INSTITUTE AND FACULTY OF ACTUARIES

SAMPLE SOLUTIONS

April 2015 examinations

Subject ST7 – General Insurance: Reserving and Capital Modelling Specialist Technical

1 (i) Covers the aggregate of losses above an excess point and subject to an upper limit..
..of losses sustained from single event/defined peril over a certain period.

(ii) This is the total premium charged divided by the width of the layer of cover provided.

2 It is important to consider potential cause-and -effect relationships between risks.

We may model such relationships better using deterministic relationships rather than relying on statistical dependence structures.

It is more straightforward and, therefore, quicker and cheaper to build a deterministic model than a stochastic one.
Deterministic model is easier to sense check
…and easier to flex
It does not require the same level of expert resource as a stochastic model
.. and gives rise to less risk of model error.

There is less danger of parameter error

...and less danger of spurious accuracy, particularly in the tail
A deterministic approach may be appropriate where there is less data

By reducing the computational power necessary to generate many thousands of simulations, we can introduce more detail in other dimensions,
such as detailed descriptions of reinsurance programmes or treatment of underlying risks.

This may aid the intelligent selection of a limited number of scenarios.

It could be more efficient than a stochastic model where we hope that the important scenarios appear amongst a larger number of randomly generated outcomes.

We can integrate the capital model more closely with risk management,
by extending the scenario modelling to scenario planning and “what-if” analysis.

We commonly use stress and scenario tests for those risks that cannot easily be modelled quantitatively and where more subjective judgment is required.

This allows us to concentrate more on the more important areas of the distribution of outcomes for the key risks when a full specification of the distributions is impossible.

By developing deterministic stresses and scenarios, we can help to link the capital model with the risk register, helping to integrate capital and risk management.

It can be easier to communicate the results of stress and scenario tests to senior management, and to give them comfort as to the reasonableness of the overall capital value.

It is important that users of the output understand the results from the model as well as methods and assumptions.

By showing the effect of a limited range of stresses and scenarios – some of which may have been developed in consultation with those users – we can often make the results more comprehensible to them.

3 (i) Two out of three reasons:

Reason 1: claims payments may have speeded up.

This will mean that applying average development factors to the latest paid claims will result in an excessive estimate of ultimate claims.

The processing of gross payments or recoveries may be underlying this

Reason 2: reserves for outstanding claims have been reduced.

This will mean that applying average development factors to the latest incurred claims could result in an inadequate estimate of ultimate claims.

Reason 3: the tail factor applied to the paid claims is excessive or that applied to the incurred claims is inadequate.

This is somewhat unlikely, given the fact that the paid tail is normally greater than the incurred tail, but it should be checked.

(ii) This can be tested by examining paid development factors for each individual accident year.

If we calculate these and look at the factors from individual columns we are likely to see that the factors increase over the years.

A second test, if the data are available, would be to calculate the average claim paid.
This can be found by any of the following calculations, dividing one triangle into another.

The average payment per advised claim,
.. total paid claims divided by total number of claims advised.

The average settled claim
.. total payments on settled claims divided by total number of claims settled.

The proportion of advised claims that have been settled.
.. total number of claims settled divided by the total number of claims advised.

If claim payments are indeed speeding up then all of these triangles will show increases reading down the columns.
The actuary can make these calculations only if he has the necessary triangles available: only the triangle of total claims paid will necessarily have been available for him to have used the paid chain ladder.

As part of the test, the actuary needs to allow for inflation.

We either need to adjust for these triangles for inflation or else see whether they increase in a way that cannot be explained by the level of inflation that we have expected.

We should examine the triangle of average outstanding claims: total claims outstanding (incurred minus paid) divided by the triangle of numbers of outstanding claims (number of reported claims minus numbers of settled claims).

If this is the reason for the discrepancy then the incurred claims will be a poor guide to the ultimate claims and the paid projection is likely to be more reliable.

What we would expect is that the average outstanding claim in this triangle at each duration, again reading down the columns of the triangle, will increase at an appropriate rate.

Again, inflation will need to be allowed for in this: we should expect the average claim reserve to rise over time and the absence of this could be taken as evidence of erosion of reserving standards.

If the amounts read down the columns have reduced over time then this is strong evidence of erosion.

Test analysis and assumptions by obtaining information from underwriter and claims. They may be able to provide some background, although it would be dangerous to take their opinions as fact when uncorroborated by further evidence.

They may have anticipated some change in conditions, such as a future increase in the rate used to discount future payments on claims for long-term injury, that might justify a lower estimate of ultimate claims than the paid development would imply.

It may be helpful to examine the triangle of paid:incurred ratios. (Or, equivalently, of incurred:paid or outstanding:incurred and paid.)

This will show us whether the problem is one that has arisen gradually over the years or whether it is a problem of the data in the most-recent diagonal.

If the triangles of numbers of claims are not available then we will need to make other enquiries. We could examine the projected loss ratios: other things being equal we will expect reasonably constant loss ratios over the years (or to vary with the underwriting cycle.)

It would be helpful in this if we had information about premium-rate changes over the years and any changes known about in terms and conditions and in the market conditions generally, such as the emergence of a new type of claim.

We may also need to carry out some original research in claims files.

Salvage and subrogation may affect the development of triangles of claims.

Test the effect of salvage and subrogation to assess the impact of recoveries.

These recoveries are often made late in the development of claims. It may be that they have been anticipated in the incurred claims but that the paid tail has not yet reached the point where they have become significant.

In this case the paid projection will be overstated and the incurred will be more likely to be accurate.

It may also be appropriate to re-examine the tail factors that had been applied to generate the projections.

Compare with benchmark development factors.

Additional mark for any further discussion on length of tail or additional tail analysis.

4 (i) Assume no change in NWP from 2013 so NWP = NEP

Assume net premium/incurred is net of reinsurance not acquisition costs.

Solvency ratio = Free Reserves/Net Written Premium
Solvency Ratio (A) = 450/760 = 59.2%
Solvency Ratio (B) = 250/300 = 83.3%

Assume ratio expressed on premium including acquisition costs.

Claims ratio = Gross claims incurred/Gross Earned Premium
Claims ratio (A) = 500/800 = 62.5%
Claims ratio (B) = 300/400 = 75%

ROCE = Profit Before Tax/Free Reserves at start of year

Assume free reserves at start of year = free reserves at end of year – profit in year, assuming no dividends or tax

Where profit = net earned premium – net incurred claims – commission – other expenses + investment income

ROCE (A) = (760 – 475 – 80 – 100 + 40)/(450 – 145) = 48%
ROCE (B) = (300 – 270 – 80 – 40 + 20)/(250 + 70) = –22%

Full credit given if attempt made to amend free reserves for example to estimate an average free reserve over the year.

(ii) **Solvency Ratio**

Solvency ratio is better for B despite writing loss making business.
..could be that A is expanding so is using free reserves to fund growth
..this is supported by UPR being large compared to outstanding reserves.

Possible that the valuation basis for assets and liabilities is different for A & B.

Claims Ratio

Company A has a much better claims ratio than Company B.

B may be worse due to poor underwriting/inadequate pricing.

B could also have been adversely impacted by catastrophe event.

Comparatively small volume written by B may make result more volatile.

Different reserving philosophy

e.g. stronger case reserves or reserve margins used in Company B

Different types of business written.

e.g. longer tail, different claims propensity, earnings pattern, APH exposure etc.

ROCE

Level of losses from company B serious using up a third of free reserves in a year.

Company A profitable so returns healthy return on capital.

Other

Reinsurance

B uses more reinsurance than company A
..but gets poor value from it (RI LR 30% vs 62.5%)

B may have purchased more reinsurance to try and mitigate the poor performing business

May have purchased reinsurance for different purposes (cat/working layers/QS)

Evidence suggests A is using QS and B non-proportional

Investments

A achieves much higher return on investments than B
..but A has a more risky portfolio including equity investment.

Relative size of company

A only slightly larger balance sheet than B but writing twice as much net premium.

Could indicate that B is trying to reduce business to return to profitability.

Expenses

A pays much lower commission than B (10% vs 20%).

May indicate different distribution channel e.g. A direct vs B broker.

Other expenses show B appears to be slightly more efficient than A.

Mark for any general comment around 1 year data not sufficient to determine trend.

Calculation of additional useful ratio
..sensible explanation of ratio.

5 (i) Comment that the figures may be pre/post diversification credit.

Property cat has a relatively high capital allocation relative to premium written..
..may reflect concentration risk by location
..reasonable as exposure to hurricanes/earthquakes means significant catastrophe risk.
..and therefore results can be very volatile thus capital for underwriting risk..

..although unlikely to have large reserves so reserving risk will be small.

Allowance for demand surge or liquidity risk

Professional indemnity also has quite a high capital requirement relative to premium
..likely to be dominated by reserving risk as long tailed business
..may also be allocated more market risk as benefits from investment income.

GL also long tail but only written for one year so unlikely to have high reserves
..however as new class of business may be allocated more capital for new business risks
i.e. uncertainty around pricing, lack of historic data etc. (underwriting risk).

Pet insurance meanwhile has been written for a number of years..
..and normally has low reserves and fairly stable loss ratios..
..all which contribute to its overall low capital requirement.

Motor class written for a number of years so likely to have significant reserves

..possible risk of legal changes increasing cost of settling claims..
..may be considering aggregation with GL as both exposed to bodily injury claims.

Motor class is written direct so lower credit risk than brokers holding balances.

No information on past premium and mix – historical premium may be different to expected future premium

Perceived political risk

Additional Info

Information on level of reinsurance purchased for each unit would be needed
..to comment on respective levels of credit risk

Growth in class of business over time

Relative expense levels by class of business

Other capital allocation methods may give very different answers...
...as may a different actuary using different judgements.

Any other reasonable observation on figures.
Justification why this is the case.

(ii) Comment relevant for considering annual profitability of business rather than capital requirements to run-off. Or a relevant comment related to risk horizon
...even after diversification will still need some capital for extreme events.

While it is certainly true that it is normally the case that not all classes will perform badly at once

This is generally allowed for through diversification credit in capital model

Often done on top-down basis when allocating capital

Also unlikely that such movements will exactly offset.

There are also examples of common causes leading to all classes perform badly at once

Not least soft underwriting cycle/rating pressures in a number of lines simultaneously.
Legal changes could impact a number of classes of business simultaneously..

..e.g. UK motor and UK GL impacted by changing bodily injury settlements.

There could be systematic underpricing and therefore losses in all classes..
..arising from inadequate data or failure of underwriting controls.

Any problems in the claims department could impact a number of classes..
..for example inaccurate case reserving or claims leakage from delays in settlement.

Therefore company-wide risks (e.g. operational, reputational) need to be allocated to individual classes of business.

Plan vs actual premium could drive very different or incorrect allocation

Any other reasonable example of common cause of poor result across number of classes
Explanation for this deterioration.

6 (i) **Assumptions**

Only have annual development profile

Linear interpolation used to get 6 monthly factors.

Derive % developed/cumulative factors for each required profile

% dev	*2014*	*2013*	*2012*	*2011*	*2010*
Best estimate incurred	24%	42%	59%	73%	80%
Best estimate paid	5%	11%	22%	35%	51%
6 month lag incurred	12%	33%	51%	66%	76%
6 month lag paid	2%	8%	17%	29%	43%
6 month acc incurred	33%	51%	66%	76%	83%
6 month acc paid	8%	17%	29%	43%	59%

Recalculate methods using revised assumptions

Year	*Low Ultimate Claims*	*High Ultimate Claims*	*Paid Claims*
2010	19.2	20.9	10
2011	17.8	24.3	7.3
2012	19.8	24.9	5
2013	16.2	22.4	1
2014	15.6	20.4	0
Total	88.6	112.9	23.3

Low reserve is 88.6 – 23.3 = 65.3, high reserve is 113.0 – 23.3 = 89.7

(ii) (a) **Bayesian Method**

Prior distribution of model parameters is first chosen based on judgement, experience or benchmarks.

Then posterior distribution calculated using Bayes' Formula.

Using simulation based techniques e.g. Markov Chain Monte Carlo, a simulated distribution of parameters can be obtained.

Mack Method

The Mack method uses formulae to derive standard errors of chain ladder reserve estimate.

Only first two moments are specified rather than full distribution.

Assumptions are:

Run off pattern is same for each period.

Future development of cohort is independent of historical factors.

Variance of cumulative claims to development at time t is proportional to claims at $t - 1$

(b) Bayesian method provides a complete distribution which Mack does not do.

Complex methods (e.g. numerical integration) may be needed to get closed form results.

..while Mack method is more straight forward to implement (even in a spreadsheet).

Bayesian approach also explicitly shows judgements in the prior distribution.

..while it may be more difficult to see where judgement is applied using Mack.

However choice of prior distribution can be very subjective, particularly if little experience

..meaning posterior distribution may be heavily influenced by this subjectivity.

Mack model meanwhile makes no distributional assumptions.

Both models can handle negative increments in data/experience.

A disadvantage of Mack for deriving a range is that the choice of distribution makes it vulnerable to inaccuracy in the tail.

An advantage of Bayes is that many metrics can be calculated e.g. Confidence intervals, quantiles

Mack is more sensitive to the quality of the data

Mack does not reflect all possible values and therefore the range maybe underestimated

Mack approach is more widely used in practice. Bayesian method provides a complete distribution which Mack does not do.

(iii) Mean (best estimate ultimate claims) = 20 + 21 + 22 + 19 + 18 = 100

Standard deviation = 15

Determine parameters μ, σ

$$e^{\mu+\frac{1}{2}\sigma^2} = 100$$

$$e^{\mu+\frac{1}{2}\sigma^2}\sqrt{e^{\sigma^2}-1} = 15$$

Therefore $e^{\sigma^2} - 1 = 15^2 / 100^2$

σ = 0.1492

μ = 4.5940

Require 90th Percentile:

10th/90th percentile given by $\mu + 1.28155\sigma$, $\mu - 1.28155\sigma$
i.e. 4.40288, 4.785209
so ultimate claims are exp (4.40288) and exp (4.785209)

Therefore range of ultimate claims is {£81.69m, £119.73m}

Paid claims are £23.3m so reserve range is {£58.39m, £96.43m}

7 (i) (a) The two main types of cover are buildings and contents.

Buildings

Cover is reinstatement as new

Sum insured is cost of rebuilding

Content

Cover is either:
Indemnity

The policy will pay the value of the item at date of loss (i.e. allowing for wear and tear)

New for old/reinstatement as new

The policy will pay the cost of replacing the item with a new item of similar quality

Sum insured should be a minimum of 100% of value on either basis

Although there are policies which have a sum insured based on number of bedrooms.

Marks awarded for perils e.g. freezer, high value.

(b) **Business is sold**

Intermediaries (separate from the insurer)

Independent intermediaries free to sell the policies of any company

Tied agent limited to selling the policies of one company

Company sales staff

Direct sales staff (generally by phone)

Internet sales (direct or via aggregators)

Other e.g. Affinity, Off-the-page, mail shots

(ii) First need to understand where your exposures are and consider coastal vs river flooding areas

..because of differences between coastal/sea and river flooding:

Sea flooding is likely to be more destructive
because of increased volume of water and salinity

Sea flooding affects property fairly close to sea level
river flooding affects properties on flood plains of rivers

There is also surface flooding from excessive rainfall, blocked drains etc. which is very difficult to forecast

Consider cat modelling software

Coastal Flooding

Obtain history of maximum sea levels over long period, say 100 years.

Project maximum likely sea level

Allowing for trends

Identify all properties which are at or below this level

Use postcodes to determine location

Using ordnance survey maps or other contour maps identify which postcodes are at risk

Make qualitative judgements as to proportion of properties at risk within each postcode

Add together the sum insured for all exposed properties adjusted by the last two factors

River Flooding

Theoretically possible to use same approach as for coastal flooding

Use historical data to locate areas with a history of flooding

Sum total insured values in these areas

(iii) (a) Proposal form additional information:

Height of property above sea level

Number of floors of house

For a flat which floor(s) it is on

Other trends in weather or rainfall to monitor water table

Public body/government publications

Distance from and height above closest river

Geographic data

Height of sea/river defences:

Quality of defences (earth/concrete etc.)
Could relatively easily survey parts of the coastal defences

Meteorological information

Trends in sea level as result of global warming

(b) Information such as height of property not known by most policyholders.
While others such as number of floors will be straight forward.

With all questions on a proposal form there is likely to be a moral hazard if the proposer believes that flood exposed property would attract a higher premium

Other relevant factor

(iv) Choices for who should bear the cost of flooding:

High risk householders
..by paying the full premium that corresponds to the risk of flooding.

Other/all policyholders and/or insurance company shareholders
..by high risk householders being subsidised by the remaining policyholders who pay more than their risk requires.
or the shareholders accepting lower average profits to pay for flood losses.

Construction companies

The taxpayer
..by the government providing subsidy for insurer to provide coverage or acting as insurer of last resort.

(v) **Option 1**

Advantages
It is likely that flood insurance would continue to be made available to the vast majority of households other than where the likelihood of flood damage is high (minor impact on low risk households).
Further action to facilitate the insurance market for high risk households could help with the availability of insurance.

It would ensure that those households most at risk from flooding had an incentive to reduce the risk and should be rewarded for doing so through pricing.

This would not require legislation and could be put in place relatively quickly.

Helps ensure the capital model accurately models the risk

Greater understanding of risk is encouraged

Helps correct market inefficiencies

Disadvantages
It is highly uncertain what the impact would be on the affordability of insurance

..and the speed at which the insurance market would move towards risk-reflective prices.

If insurers were to move rapidly to risk-reflective prices or to cease offering cover in some circumstances this could cause serious difficulties for high-risk households.

Option 2

Advantages

Households at high risk of flooding should always be able to find cover.

The costs of the levy should mirror the existing cross-subsidy between low and high risk policyholders therefore not placing pressure on bills in general.

If set up by the insurance industry would benefit from its expertise.

Customer experience of households would not change significantly since those seeking quotes would continue to conduct transactions with the insurer of their choice.

Not-for-profit is perceived to be fairer for all

Disadvantages

Some households at risk of flooding might still not be able to afford flood insurance even with the prices set.

Reinsurance costs may be higher than expected requiring extra funding from insurers.

The economic costs for this option may be greater than the economic benefits

If the premium charged to a high risk householder is not much changed from previously this would reduce the incentive for individual households to manage their risk of flooding.

As the levy on insurance funds is likely to count as State aid their may be political ramifications which might slow down or prevent implementation

There is an extra layer of cost in running the pool

May require some capital support particularly in the early stages of set up

Option 3

Advantages

This would provide a degree of certainty to households on the level of certainty they can expect to receive

Support could be given directly to policyholders.

The prices paid by households at risk of flooding may be lower than under Option 2 because the levy would not need to pay for the additional reinsurance costs.

As premiums are likely to be at least somewhat risk-reflective it retains some of the incentives on individual households to act to reduce risk.

Although requiring legislation could be implemented more quickly than Options 2 or 4.

Disadvantages
The impact will be uncertain, depending on whether insurers are willing to underwrite high risk households even taking account of subsidies.

Subsidised by low-risk policyholders

The effectiveness depends heavily on whether insurers agree with the assessment of flood risk by the government.

There would be no certainty for high risk households about the likely price for insurance.

Providing the same level of subsidy to all high-risk households would mean unnecessarily high subsidies in many cases.

If the subsidy were paid to the insurers rather than policyholders there would be scope for insurers to take advantage of the system and not pass the full benefit on
..if subsidies were paid to householders directly this would be administratively complex and costly.

If not supported by the insurance industry there might not be a smooth implementation.

Option 4
Advantages
Depending on the level of the obligation target set, high flood risk households under an obligation would in general pay a lower price than under Option 2 and comparable to Option 3 for a comparable amount of cross-subsidy.

There is still likely to be a greater element of risk-reflective pricing for high-risk households encouraging those most at risk to take risk reducing action.

A level playing field is created with all household insurers participating on the same basis.

It is likely that the benefits of introducing an obligation would outweigh its costs.

Customer experience of households would not change significantly since those seeking quotes would continue to conduct transactions with the insurer of their choice.

The obligation would not count as State Aid, so no political ramifications.

Disadvantages
This constitutes a significant intervention in a complex market.

Its impact on pricing is more difficult to assess than for the other options.

An obligation would need to be designed carefully to ensure it had the desired effect.

If a householder's flood risk was misclassified this could lead to either unnecessary discounting of premiums or high-risk households left without the support of the obligation.

..This could be mitigated by allowing households to opt in, on presentation of appropriate evidence, or opt out of the obligation but this would rely on proactive action and would add to administration costs.

If the obligation were set too low, high risk households may not benefit
.. if too high, insurers may decide to no longer offer home insurance.

This would take time to implement.

Discourages anything other than box-ticking

Does not manage the underlying risk

If not supported by the insurance industry there might not be a smooth implementation.

END OF EXAMINERS' REPORT