INSTITUTE AND FACULTY OF ACTUARIES

Curriculum 2019

SPECIMEN SOLUTIONS

Subject SP8 – General Insurance Pricing
Specialist Principles

1   Desire for earnings pattern to be consistent with incidence of risk

Using powerboats in poor weather may result in a greater incidence of claims

For example the risk may be higher in Winter and Summer due to poorer visibility/ stormy conditions

However the risk may be higher in Summer than Winter if better weather leads to more congested waters

Desire for earnings pattern to be consistent with exposure

Usage of powerboats may not be constant throughout the year…

… therefore exposure is not uniform as assumed by a linear earnings pattern

This may be the result of people choosing not to use powerboats as much when the weather is poor

The insurer may intend to compare underwriting results with industry statistics, which may be compiled using a non-linear earnings pattern

Not adopting a non-linear earnings pattern for premiums the insurer may increase or reduce premiums unnecessarily

or make other inappropriate decisions e.g. sales strategies and target markets

2   (i)   the claim amounts Xi's are independent and identically distributed

The Xi's and N are independent of each other.

(ii)   This isn't a true risk premium

this would be $E(S)$, the expected loss cost

$Var(S)$ is a measure of the uncertainty/variability of the loss cost

Adding 2*std dev therefore means they have incorporated a risk margin

…the size of which depends on the degree of uncertainty captured in the distribution chosen.

This would lead to a premium that is too high.
S can often be approximated by a Normal distribution (given sufficient claims)

Mean + 2*std dev is a good approximation to the upper 97.5 percentile

It is appropriate to use data from the actual risk

The last five years may not be long enough if the experience is limited or very volatile

The claims from the more recent years may not be completely developed and will, therefore, need to be developed to ultimate

or five years may produce an answer that is skewed by out of date experience

The model assumptions may not be valid, for example the claim amounts may be correlated, leading to an incorrect estimate for the variance

The risk premium is completely experience rated and therefore gives 100% credibility to the experience of the block of policies, thus ignores external experience
it ignores judgement on future trends
it ignores claims inflation over the 5 years

May give risk premiums that do not reflect the likely long term experience of the block of policies – e.g. catastrophe events/unusually light or heavy experience

Easy to explain.

Should be easy to calculate

The risk premium gives equal weight to all years which may not be appropriate

The distributions chosen are subjective and may lead to incorrect results

The risk premium would have to be adjusted for any changes in the future risk profile

including cover level/terms and conditions/legislative changes etc.

3 Captive

A company that is wholly owned by an industrial or commercial enterprise

Set up with the primary purpose of insuring the parent or associated group companies...
… and retaining risk within the enterprise

Reasons for setting up a captive include:

To fill gaps in insurance cover that may not be available from the traditional insurance market

To manage the total insurance spend of large companies or groups of companies/ avoid ceding profit to others

To enable the enterprise to buy cover directly from the reinsurance market rather than direct insurers

To focus effort on risk management

To gain tax and other legislative or regulatory advantages

Reduce impact of market cycles on premiums

Captives may also accept external risks on a commercial basis

Pools

An arrangement under which parties agree to share premiums and losses for specific insurance classes in agreed proportions

To some extent, all insurance is pooling

The main difference between insuring with a conventional insurer and insuring with a pool is that the insured's liability to an insurer is limited to the premium charged…

…whereas the liability to a pool will be related to the insured's share of the pool

Pools are commonly used to provide cover for large scale risks, such as atomic energy risks (or other suitable example).

Protection and Indemnity (P&I) Clubs are an example of pooling

These are mutual associations of ship owners.

Some of the largest clubs themselves mutualise in respect of very large claims

Originally formed to cover certain types of marine risks (e.g. liability)…
… that could not be covered at an acceptable price under a commercial marine policy.
Provide technical assistance and advice on issues relating to the shipping industry

4 (i)   experience rating is not appropriate for low frequency, high severity risks

as observed losses may not reflect the true underlying risk

because the period over which losses have been observed may be much shorter than the return periods under consideration

in some cases certain event scenarios may not have occurred in history

for example, a five year burning cost model is unlikely to be reliable for pricing tornado risk if strikes are only likely every 25 years

there will also be a lack of claims data exacerbated by high retention levels

(ii)   **Inventory module**

SI / EML needs to be changed from buildings to crop value

it will need to build an inventory of the different types of crops that may have to be covered (e.g. fruit, grain, root etc.)

it will need to include the season in which the crops are grown i.e. summer or winter crops

it will also need to know the geographical location of these crops as these will be in rural locations as opposed to the buildings which will be in urban areas/cities
..and their spatial coverage or the size of the farm on which the crops are grown (a crop will have a larger footprint than a building)

they can build in temporal factors to reflect the growing stage of the crop over the season

Vulnerability module

losses to crops will be a higher proportion of the sum insured than commercial property because

a crop hit by a tornado will most likely be a total loss

a commercial property (e.g. office block) hit by a tornado may suffer extensive damage but rarely a total loss

the speed at which damaging losses occur will be much lower

crop damage will start occurring at relatively low wind speeds whereas commercial property damage will tend to occur at relatively high wind speeds

the vulnerability module is likely to be simpler with fewer parameters

crops will vary very little in their vulnerability

properties can vary significantly, and some may even be built to withstand tornado strike

consequential loss/business interruption may be required for commercial property, whereas no such thing would be required for crop,

and demand surge can inflate rebuild costs for commercial property following a catastrophe, which is not the case for crops

5 Benefits

Compare own experience against that of other companies in the market…
…both at the overall level and at the level of categories into which the data is classified

Helps to understand where business is different from competitors
…so that they can identify growth opportunities

The ability to construct claims development data will help with reserving accuracy.

The above advantages will help improve pricing accuracy
… and reduce the risk of insolvency e.g. due to anti-selection
… and should give more choice and more competitive premiums

Standard data definitions will help with data quality
… and consistency across participants and over time

Quarterly submissions should ensure that the data is reasonably up to date

Requiring submissions within one month of the end of each quarter will also ensure the data is up to date

Requiring all insurers to participate will ensure the largest possible dataset
… and lack of bias to particular companies
By requiring large and established insurers to share data, it will help new entrants to the market
….and existing insurers to enter new classes.

Requiring companies to demonstrate they hold good data reduces operational risk

Data sharing may assist in the identification of insurance fraud

It allows the regulator to monitor the activity of the market

Problems

Potential for distortions due to heterogeneity if subdivisions too coarse

Insurer unable to segment data by the specified classification

Data provided by the scheme may not be comparable due to:
Companies operating in different sections of the market
Policies sold by different companies not the same (e.g. perils covered)
Companies have different practices (e.g. u/w, claims handling, etc.)

Data may not be stored or submitted in the same way
Rating factors may be coded in different ways

Market data slightly less up-to-date than internal data

Market data likely to be less detailed than internal data

May make some prices homogeneous, i.e. reduce competitiveness

Maintaining the database will be a cost to the market which is likely to be passed on to consumers

There may be errors in data submissions or misinterpretation of definitions and requirements

All of these could lead to the wrong conclusions being drawn from analysis

May be difficult/expensive/time consuming for companies to collect the data for submission. (e.g. data held by third parties)

There may be competitive disadvantages created for experienced companies that have to share their data with others

6   (i)   Adjustments include:

Develop claims from more recent periods to ultimate

– in order to allow for IBNR and IBNER claims

If the experience has been unusually heavy or light
– for example, a prolonged period of extreme weather or a manufacturing fault in a certain type of vehicle.

An adjustment will be required for any exceptional claims

Trends in claim frequency
– for example, cars becoming more reliable and therefore fewer claims or it becoming more common to run out of fuel and therefore more claims

Rebasing or allowing for trends in exposure
– for example, people driving less because of the escalating cost of motoring

Claims inflation – such as parts and labour

Changes in mix of business
– especially if the company has started writing through new channels
– mix of new versus older or second-hand cars

Changes in cover
– for example, the company may have changed excesses or limits etc.

Changes that affect claimant behaviour, such as an NCD scale.

Changes in underwriting
– Stricter on the types, age or quality of cars underwritten resulting in better claims experience

Changes in sales method, e.g. whether it is bundled with other covers

Legislative changes
E.g.,
– for example, the law may change so that in future broken down vehicles are towed to specific locations
– or that accommodation is made available
– or that a hire car must be provided

Claims handling processes
– improvements in fraud measures
– action taken to reduce claims leakage (e.g. better training of claims handlers and more quality checks)

(ii)   How will the product be rated, i.e. a flat rate per car sale, or using rating factors?
– Using rating factors means changing mix is less of a concern
– However car dealership unlikely to want to collect rating factors, especially those about the policyholder.

How old are the cars they sell? – new ones are less likely to breakdown.

Will there be a difference in selection risk?
E.g., depending on
– whether the cover is available to all customers
– whether certain customers already have cover independently
– whether customers remember that they have the cover when a claimable event occurs

To what extent does the garage carry out inspections on used cars?

The use of the cars sold (e.g. private use or fleet/taxis) and coverage (e.g. abroad?)

This may reduce overall exposure

Will the same cover be provided to each buyer, and if not how will it differ?

What make of cars are they selling?
E.g.,
– they may be more/less reliable than average

– and/or they may be easier and cheaper, or more expensive to get going again.

Claims experience of policyholder/claimant behaviour from any other similar business ventures in the past.
When will the new rates be in force?

How long will the cover be for?

7   (i)   To grow the business, i.e. new source of GWP

To grow profit.

– fixed expenses may be spread more thus reducing per policy expenses (economies of scale)

To meet demands from brokers/advisors/policyholders and therefore make the insurer's whole proposition more attractive.
– this is also beneficial when tendering for business with new partners.

To differentiate their offering from other insurers in a competitive personal lines market

To increase diversification
– as accident, sickness and unemployment insurance risks are likely to have low correlation with household and motor.

As the benefit is fixed, claims will have low volatility

leading to (relatively) lower capital requirements, and therefore potentially reducing the return on capital required.

To increase cross-selling opportunities to the other products.

(ii)   Front the business with an experienced insurer to begin with until own experience is gained.

Coinsure with a more experienced underwriter.

Obtain assistance/advice from reinsurers, consultants or brokers

Employ actuaries and underwriters with previous experience in this line of business.

Track the market, i.e. research and replicate market pricing structures.

Obtain claims data from government/industry-wide/medical research data collection schemes, if any exist.

The insurer could purchase another insurer's product book of business including the existing rating structure, as well as exposure and claims history

(iii)   Quote volumes.

Monitor effectiveness of marketing campaigns.

Which channels are most effective at drawing quotes.

Suggests possible marketing strategies.

Analysis of actual initial expenses and commission compared with expected.

Helps to assess rating adequacy/profitability.

Quote distribution/mix.

This indicates the types of risks likely to be attracted through different channels.

Again, suggests possible marketing strategies.

Conversion rate/strike rate.

High conversion could suggest premiums are cheap relative to the competition.

Conversely low conversion suggests premiums are expensive relative to the competition.

Analysing conversion rate by rating factor may reveal problems with the rating structure, or opportunities.

Test live rates to ensure algorithm has been implemented correctly

Monitor discounting activity (if permitted) at point of sale

New business volumes.

Volumes should be consistent with those expected in business plans, but differences may arise due to

market reaction to launch
marketing activity other
suitable reason.

Volume should be monitored to ensure policy admin staff are able to deal with increased work load.

Capital and reinsurance requirements may also need to be reviewed if volumes different to plan.

Not-taken-up rates or early cancellations.

Should be similar to household and motor – higher rates should be investigated.

Can detect fraudulent behaviour e.g. if cash-back or other offers available.

Should be examined by distribution channel to ensure miss-selling is not an issue.

Mix of business – is it as expected?

A high penetration in a certain rating cell could indicate the insurer is being selected against.

Cross-subsidies (if any) may compromise profitability if mix is not as expected.

Comparison with competitors' rates

To identify opportunities to gain profit per policy or overall volumes.

Early claims experience.

and claims declinature rate

To identify problems with policy wording, poor underwriting or fraud ideally by channel or source of business.

8 (i) Non-proportional reinsurance.

Indemnifies the cedant for the amount of each individual loss

… above a stated excess point.

Normally subject to an upper limit.

There are normally multiple layers (including a working layer), each coming into operation when lower layers are fully burnt through.

The excess point and upper limit may be fixed, or indexed as specified in a stability clause.

There should be not gaps between layers and the indexation/fixation of the layers should be consistent in order to avoid unforeseen exposure to risk.

There may be a deductible percentage within a specific layer, to reduce moral hazard.

There may be reinstatements, either free or subject to an additional premium.

There might be a profit commission.

(ii)   Potentially proportional to risk (at least the risk should be a monotonically non-decreasing function of exposure).

Practical measure, i.e. available, acceptable, verifiable and measurable.

Use of the contents section only prevents distortion from the buildings or other sections.

Ideally, we would use scooter year

but there is no data available from the cedant.

However, this is not a great measure, as there will be a lot of variation in the extent of scooter exposure.

Contents sum insured or premium could be an exposure measure related to the scooter risk

because (all else equal) more scooters should mean a higher SI and higher premium

these measures are easily available

but the relationship is not very strong.

Scooter miles would also be related to the scooter risk

but would be very difficult to verify

(iii)   Assume that ILFs do not need adjustment for inflation.

Assume the (ground-up) loss frequency is independent of the limit purchased

Assume the (ground-up) severity is independent of the number of losses and of the limit purchased

Assume that business is written on a losses occurring basis

Assume that treatment of loss adjustment expenses is consistent between the motor and scooter treaties.

To adjust the motor treaty loss cost to the scooter treaty, we use the formula

$L_S = L_M$ * [ILF(10) – ILF(1)] / [ILF(10) – ILF(5)]
$= L_M$ * [2.096 – 1] / [2.096 – 1.931]
$= L_M$ * 6.64242

Assume that movements (new business and cancellations) occur evenly throughout the year
…so that these policies get half a year's exposure.

Assume that the proportion of policies with a contents section is the same for new business and cancellations as for the rest of the book.

Contents section exposure = [288,280 + (19,000 – 9,000)/2] * 0.83

Alternative assumptions are acceptable if calculation method is consistent

= 243,422
Expected loss cost for scooter treaty = 243,422 * £6 * 1.5% * 6.64242
= £145,522

(iv)   Assume that investment income is negligible.

Assume no other loadings (retrocession, profit commission etc.)
Assume that RoC is a one-year calculation, i.e. no residual value at the end of the year.

Solution variant 1:
RIP = Claims + Expenses + Commission + Capital charge
Expenses = 0.15 * 145,522 = 21,828
(or Claims + Expenses = 1.15 * 145,522 = 167,351)
RIP = 167,351 + (RIP * 0.2) + (RIP * 0.12 * 0.77)
RIP (0.8 – 0.0924) = 167,351
RIP = 167,351 / 0.7076
= £236,505

Solution variant 2:
RoC = (RIP – Claims – Expenses – Comm) / Capital

0.12 * 0.77 * RIP = RIP * 0.8 – Claims * 1.15

RIP (0.8 – 0.0924) = Claims * 1.15

RIP = £145,522 * 1.15 / 0.7076
 = £236,505

Minimum premium = 0.03 * 9,000,000 = 270,000
So premium charged is the higher of the two, i.e. 270,000

9   (i)   Intrinsic Aliasing

- Occurs due to inherent dependencies in definition of covariates

- Most commonly arise where categorical factors are included in the model

- For example, a factor "occupied during the day" has the levels $X_1 = $ "Y" and $X_2 = $ "N", so if $X_1 = 1$ then X_2 must be 0, and vice versa (or similar categorical factor example).

- Intrinsic aliasing is overcome by giving each factor a base level

- This is normally done automatically by GLM software…

- … but the choice of base level will depend upon the software used

Extrinsic Aliasing

- Also occurs due to dependencies in definition of covariates...

- … but due to nature of the data instead of properties of covariates themselves
- Occurs when one level of a factor is perfectly correlated with a level of another factor

- For example, if in the data in Part (ii) all of the exposure for Sidious were in the Unknown category, these rating factor levels would be perfectly correlated.

- In this case, one of the levels of one of the factors needs to be removed from the model.

- Again, the GLM software would normally do this automatically.

(ii)
- The data provided by Sidious will result in near aliasing

- The "Unknown" level of number of bedrooms is almost but not perfectly correlated with Sidious…

- … so extrinsic aliasing will not occur

- and the GLM software will not remove parameters from the model.

- Convergence problems can occur as a result of near aliasing

- e.g. if there are no claims for the 17 exposures, and a claims frequency model is built using a log link, we could have large and opposite-signed parameters for Sidious and Unknown number of bedrooms (or other similar example)

- Whilst this may give an appropriate projection for the 13,953 exposures from Sidious with Unknown number of bedrooms, the value of the Sidious parameter would be driven by the experience of only 17 exposures

- The results could be confusing or misleading

- Ask Sidious to correct its data

- Ask for an extract of data from the old system

- Reclassify the 17 exposures to the "Unknown" category

- Exclude the 17 exposures from the model

- Consider excluding one of the factors from the model

- Use offsets to fix some of the relativities, which may help the model to converge

- Whatever the action taken, it is important to ensure that the pricing scheme is still able to generate a sensible price for any combination of rating factor levels

- Obtain additional data, if available…

- … and estimate the correct distribution of bedrooms from this

10 (i)

U/W year	vehicle years	claims	total cost	frequency	frq adj for new cover	frq for new cover
1	1,692	127	286,000	0.075059	0.95	0.071306
2	1,931	142	350,000	0.073537	0.95	0.069860
3	2,262	168	413,000	0.074271	0.95	0.070557
4	2,566	180	458,000	0.070148	1	0.070148
5	2,954	210	565,000	0.071090	1	0.071090
Total	11,405					

U/W year	year 6 money terms		average cost	"As-if" total cost (=exposure * frq * acpc)
1	1.159274074	331,552.39	2,610.65	314,974.77
2	1.12550881	393,928.08	2,774.14	374,231.68
3	1.092727	451,296.25	2,686.29	428,731.44
4	1.0609	485,892.20	2,699.40	485,892.20
5	1.03	581,950.00	2,771.19	581,950.00
Total				2,185,780.08

Risk premium = Yr 6 exposure * (Total historic as-if cost) / (Total historic exposure)

= 584,536

(e.g. taking average frequency and cost per claim over the five years gives the following risk premium : 3,050 * 0.0705923 * 2,708.33 = 583,121.89)

assume no significant change in mix of business which could change frequency and/or severity in year 6

assume completely experienced-rated

assume claims inflation will be 3% for the next year

assume no trending of the frequencies/average costs required

no trend apparent in the adjusted frequency or adjusted ACPC

(ii)   Assume claims and expenses occur evenly over the year…

… therefore, expenses and claims outgo occur at mid-point of year.

Treat profit as an up-front loading, which is reasonable as it is a percentage of premium, but other timings are allowable.

Assume inv income rate is annual effective

Assume commission is paid at the start of the policy year.

The answer below assumes a front-loaded profit. Equal credit was given if an alternative assumption is made regarding timing and the correct discount factor is used.

Let:

Df	be discount factor	= 1.03923
Er	be expense rate	= 40%
Pm	be profit margin	= 15%
Cr	be commission rate	= 10%
RP	be risk premium	= £584,536
NP	be net premium	
GP	be gross premium	

Equation of value:

GP = Commission + (RP + Expenses)/(discount factor) + Profit

$NP = (RP + er*NP)/df + pm*NP$
$NP = RP/df + er*NP/df + pm*$NP
$NP(1 − er/df − pm) = RP/df$
$NP = RP/ (df − er − pm*df)$
$GP = NP / (1 − cr)$

NP = £1,209,353
GP = £1,343,725

Alternative Approach

GP = commission + profit + (expenses + claims)*(discount factor)

GP − commission = profit + (expenses + claims)*(df)
0.9*GP = 0.15*0.9*GP + (0.4*0.9*GP+584,536)*(1.08)^(-0.5)

0.9*GP = 0.135*GP + (0.36*GP+584,536)*0.9622504486
0.9*GP = 0.135*GP + 0.3464101615*GP + 562,470.0283
0.4185898355*GP = 562,470.0283

GP = 1,343,725

Alternative answer with mid-year profit assumption:

GP = Comm + (RP + Exp + Profit)/*df*
$NP = (RP + (er + pm) * NP) / df$
NP = RP/df + er*NP/df + pm*NP/df
$NP(1 − er/df − pm/df) = RP/df$
$NP = RP/(df − er − pm)$
NP = £1,194,806
GP = £1,327,563

Alternative answer with end-year profit assumption:

Let $df2 = 1.08$
$GP = \text{Comm} + (RP + \text{Exp})/df + \text{Profit}/df2$
$NP = (RP + er*NP)/df + pm*NP/df2$
$NP = RP/df + er*NP/df + pm*NP/df2$
$NP(1 - er/df - pm/df2) = RP/df$
$NP = RP/(df - er - pm/df)$
$NP = £1,181,136$
$GP = £1,312,373$

(iii)   Business objectives – could be trying to grow book

Competition may impact on achievable volumes and mix

Position in insurance cycle

e.g. by colouring judgment (tide of optimism)

e.g. takes time for real claims performance to become known/cyclical effects on reserving levels

A different premium may be charged depending on customer price elasticity.

The level of cover may have changed over the years (e.g., excesses)

Cross-subsidies may allow the premium to be discounted if bundled with other covers e.g. breakdown.

Similarly, a special rate may be given if the insured has already purchased other insurance from the insurer

Changes in regulation mean inflation and claims cost projections need to be revised.

The fleet mix/exposure changes significantly.
– e.g. new information received on size of fleet/type of vehicles
– the fleet may have changed its rules about who can drive
– the use of the vehicles may have changed (e.g. may now carry dangerous goods)

The insurer may want to include a large claim loading based on experience with similar books of business

Number of vehicle years may not be as predicted

Likely to have a retrospective adjustment to allow for changes throughout year 6

It may be advisable to apply a loading for contingencies or to allow for volatility in claims experience

The last five years may have been unusually light/heavy

Other soft factors e.g. the fleet employs its own engineers and vehicles are examined after each trip

Might not be able to get capital at same cost as assumed

The cost of reinsurance might need to be included.

More recent years might be considered too underdeveloped to give equal weighting in claims cost

It might be considered that there is insufficient allowance for external effects such as bodily injury trends

There might be a regulatory constraint on rating levels

There might be a minimum premium per vehicle

The premium may have to be adjusted to ensure the Broker relationship is not affected

END OF SOLUTIONS