Subject ST8

CMP Upgrade 2016/17

CMP Upgrade

This CMP Upgrade lists the changes to the Syllabus objectives, Core Reading and the ActEd material since last year that might realistically affect your chance of success in the exam. It is produced so that you can manually amend your 2016 CMP to make it suitable for study for the 2017 exams. It includes replacement pages and additional pages where appropriate. Alternatively, you can buy a full set of up-to-date Course Notes / CMP at a significantly reduced price if you have previously bought the full-price Course Notes / CMP in this subject. Please see our 2017 *Student Brochure* for more details.

This CMP Upgrade contains:

- all significant changes to the Syllabus objectives and Core Reading.
- additional changes to the ActEd Course Notes, Question and Answer Bank and Series X Assignments that will make them suitable for study for the 2017 exams.

1 Changes to the Syllabus objectives and Core Reading

1.1 Syllabus objectives

There have been no changes to the Syllabus objectives.

1.2 Core Reading

This section contains all the ***non-trivial*** changes to the Core Reading.

Chapter 9

Pages 7 to 32

Much of the Core Reading in Chapter 9 has been deleted or re-written. We feel that these changes are not significant, and in many cases they simplify the course. However we have included them in this Upgrade for completeness. Therefore please remove pages 7 to 32 and replace them with pages 7 to 28 that can be found at the end of this Upgrade.

Chapter 10

Page 22

The following sentence has been added after the first paragraph of the section entitled "Written and signed amounts":

Within the context of the London Market, Signed Premiums are the written premiums at the signed share of a risk.

Chapter 12

Page 5

The bullet points under the heading "Risk premium" have been reworded to avoid ambiguity. They now read:

- **the pure risk rate**
- **including a loading for catastrophe and/or large loss claims**

The third bullet point under the heading "Office premium" now reads:

- **a charge to reflect the cost of capital or volatility**

Page 33

The following sentence has been added to the start of the last paragraph on this page:

One commonly used method is to set the profit loading to achieve a target return on capital.

Page 34

The following Core Reading (and ActEd text) has been added after Question 12.15:

There are other approaches for setting profit loadings based on risk metrics other than capital; *eg* Wang's Proportional Hazards approach.

The "proportional hazards transform" is one of a family of methods that attach an artificially inflated probability to the worst outcomes. Hence, this approach will impose a higher profit loading for policies that have heavier tail probabilities.

Chapter 13

Page 5

The following sentence has been added at the end of this page:

Further, the factors may be reflecting noise in the data sample, rather than a true differential in risk.

Pages 13 and 14

Section 2.4 on page 13 has been rewritten, and a new bullet point has been added on page 14. Please use replacement pages 13 and 14 provided at the end of this Upgrade.

Chapter 14

Pages 19 to 21

There have been significant changes to these pages, including (but not limited to) clarification of the Kolmogorov-Smirnov statistic and Anderson-Darling statistic. Therefore, please remove pages 19 to 22 and replace them with pages 19 to 22c that can be found at the end of this Upgrade.

Glossary

The two bullet point sentences have been deleted from the definition of "Events not in data (ENIDs)".

The definition of "Technical reserves (provisions)" now reads:

Technical reserves (provisions)

The accounting entries in the balance sheet that represent the insurer's liabilities from the business that has been written.

Under Solvency II, technical provisions comprise claims provision + premium provision + risk margin, where:

- **The claims provision is the discounted best estimate of all future cash flows (claim payments, expenses and future premiums) relating to claim events before the valuation date.**
- **The premium provision is the discounted best estimate of all future cash flows (claim payments, expenses and future premiums due) relating to future exposure arising from policies that the (re) insurer is obligated to at the valuation date.**
- **The risk margin is intended to be the balance that another (re)insurer taking on the liabilities at the valuation date would require over and above the best estimate. It is calculated using a cost of capital approach.**

The following definitions have been removed from the Glossary:

- Accounting classes*
- Base Capital Resources Requirement (BCRR)*
- Claims equalisation reserve
- Equalisation reserve (provision)
- General Insurance Capital Requirement (GICR)*
- Guarantee fund*
- Minimum capital requirement (MCR)*
- Required Solvency Margin*
- Statutory returns*

The following abbreviations have been removed from the Appendix:

- BAS Board for Actuarial Standards
- BCRR Base Capital Resources Requirement
- ECR Enhanced capital requirement
- ICA Individual capital assessment
- ICAS Individual capital adequacy standard
- ICG Individual capital guidance
- LSICA Lloyd's Society individual capital assessment

The following abbreviations have been added to the Appendix:

- APS Actuarial Profession Standards
- FRC Financial Reporting Council
- RSR Regular Supervisory Reporting
- SFCR Solvency and Financial Condition Report

2 Changes to the ActEd Course Notes

This section contains additional ***significant*** changes to the ActEd Course Notes. However, if you wish to have all the changes to the ActEd Course Notes, you will need to buy a full set of the up-to-date version (which you can do at a significantly reduced price if you have previously bought the full-price Course Notes / CMP in this subject).

Chapter 1

Page 15

The following two sentences have been added after the second paragraph:

Since Solvency II came into force, UK (and other EU) insurance companies no longer need to hold claims equalisation reserves. However many other countries worldwide still hold them.

Chapter 6

Pages 39 and 40

We have expanded the discussion of LPTs to reflect the content of recent exams. Please remove pages 39 and 40 of your Course Notes and replace them with pages 39, 40a, 40b, and 40c, which can be found at the end of this Upgrade.

Page 53

The last paragraph on Page 53 now reads:

> *Loss portfolio transfers* are not a form of reinsurance. They involve the transfer of liability for a specified book of business from one insurer to another. Reserves are transferred to the new insurer along with all remaining exposure to the business.

Page 57

In Solution 6.9, the following sentence has been added after the end of the first sentence:

If they cede the largest possible proportion then they must use all 8 lines. In which case the percentage ceded will be $\frac{8}{9} = 88.9\%$.

Chapter 8

Page 11

The discussion of Solvency II at the top of the page has been updated. Please remove pages 11 and 12 of your Course Notes and use the replacement pages that can be found at the end of this Upgrade.

Chapter 9

Pages 7 to 32

As stated above, much of the Core Reading in Chapter 9 has been deleted or re-written. As a result, the ActEd text has also changed. Again, we feel that these changes are not significant but we have included them in this Upgrade for completeness. Therefore please remove pages 7 to 32 and replace them with pages 7 to 28 that can be found at the end of this Upgrade.

Chapter 12

Page 34

As stated above, some ActEd text has been added after the new Core Reading on Wang's Proportional Hazards method. (We include both the new Core Reading and the ActEd text here, for clarity.)

Please add the following two paragraphs, after Question 12.15:

There are other approaches for setting profit loadings based on risk metrics other than capital; *eg* Wang's Proportional Hazards approach.

The "proportional hazards transform" is one of a family of methods that attach an artificially inflated probability to the worst outcomes. Hence, this approach will impose a higher profit loading for policies that have heavier tail probabilities.

Chapter 13

Pages 13 and 14

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Chapter 16

Page 38

The first sentence of ActEd text on this page has been changed. It now reads:

The *error structure* relates to the statistical distribution assumed for the response variable Y_i.

Page 59

The sentence immediately after Question 16.15 has been corrected. It now reads:

The grouping done for levels 15 to 20 in the car age example earlier in Section 5.5 is another example of a custom factor.

Chapter 17

Page 47

The last two paragraphs on this page have been changed to read:

A log link function will produce a multiplicative rating structure. Typical distributions are Poisson for the frequency model and gamma for the severity model.

Claim propensity models tend to be multiplicative and have a binomial error structure.

3 Changes to the Q&A Bank

This section outlines the changes that have been made to the Q&A Bank. However, if you wish to have all the changes to the Q&A Bank, you will need to buy a replacement CMP (which you can do at a significantly reduced price if you have previously bought the full-price CMP in this subject).

All ¼ marks have been changed to ½ marks, which we believe to be reflective of the examiners' current marking strategy. (The total number of marks available for each question remains unchanged.)

Other significant changes to the Q&A Bank are detailed below.

Q&A Bank 2

Solution 2.2

The following point has been added to the solution:

- legislative restrictions (*eg* Treating Customers Fairly) [½]

Q&A Bank 3

Question 3.15

The second sentence of this question should read:

The characteristics of the claims (in £000s) arising from these policies are as follows:

4 Changes to the X Assignments

This section outlines the changes that have been made to the X Assignments.

If you wish to have all the changes to the X Assignments, you will need to buy a replacement CMP (which you can do at a significantly reduced price if you have previously bought the full-price CMP in this subject).

However, if you wish to have your assignments marked by ActEd this session then you can order the current assignments free of charge if you have purchased them in the same subject the previous year (*ie* sessions leading to the 2016 exams), and have purchased marking for the 2017 session.

Assignment questions

Question X5.8

Part (i) has been reworded so that the solution more closely matches the question. It now reads:

(i) Describe the disadvantages of using this method for calculating P. [6]

Assignment solutions

While the *content* of the solutions remains largely unchanged, there have been many changes to the *marks* available for each question. This is so that our assignments reflect the examiners' new marking strategy more accurately.

Solution X4.1

The following points have been added to the solution for part (ii):

We should calculate the standard error, since:

- a poorly defined parameter will have a large standard error [½]
- standard errors can help assess the reasonableness of the relativities. [½]

We could fit an interaction between this factor and other factors, *eg* distribution channel, again to check for consistency across relativities. [½]

A random factor could be created in the data, as another means to check consistency.

[½]

Solution X5.8

The following comment on exam technique has been added to the start of the solution:

Note that for part (i) you can talk about the disadvantages of credibility theory in general, and the square root rule in particular.

5 Other tuition services

In addition to this CMP Upgrade you might find the following services helpful with your study.

5.1 Study material

We offer the following study material in Subject ST8:

- Flashcards
- MyTest
- Revision Booklets
- ASET (ActEd Solutions with Exam Technique) and Mini-ASET
- Mock Exam A
- Additional Mock Pack.

For further details on ActEd's study materials, please refer to the 2017 *Student Brochure*, which is available from the ActEd website at **www.ActEd.co.uk**.

5.2 Tutorials

We offer the following tutorials in Subject ST8:

- a set of Regular Tutorials (lasting three full days)
- a Block Tutorial (lasting three full days).

For further details on ActEd's tutorials, please refer to our latest *Tuition Bulletin*, which is available from the ActEd website at **www.ActEd.co.uk**.

5.3 Marking

You can have your attempts at any of our assignments or mock exams marked by ActEd. When marking your scripts, we aim to provide specific advice to improve your chances of success in the exam and to return your scripts as quickly as possible.

For further details on ActEd's marking services, please refer to the 2017 *Student Brochure*, which is available from the ActEd website at **www.ActEd.co.uk**.

5.4 Feedback on the study material

ActEd is always pleased to get feedback from students about any aspect of our study programmes. Please let us know if you have any specific comments (*eg* about certain sections of the notes or particular questions) or general suggestions about how we can improve the study material. We will incorporate as many of your suggestions as we can when we update the course material each year.

If you have any comments on this course please send them by email to **ST8@bpp.com**.

The premium that is payable for the cover will depend on the risk appetite of the market.

Usually it is only possible to reinsure a layer above a specified amount. This specified amount may be in excess of the current level of reserves. There could be an upper limit. If the ultimate cost of losses is in excess of this, the insurer is liable for the excess. The reinsurer may also insist that the insurer has a small participation in the layer.

Claims are usually still handled by the insurer and hence there are the associated expenses. Reserves are maintained by the insurer and it receives all investment income generated from the investments backing these reserves.

There is no transfer of reserves from the insurer to the reinsurer. The insurer simply pays a premium for the reinsurer to take on responsibility for the development of reserves beyond a specified position.

Question 6.24

What sort of traditional reinsurance arrangement would achieve this?

The insurer is exposed to the credit risk of the reinsurer. Legally, the insurer remains liable to the insured parties for all claims within the block reinsured. Hence, some but not all of the risk from adverse run-off of the reserves is removed.

6.3 Loss portfolio transfers (LPTs)

LPTs are an arrangement whereby the liability for a specified book of business is passed in its entirety from one insurer to another. Policyholders will be informed of this "novation" and the deal may need to be approved by a court. This enables the original insurer to concentrate on any remaining book of business.

The Glossary defines a "novation" as "The transfer of the rights and obligations under a contract from one party to another." Note that this definition is strictly only part of the Subject SA3 Core Reading.

Novation is not strictly reinsurance since the new insurer is responsible for the liabilities in total from the date of the transfer.

The original insurer will transfer the reserves and the remaining exposure to the new insurer. It is likely that there will be a premium in addition to the existing reserves. This would normally include a claims handling service.

All adverse claims risks and the investment income will be passed to the new insurer.

Advantages of LPTs

- **They can improve the credit rating of the original insurer.**
- **The new insurer will gain diversification if not already in this area and achieve a larger client database. There are specialist players in the market that can possibly run-off such portfolios more profitably than the original insurer.**
- The original insurer will no longer have any remaining exposure to the book of business, including any subsequent reserve deteriorations.
- The deal may be good value for money for one of the companies. For example, the reserves transferred, plus any additional premium payable and investment income earned, may be more than sufficient to pay the remaining claims, so the new insurer may end up making a profit.
- The original insurer's capital requirements will be lower and capital will be freed up for other purposes.
- The new insurer may gain access to historical data for the class of business.
- An LPT is a quick method for exiting a line of business (and a quick way for the new insurer to acquire a book of business).
- The original insurer may no longer need expensive specialist resources, *eg* claims handlers, to manage the liabilities.
- Unlike with some forms of reinsurance arrangement (*eg* adverse development cover), if the new insurer defaults on its liabilities they will not fall back on the original insurer.

Disadvantages of LPTs

- **Assets may need to be realised to pass across the value of the reserves to the accepting insurer which is particularly important if there is mismatching or if tax gains / losses would be crystallised.**
- **If the new insurer defaults, this could damage the reputation of the original insurer.**
- **The transfer may require the buy-in of reinsurers where there are existing reinsurance arrangements covering the portfolio.**
- **There will be an associated cost to the original insurer of the risk transfer, which will depend on the current risk appetite of the market. This cost would be any premium payable plus the "lost" investment income.**

- Any required court approval may be time-consuming and expensive, and may not necessarily be obtained.
- The new insurer may be exposed to the future emergence of new latent claims on the portfolio which may not have been anticipated / allowed for in the LPT calculations.

The "premium payable" referred to above is an amount to compensate the new insurer both for taking on the risk and for expenses associated with the transfer. This would be paid on top of the value of the reserves. The "associated cost" referred to is therefore this premium plus the value of any investment income effectively lost if the transferred value of the reserves uses a discount rate which turns out to be too low.

This page has been left blank so that you can slot the replacement pages into your Course Notes

For many years, the EU regulatory minimum capital requirement (MCR) for general insurers (known as "Solvency I") was approximately 16%–18% of annual premiums. This was modified in some situations (*eg* if claims were very high), but nevertheless the Solvency I MCR formula is very simplistic compared to the risk-based Solvency II regime, which became effective on 1 January 2016. Solvency II is covered in more detail in Subjects CA1 and SA3.

Question 8.6

What do you think was the rationale behind this approach?

Using only simple measures, such as the former EU minimum, does mean that if an insurer cuts its premium rates, it does not need to hold so much capital. This does seem counter-intuitive: if it cuts its rates, it is more likely to become insolvent (*eg* due to inadequate premiums) and it would need to hold a higher level of capital to cover this risk!

This meant that it required less commitment of capital to write a policy if it were underpriced than it would have done if it had been overpriced, the exact opposite of what risk-based considerations would merit. This means that companies can write more business – in terms of the amount of risk taken on rather than the amount of premium written – as premium rates fall. Conversely, as premium rates rise they must restrict the amount of risk taken on unless they can raise more capital. This exacerbates the difficulty of finding cover and will tend to drive premium rates even higher.

Economies of scale

The economics of insurance business may also help to enforce the cycle. Insurers' overheads tend to be, if not fixed, then less variable than premium rates. There may be little or no cost saving (apart from commission) from an insurer not writing a policy. Therefore if business at least covers its claims cost it may be marginally profitable for an insurer to write it, even if business overall makes losses. However, in the depths of soft markets, it is common for business to fail to do even this. Insurers sometimes do not want to lose market share because of the cost of acquiring the business again in the future, loss of reputation and other reasons.

In a competitive market, an insurer may set premiums at a level that makes an insufficient contribution to its fixed expenses. This may be justified on the grounds that there is still *some* contribution to fixed expenses, as opposed to the zero contribution which would result from trying (and failing) to sell an uncompetitive product with a "correct" contribution built in.

So, it is important that an insurer is aware of the true underlying profit or loss of its business. Otherwise it is all too easy for it to get carried away with making premium cuts in line with the competition and end up in a position where premiums do not even cover claim costs, and this can result in unprofitable business.

1.4 Investment conditions

Insurance companies take premiums from customers and hold them until they have to be paid out in claims; these monies will be placed in financial investments during this period. Most of their capital is also available for investment.

An insurance company needs to decide how to invest the money that it has at any one point in time. It will be exposed to the investment conditions of the assets it invests in. For example equity investments will be exposed to changes in the underlying market values (of the individual shares or of the market overall).

The capital that the insurance company holds can be split into two broad categories:

- that required to meet the liabilities, *eg* the statutory reserves, plus
- the free assets, which is the excess of the company's assets over its liabilities.

Generally, an insurer will try to hold assets to match its liabilities (by term, nature, certainty and currency), but will have greater freedom over how it invests its free assets.

In this, insurers are unlike non-financial companies, whose capital is usually tied up in capital goods or stock. This means that income from invested securities is an integral part of insurance business.

Only a small proportion of an insurance company's assets is likely to be tied up in fixed assets, such as the office buildings or machinery. Therefore, where the assets are invested, and the investment return those assets make, are more important decisions for an insurance company to make than they are for other companies, such as manufacturing firms.

Accumulations of risk may occur due to the insurer's business acquisition strategy (*eg* it might target policyholders of a particular type) or they may arise inadvertently (*eg* there may be a large concentration of policies taken out by individuals living close to the insurer's head office). Accumulations may also arise as a result of a catastrophe event.

Due to the variability in the size of claims, there may be uncertainty as to whether changes in claim costs from year to year are due to changes in underlying risks or are simply the result of random variation.

The level of random variation will be higher, the smaller the portfolio of business. This problem is therefore greater for small companies (or small classes of business) where we would expect a larger variation from year to year.

Claim payment patterns

There are typically delays between:

- the date of the claim event
- the date of reporting the claim
- the final settlement of the claim.

In addition, the date of the claim event itself may be uncertain.

Question 9.4

What sort of claim events may be uncertain in their timing?

The delay between the claim event and the reporting of the claim will depend on the type of claim and the speed at which policyholders report potential claims.

The delay between the claim being reported and settled will also vary by type of claim. Large claims are likely to suffer the longest settlement delays, especially in liability classes where the claims may need to be settled by the courts. Large claims are discussed later.

Changing development patterns

Claims development patterns can be expected to change over time. This may be due to a number of factors.

Examples

There may be political pressure on insurers to speed up the payment of claims following a natural disaster, or payment / recording of claims may slow down due to staff shortages.

It is important that these types of change are understood when determining pricing levels, to ensure premiums are adequate to cover the future emergence of claims.

Question 9.5

Suggest two examples of factors that could change the development pattern that the insurance company would be unaware of.

Demand surge

Following a major catastrophe, there will be increased demand for goods and services in the affected areas.

Example

The demand for builders may increase following a flood. This increase in demand could force up the price for such goods and services to an unpredictable extent.

Higher prices could mean higher claim amounts.

Climate change

Over the last decade, global weather patterns have changed significantly from an insurance point of view. Various agencies have produced climate models that predict further volatility in global weather patterns.

Example

Global temperatures are slightly higher and severe weather events are becoming more frequent.

This will result in the expected outgo from future events also becoming more uncertain.

Bodily injury claims

Some governments have introduced legislation concerning the payment of bodily injury claims. The idea is that to indemnify the policyholder, the claim payment should be in the form of income replacement, in addition to any lump sum. This effectively places a life liability on the insurer, which introduces additional uncertainty.

Incorporating the future incidence and quantum of these types of awards will lead to additional uncertainty in the setting of premiums.

Differences in third party behaviour (eg lawyers actively seeking out asbestos claimants)

The behaviour of third parties may also impact claim characteristics for certain classes.

Example

Lawyers may actively seek out people affected by asbestos-related diseases. This would increase the claim frequency, and may also have an effect on severity.

Question 9.6

How might severity be affected by this?

Government legislation

Legislative actions can be divided into three main types:

- fiscal changes, such as increases in tax on insured items – many claims are settled on a replacement basis (*ie* the insurer replaces the damaged item), so if the sales tax on that item increases, the cost of replacing that item will increase
- changes in the law that increase the amount of cover being provided, such as removal of a legal limit on compensation levels
- changes in the law that restrict or forbid the use of certain factors in underwriting.

In the first two cases, an insurer is unlikely to have foreseen such changes; therefore there may be a sudden change in the reserves that need to be held. Furthermore, since premiums cannot be changed retrospectively, the changes will adversely affect profits until some time after the premiums or cover can be adjusted. The third type of change will be known about in advance, but may expose the insurer to anti-selection for which the cost cannot be accurately assessed. This may result in the need for higher reserves.

Example

The introduction of new legislation, such as 'Treating Customers Fairly', may reduce an insurer's ability to use certain rating factors / levels of price change, which may lead to a reduction in ability to charge adequate premiums for the risk being accepted.

The effect of economic conditions on claims

Many types of incident giving rise to claims are influenced by economic conditions, whose changes are difficult to predict as regards both timing and extent. There is therefore a continuing uncertainty as to the number and cost of the claims that will occur when conditions change.

Examples

Mortgage indemnity is one class that is heavily affected by economic conditions.

The claims experience of other insurance classes such as motor, household and commercial fire is also correlated to the economic conditions in some countries.

A number of economic variables could have a direct impact on claims. For example:

- inflation – this will directly affect claim amounts

Question 9.7

Outline three types of inflation that can affect claim amounts.

- unemployment – this could lead to certain sections of society being unable to afford insurance, and so produce a different mix of business

- economic growth – this could lead to more sections of society being able to afford insurance (and higher levels of cover in some cases), and so produce a different mix of business

- change in the value of the exchange rate – for business transacted in a currency other than that of the country in which the insurer is based, there is a risk that the insurer's results will be adversely affected by changes in the exchange rate between the two currencies; there will also be uncertainties stemming from currency mismatching between assets and liabilities, and because it may be impossible to predict the currency in which a claim will have to be settled.

Question 9.8

Give three examples of general insurance classes in which there is likely to be a high level of uncertainty relating to the currency of the claim payments.

In addition, the economic conditions can have a wider impact on the environment; for example, crime rates may increase during recessions.

The rates of crimes such as theft and arson have shown considerable variation from year to year and from country to country. General insurance companies might actively engage in trying to encourage policyholders to take steps to reduce crime, in a hope to reduce claim costs.

1.2 Internal sources of process uncertainty

Planned or unplanned changes in mix

Different risks will exhibit different claims characteristics, *eg* claim frequency, severity, volatility, timing of payments *etc*. The degree of uncertainty inherent in the business will therefore depend on the mix of risks that have been written.

In addition, any changes in the mix of business will increase this uncertainty.

Question 9.9

(i) Suggest possible strategies that might lead to a change in business mix.

(ii) Suggest other reasons why the business mix might change.

Booked reserves different to best estimate

The pricing actuary would normally use best estimate reserves to calculate premium rates. Any prudence to allow for profit, contingencies, *etc* should be allowed for explicitly as a loading, so that the effects can be quantified and monitored more accurately.

Reserves booked will usually be greater than best estimate due to:

- smoothing of results
- difficulty in setting reserves, particularly reinsurance recoveries
- requirements of regulatory bodies
- peer pressure.

New markets

Entering a new market or territory will incur expenses for the insurer, including set-up fees, accommodation costs, fees to the regulator and legal costs. It may not be acceptable within the market to pass on these fees directly to the policyholders, if other insurers have a lower expense base.

New distribution channels

Claims frequency, severity and development may be expected to vary by distribution channel.

If a business acquisition or renewal strategy tends to attract policyholders with different characteristics from those of the existing clientele, the resulting claims experience may differ from that of the past.

Example

Direct sales may be expected to develop more quickly than broker sales if claims from broker sales are reported through the broker. They may also be less frequent if the broker has a facility to filter out any fraudulent claims.

The internet is now the dominant sales channel for personal lines and smaller retail products. The lack of a face-to-face meeting or a telephone call when buying a policy certainly increases the possibility of fraud, which will affect frequency and severity of claims.

The number of distribution channels is likely to increase in the future, as insurers pursue ever more innovative ways of attracting new business and reducing costs.

New claims handling procedures eg online

Some insurers offer an online claims reporting service. This may increase policyholders' propensity to claim, thereby increasing claim frequency. It may also cause an increase in fraudulent behaviour; for example, policyholders reporting nonexistent claims, or exaggerating existing claims, which would increase both frequency and severity.

Both of these increases are unpredictable and introduce additional uncertainty into the setting of future premiums.

Increased use of profit share arrangements

Profit share arrangements may incentivise the broker to pass on better quality business to the insurer. If the use of profit share arrangements increases and no adjustments are made to reflect this, this may reduce the expected profitability of the business being written.

2 Process uncertainty – effect on other areas of the business

Process uncertainty can also affect other areas of an insurer's business, besides claims. Some examples are discussed below:

2.1 Aggregators

During the last few years, a number of "aggregator" companies have been set up, dealing mainly with personal lines business. These companies find the best price for the customer from a pre-selected panel of insurers.

This has resulted in more transparency in pricing levels across the market, which could lead to more instances of anti-selection for under-priced segments of a portfolio.

> ***Example***
>
> Examples that operate in the UK include Compare the Market, Money Supermarket and Go Compare.

Insurers may have to pay a fee or satisfy certain conditions to be a member of this panel, which can have an uncertain effect on expenses.

There may also be different commission arrangements to those of a traditional broker, for example, a per policy charge as opposed to a percentage of written premium.

2.2 Off-shoring

During the last few years, there has been a trend for insurers to relocate some of their back office functions to different countries to access a cheaper labour market.

Back office functions include functions such as call centres and policy administration. In recent years, India has been a popular place to off-shore functions to.

> ***Question 9.10***
>
> Why do you think India has been popular?

Such a move is likely to have high set-up and redundancy costs.

The insurer also faces the uncertainty of currency fluctuations, assuming the off-shoring agreements are arranged in the off-shore currency.

2.3 The effect of economic conditions on investments

The general economic cycle is difficult to predict and has a significant effect on investment markets, most notably on investment returns.

This is because there is a natural link between the two, and because the government or central bank may use various policies to control economic variables, such as inflation and economic growth.

Poor investment returns include:

- lower than expected investment income, which can lead to the reserves that are held being inadequate to meet the liabilities
- movements in asset values, which can jeopardise an insurer's solvency, (since solvency is measured by comparing the value of assets and liabilities).

Example

During recessions, the value of many asset classes falls. This is due to a fall in demand for the assets, and an increase in the uncertainty of risky assets.

In order to stimulate economic activity, the government might reduce interest rates in order to increase spending (by reducing saving and increasing borrowing). Lower interest rates will affect the value of many different asset classes.

Lower interest rates might increase inflation, which would then impact returns from various asset classes.

Movements in asset values can impair solvency if there is:

- a fall in certain sectors of the market in which investments are held, such as Japanese equities
- a failure or adverse performance of individual assets or investments, such as Poorco PLC
- an adverse movement in currency rates, such as the Rand versus the Euro.

Investment return can sometimes be an important source of income for an insurer, especially if it writes long-tailed classes of business.

Question 9.11

Why?

The best way to minimise asset risks is to ensure that the assets match as closely as is practical to the corresponding liabilities, *eg* by nature, term and currency. Unfortunately, with general insurance business, this is usually impossible due to the uncertainty surrounding claim timings and amounts.

Exchange rates

There will be additional uncertainty as a result of future exchange rate movements, if it is likely that claim payments would be in a different currency from the premium payments.

2.4 The effect of economic conditions

General economic conditions will have an effect on expenses.

Example

An increase in inflation will have an effect on the average level of expenses.

Question 9.12

Which index (or indices) are expenses likely to increase in line with?

Changes in economic conditions could influence claim propensities, particularly within personal lines.

For example, during a recession the number of theft claims tends to increase as does the number of fraudulent or inflated claims.

2.5 New types of investment

With capital markets becoming increasingly complex, there is now a much wider range of investments in which the insurer may choose to invest. Some of these investments may be less certain than more traditional asset classes.

> ***Example***
>
> An example of this is securitised bonds, where the interest and capital repayments are contingent on some event *not* happening, or on the business on which the bond is securitised making adequate profits. The return on such investments is dependent on what it has been securitised on and so could be very uncertain.

Some of these new asset classes may be restricted or prohibited by local regulation.

2.6 Competition

The level of competition can be affected by a number of factors. Two such factors are:

- globalisation of insurance markets
- changes / differences in regulation.

Any changes in the level of competition will have an uncertain effect on a general insurer's mix of business and claims experience.

Globalisation of insurance markets

Insurance markets are becoming far more globalised and insurers are more willing to write business originating outside their home territory. This can lead to increased competition between insurers, so similar business may not be as profitable as it has been in the past.

This can also have an uncertain effect on the insurance cycle.

2.7 The insurance cycle

The insurance cycle is the observed tendency of insurance prices and hence profitability to vary in a cyclical fashion over a period of several years. It can be very difficult to predict, as the frequency and amplitude of the cycle can change every time the market turns.

How the insurer reacts to the cycle can also be an important factor.

Example

An insurer may decide not to follow the market down during a softening period of the cycle, instead opting to lose some business and hopefully retain profitable business.

If this is the case, the insurer's historical experience may not be a good indicator of future outturn.

2.8 Expenses uncertainty

Specific influences on expense uncertainty stem from:

- uncertainty over commission and other sales-related expenses, *eg* for existing and new distribution channels
- uncertainty arising from changes in operations, *eg* new markets and off-shoring.

3 Parameter uncertainty

Parameter uncertainty refers to the uncertainty arising from the estimation of parameters used in a model. Given that any model is an artificial representation of a real life situation there will always be a certain degree of parameter uncertainty in pricing models.

One of the requirements of a good model is that the parameter values used should be accurate for the classes of business being modelled. However this is easier said than done. Indeed, there might be several possible selections for a parameter, each appearing to be equally reasonable, yet a judgement has to be made as to which to select.

Other requirements of a good model are discussed in Subject ST7.

In this section, we discuss a number of sources which come under a broad heading of parameter uncertainty. Please note that this is not intended to be an exhaustive list and that other sources of parameter uncertainty exist.

3.1 Uncertainty arising from the data used

Data may be:

- of a poor quality
- internally inconsistent
- incomplete
- nonexistent.

Poor quality data

There will be occasions where the raw data is poor; for example, claim/policy details may be inaccurate, with perhaps claim dates recorded as being prior to policy inception.

Inconsistent data

Data may also have inconsistencies, for example, changes in claim recording procedures.

Incomplete and nonexistent data

In some instances, data may be incomplete or even nonexistent, for example, when a new class of business is being written.

Insurers may also write business in new territories where they have relatively little experience. This will lead to uncertainty in setting prices.

Question 9.13

Other than for new classes of business, when might data be nonexistent?

Uncertainty at extreme values

Data may not be nonexistent for a whole class of business – an insurer may have a significant body of good quality data for the majority of risk cells, however it may lack adequate data in the tails of any distribution.

When fitting a particular distribution to a set of data, it is usually very difficult to fit the tails of the distribution. This may be because there is no data at these extreme values, or the data that exists is too volatile to be usable. Assumptions will therefore have to be made from what is available. This will give rise to uncertainty in the model output. Care should be taken when interpreting the model's output.

Certain events have little / no data

Certain claim events have insufficient data to build a reliable pricing model, or historical data may be deemed to be inappropriate.

Capital modelling is discussed in Subject ST7.

Note the increasing use of the term ENID (events not in data).

Example

Global weather patterns may be changing at such a pace that renders historical weather data obsolete.

On all of these occasions, assumptions will have to be made. These may be based on similar classes of business, benchmark statistics or the modeller's subjective judgement. In any case, inadequate data will lead to uncertainty within the model.

Format of data

Claims data can be stored in a number of different ways; for example, gross or net of reinsurance, or inclusive or exclusive of claims handling costs. It is important to have an understanding of exactly what is and what is not included in the data.

If there is any change in data storage protocols in the historical data, it should be considered whether adjustments will have to be made, since this may have an effect on the claims development pattern.

The example below shows how several of the problems described in this section can arise.

Example

Inadequate data supplied by third party claims handlers

There may be occasions when an insurer outsources its claims handling function, either to a broker or a specialist claims handling firm. On these occasions, data recording will be out of the hands of the insurer, and there may be some difficulty in checking data validity.

If different claims handlers are employed for different classes / sources of business, the way in which data is recorded may be inconsistent.

There may also be delays in passing the data to the insurer and these delays may also differ between claims handlers.

This will make it difficult to establish claims development patterns.

Question 9.14

Suggest how third party claims handlers may distort an insurer's data in terms of:

- claim frequency
- claim severity
- claim delays.

3.2 Change in case estimate reserving philosophy

Reserving philosophy within a company will change from time to time.

> ***Example***
>
> **If claims handlers have under-reserved a case in the recent past, they may be inclined to overestimate future claims to compensate.**

There may also be changes in reserving philosophy following a change in senior personnel.

This could involve a change in reserving methods, or a change in the basis used for the reserve estimates (within an acceptable range).

If changes in reserving philosophy are known, it may be possible to make adjustments when setting future premium rates.

3.3 Large and exceptional claims

Large claims

Large claims can be expected to have different frequency and severity distributions to attritional and catastrophe claims.

There will be additional uncertainty when setting large claims provisions within pricing models

On some occasions, there may be an absence of large reported claims, and the pricing actuary may wish to add a loading to reflect this fact. This will give rise to additional uncertainty.

Catastrophes

Catastrophic losses can take the form of one immense loss, such as an oil-rig explosion. Alternatively, there may be many smaller insured losses, all stemming from a common, identifiable event such as a hurricane.

Catastrophes are typically hard to predict, so are hard to allow for when pricing. Catastrophe modelling is discussed later in this subject.

One way to reduce the impact of catastrophic losses is to write business in a wide range of geographical locations and across many classes. Catastrophe reinsurance will also help (more of this later in the course).

Latent claims

Catastrophic claims can also result from sources that were unknown, or for which a legal liability was not expected, at the time of writing the business. The cost of such claims cannot be calculated with any accuracy for the purpose of setting premiums.

The first problem with latent claims is that it is impossible to know where the potential claim is lurking. Secondly, if the claim does materialise, the future claim cost is completely unknown.

> ***Example***
>
> Will there be future employers' liability claims for damage to people's eyes from using computers too much? If so, how much will the claim amounts be, and how many people will be able to claim?

The development of these claims is often uncertain: one court judgement can act retrospectively over many policies, which can result in large losses for the insurer.

The effect of judicial decisions is very similar to that of inflation. In fact, the effect of judicial decisions is often simply referred to as "court inflation".

Court inflation results from court awards. The differences between court inflation and price inflation are as follows:

- court inflation, historically, has been higher than price inflation
- court inflation tends to remain level for a period, then increase in sharp jumps when new precedents are created
- court inflation is less predictable than price inflation.

From time to time, judicial decisions will set new precedents for the admission of certain claims, and the amounts at which they will be settled.

Decisions relating to imprecise policy wordings can lead to the admission of new types of claim that had not been allowed for in the original costings. Liability claims are particularly exposed to this type of risk.

Courts also periodically set new levels of award or compensation for existing categories of claim. The effect of such awards will be to increase immediately the average amount at which all future claims of a similar nature are likely to be settled, including those that have already been reported. Such awards are very hard to predict, so it is even harder to allow for this form of inflation than normal claim inflation.

Example

Claim payments that are intended to represent the future lost earnings of an individual, following an accident, are likely to be based upon the present value of that future income. The courts may from time to time change the rate of interest at which insurers are allowed to discount future earnings. This change could have a dramatic effect upon the overall claim payments. Court awards can be impacted by decisions made in other countries too.

3.4 Claims inflation not as expected

Inflation assumptions will be required when setting premiums for future periods of insurance.

The actual inflationary experience could be a significant determinant of price adequacy.

3.5 New distribution channels

Different distribution channels will have different expense profiles.

Question 9.15

Without reading on, comment on whether the main expenses are fixed or variable for:

- broker sales
- internet sales.

Example

Broker sales may have a high variable cost and a low fixed cost, whereas internet sales may have a high fixed cost and very little variable cost.

Some expenses are relatively predictable. Commissions paid to brokers and other intermediaries are almost invariably expressed as a percentage of the premiums payable. As such, they do not give rise to uncertainty in assessing the outcome of business already written. However, other expenses are less certain, *eg* underwriting costs will depend on the level of, and time spent on, underwriting.

Expense uncertainty also arises through a change in the relative proportions of business coming from existing distribution channels.

If the mix of sales differs from what was expected (either between classes or between distribution channels), so that a higher proportion of business is sold on higher commission terms, the average commission rate will increase.

Also, if different brokers are paid different levels of commission, there might be a risk that the mix of business by broker changes.

Additionally, where a differential rate of commission is paid on business acquisition to that paid on renewal, there is a persistency risk in the spreading of these different commission rates across future "level" premiums. This applies equally to any business expense which is higher at the point of policy acquisition and initial processing than it is at the renewal stage.

A further risk or uncertainty may relate to the recovery of commission on a policy proposed but subsequently not taken up, or on early lapse where the distribution agreement specifies a return of commissions paid.

While – on the whole – expenses for existing channels should be relatively certain, the expenses for new distribution channels will be far less so.

It may be difficult to predict the expense profile of a new distribution channel.

Set-up costs of a new channel must also be factored in.

4 Model (specification) uncertainty

In this section, we discuss a number of sources of uncertainty in the area of model specification. Please note that this is not intended to be an exhaustive list and that other sources of uncertainty in relation to model specification exist.

4.1 Model uncertainty

Model uncertainty arises from the choice of or specification of the model. This topic is discussed again in Subject ST7.

Model error arguably gives rise to a greater degree of uncertainty than parameter error, as it is less easy to detect.

Question 9.16

Why?

4.2 Programming error

There is also the risk that errors can creep into the actual programming of the model; for example, typing errors during model construction. This risk can be greatly reduced through thorough checking and peer reviewing of the pricing model.

4.3 Simulation error / too few simulations

The output of a stochastic model will be heavily influenced by the number of simulations carried out: obviously, the greater the number of simulations, the greater the accuracy of the output.

A "good" stochastic model should use at least 10,000 simulations.

However, large and complex stochastic models can take a considerable amount of time to run.

There is clearly a trade-off here. If the modeller has severe time constraints, there may have to be a sacrifice in the number of simulations or in the complexity built into the model.

4.4 Incorrect dependencies

A number of the variables in the model will be correlated with one another; for example, interest rates and claims inflation.

Question 9.17

How might interest rates and claims inflation be correlated?

It is important that the dependencies are programmed correctly. The correlations can be regarded as additional parameters, and it is essential that they are not overlooked.

4.5 Incorrect distributional assumptions in modelling claim distributions

It is sometimes necessary to calculate a range of possible values for a claim or contract, in which case distributional assumptions will be required.

Setting distributions for claim frequencies and claim amounts may be tricky (for the same reasons as discussed above), and there is scope for both the distributions and the parameters used to be wrong.

5 Glossary items

Having studied this chapter, you should now ensure that you are able to explain the following Glossary items:

- Act of God
- Agents' balances
- Bonus-malus
- Events not in data (ENIDs)
- Model uncertainty
- Parameter uncertainty
- Process uncertainty
- Protected NCD.

2.4 Profit optimisation

Insurers can optimise the total profit by accepting a lower profit margin on individual policies in return for a higher total business volume. Although a lower profit is achieved by each policy, the business volume generated by the lower level of premium may result in a higher total profit to the company.

In other words, the profit per policy will be lower, but the total profit across all policies may be higher as a result of selling a greater number of policies. Hence, price elasticity is a key consideration when considering a change in premium rates.

This needs to be balanced against the potentially increased risk of a larger, lower margin portfolio.

We're not talking about price elasticity here. Even if the company succeeds in increasing profit by reducing prices, the resulting portfolio will be more risky (*ie* the profit margin only needs to drop by a small amount to result in a loss).

2.5 Pricing and the insurance cycle

The insurance cycle is a phenomenon that affects all forms of insurance and reinsurance. It is driven by the changing levels of profitability in the market arising from changes in market capacity.

Stages of the insurance cycle

When premium rates are profitable (hard), new entrants are attracted to the market. This increased capacity causes rates to fall until they may even become loss making. At this point some market participants will leave the market, or reduce their market share. This effect may be exacerbated by catastrophes and economic factors. This reduction in market capacity leads to rates increasing once more until we reach our starting point of the cycle and it begins again.

This was also discussed in Chapter 8.

Reasons for insurance cycles

The cyclical nature of premium rate movements is a very real market challenge, perhaps the most challenging aspect of managing a portfolio of risks for many lines of business.

It is important that the insurer is aware of the stage of the insurance cycle that the market is in when deciding on the final premium.

There are many causes of underwriting cycles, including:

- **a delay in the understanding of the emergence of higher claims costs, which leads to under-pricing of current risks**
- **inflows and outflows of capacity to the market, often as a result of large-scale catastrophes**

  Catastrophes may jolt prices higher due to providers leaving the market hence causing a reduction in supply.

- **deliberate under-pricing (or the use of expense advantage) by key players in an attempt to drive out competitors**
- **an attempt to grow in volume in order to cover high fixed expenses** (or to achieve market share)
- **pricing strategy being determined by chasing market prices (upwards or downwards) rather than being based on sound technical prices, with no player in a given market willing to be the first to break the cycle**
- **the level of investment return available to offset underwriting losses.**

Different markets are impacted to a greater or lesser extent by these factors, and certain markets tend to exhibit more or deeper cyclical trends than others.

Importance of knowing the current stage of the insurance cycle

We should know the stage of the insurance cycle that the market has reached in order to assess how to allow for business objectives and competition. While we should evaluate every risk on its available information (or that pertaining to its class), the tide and optimism of the market can often affect judgement; and indeed the data itself may be less reliable at certain stages of the market.

Example

In a rapidly rising market, the insurer might give priority to the new business area in the allocation of systems and administration time, with the result that claims information might be less up-to-date.

In addition we might be less prudent in our claims estimation and reserving, if we believe that the business currently being written is more profitable than it really is.

Now convert the left-hand scale so that the total area under the curve is 1, *ie* by dividing through by the total number of observed claims.

Then select a function, $y = f(x)$ which has a similar shape to our plotted data. This is the probability density function (pdf).

The following loss distributions are often used:

- **Severity: log-normal, Weibull, Pareto, Generalised Pareto, Gamma**
- **Frequency: Poisson, negative binomial.**

For frequency, a negative binomial distribution is commonly used in practice, because it allows for dependencies between claims, whereas the Poisson distribution assumes successive claims are independent of each other.

Remember that key information on many statistical distributions is given in the *Tables*.

The fitting process

Choice of distribution

We need to select a method of fitting to find parameter values for our chosen distribution.

Proprietary software packages are available, which help to fit a wide variety of distributions to the observed loss data. However, fitting routines can be developed in-house.

Whichever approach is used, it is important to be aware of the underlying fitting algorithm (to choose the parameters of the distribution). Common methods are:

- **maximum likelihood estimation**
- **method of least squares**
- **method of moments**.

We may use different methods (*eg* method of moments or method of maximum likelihood) and then select the one that gives the best fit to our data.

When fitting parameters of distributions to data, one should be aware of:

- **the estimation error around the parameters, due to only having a finite sample, and**
- **the potential impact this can have on the results.**

This "estimation error" is another term for "parameter error", which was discussed in Chapter 9.

Methods for assessing this parameter uncertainty include:

- **bootstrapping**
- **asymptotic approximations for maximum likelihood estimates**
- **Bayesian methods.**

Testing fit

By plotting the density functions of the observations and fitted distribution, we can quickly assess the goodness of fit by eye.

However, statistical goodness of fit tests are more robust. As with the fitting algorithm, it is helpful to be aware of the features of any statistical tests that are used.

The following tests are commonly used:

- **Chi-Squared statistic**

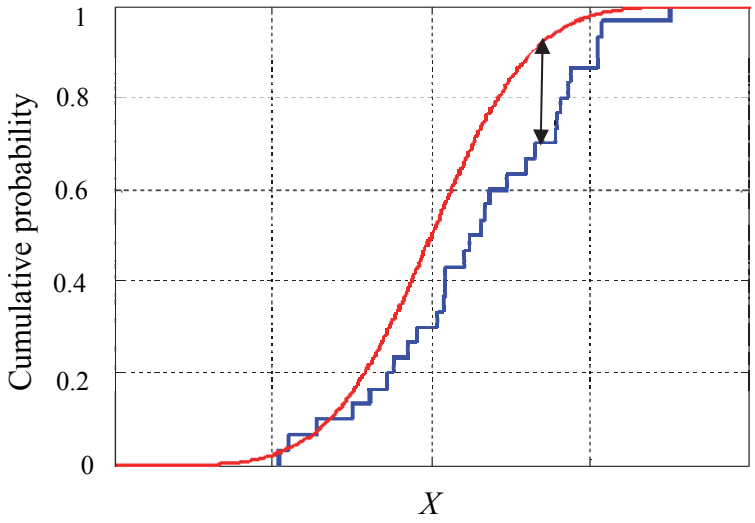
  A chi-squared test, also referred to as a chi-square test or χ^2 test, is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true, or any in which this is *asymptotically* true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-squared distribution as closely as desired by making the sample size large enough.

  Chi-squared tests were covered in Subject CT3.

- **Kolmogorov-Smirnov statistic**

  The Kolmogorov-Smirnov Goodness-of-fit (K-S GoF) test is a test of whether a one-dimensional sample comes from a specified probability distribution. The Kolmogorov-Smirnov statistic quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution.

Therefore, the K-S statistic tests the significance of the area between the two distributions in the graph below:



The null distribution of this statistic is calculated under the null hypothesis that the sample is drawn from the reference distribution. The distributions considered under the null hypothesis are continuous distributions but are otherwise unrestricted.

In its basic form, the test assumes that there are no parameters to be estimated in the distribution being tested, in which case the test and its set of critical values is "distribution-free".

However, the test is most often used in contexts where a family of distributions is being tested, in which case the parameters of that family need to be estimated and account must be taken of this in adjusting either the test-statistic or its critical values.

- **Anderson-Darling statistic.**

  The Anderson-Darling Goodness-of-Fit test (A-D GoF test) is another statistical test for whether a sample can be modelled as being drawn from a specified distribution.

  Similarly to the K-S statistic, the A-D statistic measures the distance between the empirical distribution function and the CDF of the reference distribution. However, the A-D statistic places more weight on differences in the tails of the distribution.

  As in the case of the K-S GoF test, the most basic form of the A-D GoF test assumes that the parameters have not been estimated from the data.

Comparison of K-S and A-D goodness of fit tests

The K-S GoF test is more sensitive to deviations from the reference distribution around the centre of the distribution.

The A-D GoF test is:

- **more sensitive to deviations in the tails, due to the weighting applied to these points in the calculation of the statistic.**
- **typically more powerful than the K-S GoF test, in that it is more likely to correctly reject the null hypothesis when the null hypothesis is false (*ie* if the data do not come from the reference distribution, the A-D test is more likely to pick this up).**
- Various studies have also found that the Anderson Darling statistic is more powerful for testing for normality than the Kolmogorov-Smirnov statistic.

Both tests have non-parametric (*ie* distribution-free) **versions for comparing whether two (or more) samples can be modelled as coming from the same population distribution.**

Although goodness of fit tests provide a strong indication of the distribution that should be used, it is also good practice to consider whether the chosen distribution makes theoretical and practical sense.

Question 14.9

An excess of loss contract provides cover of £250,000 in excess of £50,000 for any one claim. Assuming that the underlying gross claims have a claim frequency of c and a claim size distribution of $f(x)$, derive the equations for calculating:

(a) the claim frequency, and

(b) the average cost per claim,

under the excess of loss contract.

Combining severity distributions

When an insured has a sufficient volume of losses, we may fit a number of different severity distributions to different parts of the overall loss range. For example, we may fit separate distributions to:

- **the smallest attritional losses, say those below £5,000**
- **losses greater than £5,000 up to a large loss threshold, say £500,000**
- **losses over the threshold**
- catastrophe losses.

We can justify this approach in terms of the different nature of incidents that underlie the overall claim severity distribution. The overall distribution reflects the particular combination of different types of incidents (slips, falls, vehicle accidents, and so on) experienced by a particular company. Each type of incident may produce a quite distinct severity distribution and we would ideally fit a separate severity distribution to each incident type. However, data shortcomings often prevent this and we adopt the approach described in the bullet points above as a practical approximation.

1.6 Simulation approaches

Although we can derive a formula for the aggregate loss distribution for certain combinations of frequency and severity distributions, in practice we often derive the aggregate loss distribution through simulation.

You may recall from Subject CT6 various compound distributions, such as the compound Poisson and compound negative binomial. We can derive formulae for the moments of these compound distributions. This can give exact results but the calculations can become unwieldy (or impossible) if the method used, or the product structure, is complicated. For this reason, simulation approaches are often used.

Structure terminology

Before illustrating how simulation can be used, we define some features (or "components") of a complex structure.

It is essential to use simulation approaches when we estimate the loss cost likely to be borne by the insurer under more complex structures.

Some of the more common components found in insurance arrangements are:

- **Aggregate deductible – The maximum amount that the insured can retain within their deductible when all losses are aggregated.**

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