.45	0.60	0.75
0.20	0.25	0.30	0.45	0.60	
0.20	0.25	0.30	0.45		
0.40	0.51	0.65	0.91		
0.40	0.53	0.68			
0.40	0.52				
0.40					

Claims handling personnel changes, frivolous claims reporting increase, tort/legal reforms likely

(3)

[8 Marks]

Solution 3:

i) Uncertainty in cash flows, claims, demand surge, climate change, changing litigiousness, legislation, economic conditions, changes in business mix etc.

(3)

ii) Ranking – e,b,d,c,a (other permitted but 'e' smallest and 'a' highest)

Reasons – e has fixed small limit, event known immediately. d,c, b similar logic with increasing sum insured and timing. a has high limit, event unknown for much longer, longer tailed etc.

(5)

iii) a) Ultimate Claims decreasing due to unwinding of reserves downwards. Implies, initial reserves were set high.

(1)

b) Actuarial "best estimate" need not be 50^{th} percentile for long-tailed business or lines where there is other considerations being taken due to not all events being reflected in past data. Second, these are management booked reserves which is not the same as actuarial "best estimate" and may contain management's expectations and margins.

(1)

iv) Reserves being released from 2008 to 2012, then strengthened from 2013 to 2016. Indicative of market cycle – soft market and hard market. Excess capital early on, forces drop in prices, underwriting worsens, worsening results, forces strengthening of reserves.

(2)

[12 Marks]

Solution 4:

i) a)

	Average Severity
Brain Damage	350,000
Death	150,000
Temporary Minor Damage	65,000

2003-2006 paid = 1*350K+2*150K+1*65K = 715,000

(1.5)

b) Time period for industry data may not apply (trends etc.), mix of companies may be different in industry data, outstanding claims may not be paid especially since system reserves still in place.

(1.5)

ii)

	Mack	Bayesian
Assumptions	Distribution-free	Prior distribution
Output	Mean and Variance	Full predictive distribution
Implementation	Easy formulae	Relatively more difficult, MCMC for numerical integration
Flexible	Handles negative increments, development<1	Explicitly shows the impact of judgments
Variability	Real variability almost always greater, due to latent claims	Over dependance on choice of prior, but variability closer to real

(4)

iii) a)

$U(BF) = C + (1-p)*U(0) = p*U(CL) + (1-p)*U(0)$

(1)

b)

$U(BF) = U(1) = C + (1-p)*U(0) = p*U(CL) + (1-p)*U(0) = (1-q)*U(CL)+q*U(0)$

$U(2) = C + (1-p)*U(1) = p*U(CL) + (1-p) *[p*U(CL) + (1-p)*U(0)] = (1-q)*U(CL)+q*(1-q)*U(CL)+q^2*U(0) = (1-q^2)*U(CL)+q^2*U(0)$

$U(n) = (1-q^n)*U(CL)+q^n*U(0)$

(3)

c)

$U(BF) = U(1) = C + (1-p)*U(0) = p*U(CL) + (1-p)*U(0) = (1-q)*U(CL)+q*U(0)$

$U(2) = p*U(1) + (1-p) *U(0) = p*[p*U(CL) + (1-p)*U(0)] + (1-p) *U(0) = p^2*U(CL) + (1-p^2)*U(0)$

$U(n) = p^n*U(CL)+(1-p^n)*U(0)$

(3)

d) Actuary A's estimate = $U(n) = (1-q^n)*U(CL)+q^n*U(0)$. Since $0<q<1$, $q^n \rightarrow 0$ as $n \rightarrow \inf$.

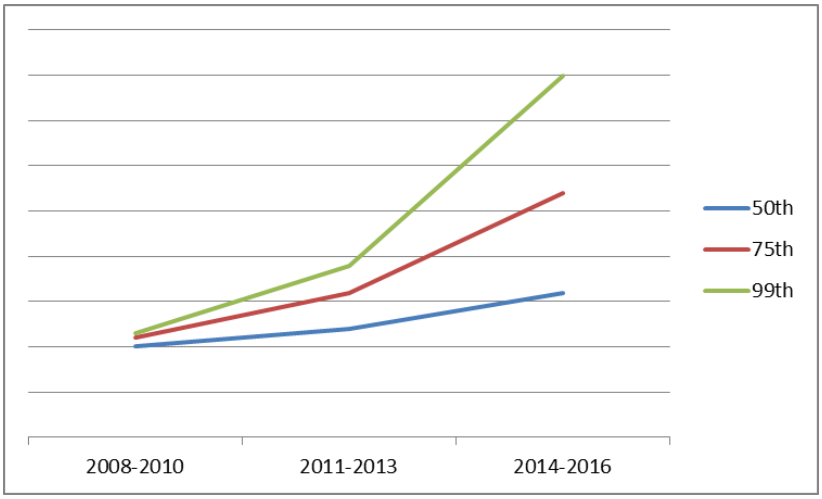
So, $U(n) \rightarrow U(CL)$

Actuary B's estimate = $U(n) = p^n*U(CL)+(1-p^n)*U(0)$. Since $0<p<1$, $p^n \rightarrow 0$ as $n \rightarrow \inf$.

So, $U(n) \rightarrow U(0)$.

(2)

iv)



Lines will slope upwards since lesser outstanding reserves for earlier year.

Rate of increase of slope will be greater for higher percentiles due to tail of loss distribution and greater proportion of "unknown" development for recent years.

(2)

v)

a) Not sufficient. Doesn't take into account timing of reserves (other prior diagonals). Any inaccuracies in that will flow through as distortions in incurred claim patterns affecting reserve analysis.

(1)

b) For shorter tailed lines, reserves will unwind faster making the distortion in incurred patterns less significant as greater proportion of claims in mature lags is due to paid claims.

(1)

[20 Marks]

Solution 5: i)

a) Reinsurance of reinsurance. Needed when a reinsurer who takes on significant liability as reinsurer needs insurance. Ceding reinsurer is retrocedant and assuming reinsurer is retrocessionaire.

(1)

b) Direct writer cedes a proportion of the risks, passing on a proportion of the premium, and the reinsurer pays that proportion of the claims. Proportion may be constant for all risks (quota share) or at the discretion of the ceding insurer (surplus)

(1)

c) Reinsurer covers losses in excess of a limit. Types are Excess of Loss, Stop Loss or Aggregate Excess of Loss.

(1)

ii)

a) A clause that may be included in a non –proportional reinsurance treaty, providing for the indexation of monetary limits (that is, excess mark and/or the upper limit) in line with specified index of inflation. **(2)**

b) For non-proportional reinsurance, the total premium charged (ignoring reinstatement premiums) for the reinsurance divided by the width of the layer covered.

(2)

iii)

Factors to consider are:

- Look at the reinsurance profit and loss accounts (or suitable ratios, e.g. recovery ratios) historically by year to understand the level of profit or losses ceded
- Analyze separately for each treaty to understand the impact of each arrangement on the overall result
- Analyze different levels of facultative arrangement (e.g. by size of risk) to determine profitability by amounts ceded
- Check to see if the period has been atypical in terms of claims experience and adjust accordingly
- Compare cost of other forms or levels of reinsurance that could have been used
    - For example, would a Property per risk treaty with a higher or lower retention have proved more profitable for the insurer (or other appropriate example)
- What are the current reinsurers' credit ratings? Is there a need to move cover to more secure companies?
- What level of financial assistance are the current reinsurers providing? Do these adequately cover acquisition and administration costs?
- What level of technical assistance is provided by the reinsurers?
- Can the company find more tailor-made solutions elsewhere?
- Any reciprocal arrangements in operation need to be assessed to determine the profitability of these arrangements and their effectiveness in reducing risk concentration
- Look at how the reinsurance programme reduces capital requirement
- Check extent to which reinsurance programme covers accumulations of risk in book
- Analyze the profit smoothing achieved by the reinsurance programme
- Consider any regulatory constraints or relaxations that the reinsurance programme has caused
- Has the reinsurer imposed any conditions, e.g. minimum retention, certain policy conditions? Are they in line with the business plan? **(5)**

[12 Marks]

Solution 6:

i) Consider following:

1) Compare companies with similar business mix within third party liability business

2) Examine individual accounting items gross and net of reinsurance

3) Examine ratios within and across years, ratios that could be considered are:

- **i.** Incurred claims (i.e. paid + change in claims reserves) to premium income
- **ii.** IBNR claims reserves to premium income
- **iii.** outstanding claims reserve to claims paid
- **iv.** IBNR to outstanding claims reserves
- **v.** Paid claims to incurred claims

4) Other relevant marks

(5)

ii) Risks and uncertainty faced by Motor third party liability business are:

- Inherent uncertainty in the individual claims (amount and frequency)
- Legislative changes
- Judicial decisions impacting the quantum of compensation
- Social changes like society being increasingly litigious
- Changes in government administrative mechanism, specially impacting the delay in reporting of the claims.
- Economic factors:
  - Wage inflation impacting the pecuniary damage compensation
  - Medical inflation impacting the expenses for non-fatal injury claims
  - Interest rates, impacting the investment income of the company. As motor third party liability is long tailed, investment income may have a significant impact on the earnings of the company.
- Uncertainty over claims handling expenses
- Changes in behavior of the third party like lawyers offering no win no fees to claimant.
- Other relevant marks

[5]

iii) Advantages

- Returns may be higher, in which case the company would improve its overall investment performance
- Equity may be better matched for real, long term liabilities
- Equities could provide diversification to the fixed income portfolio
- Other relevant marks

Disadvantages

- Returns may be lower, in which case the company would see worse investment performance
- Equity has a greater volatility of potential returns, which means there is an increase in risk
- Equities too long to match third party liabilities
- If the Capital requirements are likely to be risk-based, this would means equity treated as higher risk
- Other relevant marks

(6)

iv)

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
- Supervisory restrictions should be considered like:
  - Restriction on amount of certain type of assets
  - Custodianship of assets
  - Requirement to hold mismatching reserve
  - Admissibility of asset type as capital
- External influences
  - tax treatment
  - statutory, legal, ethical or voluntary restrictions
  - statutory valuation requirement
  - solvency requirements
  - rating agency constraints
  - competition
  - regulatory constraints
- Other relevant mark

(5)
[21 Marks]

Solution 7:

i) The factors that should be assessed before deciding on the modelling 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.

b) Budget available for the project; stochastic model generally involves more time building and parameterizing

c) What is the main reason of developing capital model: regulatory compliance, rating agency requirement or risk based decision making

d) Availability of skilled actuarial resources in the market.

e) 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.

f) Practical considerations like would it be better to have quick win by modelling deterministically and once the company is able to understand and appreciate the value of risk based capital, it could go for sophisticated model.

(3)

ii) **Advantages of stochastic model are:**

- 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.

Disadvantages of stochastic model are:

- 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.

(7)

iii) Different type of dependencies that could be modeled are:

a) Insurance Risk
  - **i.** Within a class –within and across claim type/event, years
  - **ii.** Between classes –within and across claim type/ event, years
  - **iii.** Between classes and the market -underwriting cycle
  - **iv.** Market losses across a group

b) Credit Risk
  - **i.** Reinsurer default: events across reinsurers
  - **ii.** Reinsurer default vs. total underwriting risk or cat risk (proxy for the market)

c) Market Risk
  - **i.** Inflation and interest rates
  - **ii.** Link catastrophes and equities (stock markets slump following major disaster)

d) Liquidity Risk
  - **i.** Insurance, reinsurance default and investment returns

e) Operational Risk
  - **i.** Between risks, type of activity, functions in a company, signatories, controls

f) Other relevant dependencies.

(5)

iv)

a) To stress test the model performance under varying scenarios and ensure credibility of the output.

To provides evidence that the model does what it is intended to do and is a useful and accurate representation of the business

(2)

b) Importance of validation :

- Demonstrate to external parties like regulator and rating agency, that model is good representation of the business
- To enable model to be used for internal decision making
  - Management needs comfort
  - Results at all levels of the model are important
  - Need to understand degree of confidence in each area, and
  - understand model limitations

(3)

[20 Marks]

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