1
Introduction

The process of claims reserving is at the core of the financial management of general insurance organisations. It determines what is held on the balance sheet for claims that are not yet settled, affects the premiums that are charged and impacts on the capital that is held to support the solvency of the organisation. Thus, the selection of appropriate reserving methodologies and assumptions, and the application to practical situations, often with imperfect data, are of critical importance to the operations of an insurance organisation. This book has been designed for both those who are relatively new to the subject of reserving in general insurance, and for experienced practitioners who want a single reference source on the subject. It is also anticipated that it will be of interest to those wanting to develop new reserving techniques. In writing this book, I had four key objectives in mind:

1. To produce a comprehensive description of both the theory and practice of claims reserving in general insurance. Although there are already a large number of papers and books on this subject, I have always felt that creating a single reference work covering a wide range of reserving topics would be of benefit to those new to the subject and to experienced practitioners, partly to help avoid the reinvention of previously developed approaches that I have seen occur several times during my career (by others and myself). Although most reserving is now carried out in bespoke or proprietary reserving software, which will usually have associated user guides and manuals, this book is intended to supplement those sources by covering a variety of reserving topics and techniques, the latter of which may not all be implemented in the relevant software products.
2. To provide those who wish to advance the more theoretical aspects of reserving with a clear and thorough description of the many practical issues that frequently occur when applying reserving methods in the real world. My hope is that, by doing this, more effective new approaches can be developed in future which make appropriate allowance for these practical issues, which in turn should encourage their wider application. In so doing, this should improve the reliability of reserve estimates and assist with understanding the uncertainty surrounding those estimates. More accurate reserve estimates should lead to fairer insurance/reinsurance premiums and to more reliable financial statements, both of which must be in the public interest.

3. To provide reserving practitioners with an accessible reference source for some of the more theoretical aspects of claims reserving (e.g. stochastic reserving) so that more of them might consider investigating the greater use of such techniques in practice. Such practitioners quite rightly spend most of their time focusing on the many and varied difficulties that occur when applying reserving methodologies in practice, and so do not always have time to search for (let alone fully digest) a reference source of the more theoretical aspects of reserving.
4. To provide a reference source for actuarial students studying the general insurance reserving components of a number of the global professional actuarial bodies' examination syllabi. Although some parts of the material go beyond what is within the relevant syllabi, this will provide students with a better overall context for their studies, and will also enable those students who wish to develop their knowledge further to do so, without having to cross-reference significant volumes of other material.

Reserving in general insurance[1] is still a developing subject, particularly in respect of both the practical and theoretical detail of the methods. In many situations, there is no right or wrong approach, and practitioners often have their preferences as to how to apply methods in practice, with several bespoke modifications to the standard approaches described here being used to suit the particular circumstances at the time. Whilst some of these bespoke modifications are discussed here, there will be many more that exist in the real world. To reflect this, in a number of places in the book there are suggestions, rather than definitive statements, as to what approach might be used in specific circumstances. One feature of a reserving exercise that it is possible to be definitive about, however, is that it is necessary to apply judgement at each stage of the process.

The book is designed to be of relevance to all those with an interest in claims reserving in respect of general insurance risk carrying entities, including actuaries, statisticians, reserving technicians, senior management and board members, risk management specialists, underwriters, finance staff and claims managers. It covers both general material as well as some of the more mathematical elements of reserving. However, readers who are less interested in the mathematical aspects can simply ignore those sections, as the majority of the other sections do not rely on an understanding of these parts of the book.

After covering introductory background material in the remainder of this chapter, the next chapter covers the data requirements, followed by two key chapters that provide a detailed description of a wide range of both straightforward and more advanced reserving methods. The next two chapters cover applying these methods in practice and a selection of additional reserving topics, not covered in the other chapters. The final chapter describes the specific features of reserving in a range of different contexts, including selected classes of business or claim types in the UK, US and Asia.

[1] The word "general" in this context is synonymous with "Non-Life" and "Property & Casualty", and is intended to mean all classes of insurance other than life insurance. Insurance is deemed to include reinsurance business as well as insurance business. Further notes on terminology are given in Section 1.5.

Readers who are new to the subject who wish to gain an initial overview would be advised to read the first two chapters, followed by the first four sections of Chapter 3 and then Chapter 5, which covers applying reserving methods in practice. The remainder of Chapter 3 and the other three chapters can then be studied as required. A review of the headings of each chapter in the contents page should provide a self-explanatory overview of the structure of the book. This should enable readers who are more familiar with the subject to select chapters and sections based on their own specific requirements.

I have tried to make the book as self-contained as possible, so that the reader does not have to refer to other sources in order to gain a reasonable understanding of the material being covered, although there are some areas where only high-level descriptions are given. At numerous points in the text, I have included references to original sources on which the content is based and in some cases to suggested further reading, which can be used by readers wishing to explore the relevant topics in more detail. However, since the volume of published material on claims reserving is extensive, there are many sources that could be relevant to a particular reserving exercise or research study which may not be cited here. Furthermore, the theory and practice of claims reserving continues to evolve, with new methods and approaches being developed from time to time. The practitioner can use various ways to identify sources relevant to their particular requirements beyond those cited here, and to keep up to date with developments. One such source is the bibliography at Schmidt (2015).

1.1 Basic Concepts

Although this book assumes that the reader has a good basic knowledge of general insurance, a brief introduction to the concepts underlying reserving is given in this section, to provide some context for the remainder of the book. Readers who need a more comprehensive introduction to general insurance should be able to access suitable training materials through their local insurance or actuarial institutional bodies (e.g. in the UK, the Chartered Insurance Institute and the Institute and Faculty of Actuaries).

The fundamental process that occurs in an insurance entity is that it charges a premium in return for promising to pay claims if they are covered by the relevant policy. The premium is either collected at the beginning of the policy period, or via instalments over the policy period. However, claims can be paid either during the policy period, or in some cases up to several years after the end of the policy period. Although claims are usually covered only if they occur within the period of the policy,[2] there is typically a delay between the date of the claim and the date by which the insurer knows the full amount that it will pay on the claim. The delay can occur for three main reasons. First, there can be a delay between the occurrence date and the date on which the claim is advised to the insurer. Second, even if the claim is advised quickly after the occurrence date, it can take time to agree the value of the claim. Finally, some claims are payable as recurring payments, for which the duration may

[2] Other forms of coverage are also possible, such as so-called “claims-made” policies, which cover claims made or notified during the policy period.

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David Hindley
Excerpt
More Information

be unknown, according to the terms of the relevant insurance policy. These reasons mean that, whenever an insurer is seeking to produce financial records or statements, it needs to determine the total claims that it expects to pay out, in respect of the relevant insurance policies that it has issued. This determination will inevitably involve a degree of estimation, since, by definition, it will not know the total value of claims at a particular date in respect of the policies that it has issued. The estimation process will give rise to an amount that needs to be "reserved" for the claims that are not yet paid – i.e. the future claims outgo – hence the term "reserving". When this amount is added to the amount that the insurer has already paid, it produces what is generally referred to as the "ultimate" claims – i.e. the ultimate amount that the insurer is estimated to pay in respect of a particular group of policies or claims.

For many years, the reserve (or "provision" or "technical provision" as it is sometimes called) was determined using relatively straightforward approaches, such as simply adding up all the amounts that had been estimated for each individual outstanding (i.e. not settled) claim on a case by case basis. In the UK, this changed in the early 1970s, and more numerical or statistical type approaches started to be used, based on various forms of aggregated claims data.[3] Nowadays in the UK and elsewhere, most reserving is done using these approaches and much of this book is devoted to a description of the different techniques that have been developed, and their application in practice. Consideration of the techniques can give the impression that reserving is a science, but in reality it involves an element of art as well, since in practice there is a significant degree of judgement involved in the application of the techniques.

The fact that the insurer will not know the total value of claims at a particular date in respect of the policies that it has issued can be summarised by simply stating that there is uncertainty in the future claims outgo. This uncertainty translates into uncertainty over the accuracy of the reserves, or in other words, how will the actual future claims outgo compare with the reserves established at a particular date? This characteristic of the process of reserving is also sometimes expressed in the statement that the only thing that is certain about an established reserve is that it will be wrong (i.e. that it will not exactly match the actual future outgo). A key aspect of reserving is to seek to understand how wrong it could be. Although that will not be known accurately until all relevant claims have been settled, an important part of many reserving exercises will involve estimating the uncertainty surrounding a single reserve estimate, and then communicating this to the relevant stakeholders.

There are several different types of reserve referred to by insurers. The terminology and associated definition can vary depending on the context and location of the insurer, as discussed further in Section 1.5. A brief description of some common types is given below. In some contexts the word "provision" is used instead of "reserve" for a number of these.

[3] The reasons for this are believed to include the recognition that regulators needed to be able to derive independent analytical techniques to better assess the solvency of insurers and also an acknowledgement that case reserving may not adequately capture the amounts required for claims that have occurred but have not yet been reported to the insurer. These and other factors are discussed in Ackman et al. (1982).

The descriptions given here are designed to convey the general meaning of the terms used for each type of reserve, when they are used in a reserving context. This meaning can be different to that which applies, for example, in an accounting context, as explained further in Section 1.5. Hence, the descriptions given here do not represent formal legal or accounting definitions that may apply in any particular jurisdiction.

Case Reserves: The amount in respect of claims that have been advised, but which have not yet settled. The Case Reserves are usually established either by assessment on a per-claim basis by the insurer's claims staff, or for some claims during the very early period after the claim has been advised, by an automated procedure.

Outstanding Claims Reserve: Either used as another term for Case Reserves, or, in the case of the accounts of insurers, can often relate to the sum of the Case Reserves, IBNR Reserve and IBNER Reserve. Outstanding Claims Reserve may be abbreviated to "OCR" or "OS".

Unearned Premium Reserve: The proportion of the written premiums, as at a particular date, that relate to future policy periods (i.e after the end of the latest reporting period covered by the relevant financial statements – usually the valuation date for the reserving exercise). It is often shortened to "UPR". It is typically viewed as an accounting item, rather than a reserve that is calculated by applying the types of reserving method described in this book.

Unexpired Risk Reserve ("URR"): The amount in excess of the UPR (after deduction of any Deferred Acquisition Costs, or DAC[4]) that needs to be held to cover claims and expenses that relate to future policy periods in respect of policies that the insurer has already written. It is sometimes also referred to as the "Additional Amount for Unexpired Risk", the "Additional Unexpired Risk Reserve" or the "Premium Deficiency Reserve". It is only needed if the UPR (less DAC) is deemed insufficient to cover claims and expenses in respect of the unexpired policies. As for UPR, it is typically viewed as an accounting item.

IBNR Reserve: Stands for Incurred But Not Reported Reserve. Usually relates to the amount in respect of claims that have occurred, but which, at a particular date, have not yet been advised or reported to the insurer. Can sometimes also be deemed to include the IBNER Reserve, as explained below. Depending on the context it can also sometimes include an estimate of the claims payable on the unexpired period of all relevant policies that are included in the data used for a particular reserving exercise. A related term that might be used is "Pure IBNR", which generally refers to the element of IBNR that relates only to unreported claims – i.e. it excludes any IBNER element related to reported claims.

IBNER Reserve: This stands for Incurred But Not Enough Reported Reserve. If the Case Reserves have been assessed as being too high or too low in aggregate (e.g. based on some form of statistical analysis), then an amount is estimated to adjust them so that the

[4] In simple terms, DAC are an asset which represent the proportion of the prepaid acquisition expenses (e.g. broker commissions), which are unearned at the valuation date.

aggregate amount is more appropriate. The IBNER Reserve can sometimes be included as part of the IBNR Reserve.

Equalisation Reserve: An amount established, usually by reference to a formula or procedure specified by a regulator, that is designed to smooth or "equalise" reserves over a certain period. Typically only used for certain types of low frequency/high severity events and only in certain territories.

ALAE Reserve: Stands for Allocated Loss Adjustment Expenses Reserve and relates to future expenses (as opposed to Indemnity amounts) associated with specific claims. It is often included as part of the Case Reserves, IBNR and IBNER, rather than being identified separately.

ULAE Reserve: Stands for Unallocated Loss Adjustment Reserve and relates to future expenses related to claims in general, as opposed to specific claims.

There can be other types of reserve, depending on the context, such as Reopened Claims Reserve and Reserve for Claims in Transit (i.e. Incurred and Reported, but not yet recorded on the insurer's systems).

The term **"Claims Reserve"** is also used in practice, as is the equivalent term **"Loss Reserve"**. This can mean any one or combination of the above types of reserve. One of the more common usages, however, would be that it represents the sum of Case Reserves, IBNR Reserve and IBNER Reserve; this is the definition used in this book, unless stated otherwise. In some instances, future (unpaid) premiums are deducted from the Claims Reserve, in which case the term "Claims Reserve Net of Future Premiums" or "Loss Reserve Net of Future Premiums" might be used.

Other terms may be used in different accounting, regulatory and solvency contexts in general insurance around the world. For example, the terms "Claims Provision" or "Claim Liabilities" might be used to mean one or more of the above types of reserve, but related only to claims that have already occurred at a particular valuation date. Similarly, "Premium Provision" or "Premium Liabilities" might be used to refer to the corresponding reserve in respect of the unexpired contractual obligations associated with relevant policies at that date (i.e. future claims on such policies at the valuation date).

The size of the IBNR and IBNER Reserve relative to the Case Reserves will vary depending on the circumstances. It will generally be higher for types of business where there is a long delay between the underlying incident occurring and the claim being reported to the insurer and/or settled by the insurer. Industry data at an aggregate level can provide some broad indication of the relationship. For example, A.M. Best (2016a) shows that for the US Insurance industry as a whole, IBNR was 111 % of Case Reserves as at 31 December 2015.[5] In other words, on this measure, IBNR is approximately equal to the Case Reserves. For specific insurers the relationship may be materially different from this, but in most cases the process of determining the Claims Reserve will rarely involve just using the total reserve for reported but not settled claims (i.e. the Case Reserves) and so a

[5] Using the ratio of IBNR for Loss and ALAE combined to the Case for Loss and ALAE combined for US Property/Casualty companies in aggregate, taken from Page 12 of the Quantitative Analysis Report in A.M. Best (2016a).

process will be needed to estimate the IBNR/IBNER component (which is usually, but not always, positive); that process is the focus of much of this book.

Most types of reserve can be either gross (i.e. before) or net (i.e. after) of outwards reinsurance, with the difference being the reinsurer's share of the reserve. The gross reserve will usually appear as a liability in the balance sheet of an insurer, whereas the reinsurer's share will usually appear as an asset – with the difference being the net reserve. There can also be a distinction between reserves that are booked in an insurer's financial accounts and those established on a specified basis. A common basis that is used is referred to as either an "Actuarial Best Estimate" ("ABE"), "Actuarial Central Estimate" ("ACE") or just "Best estimate", which represents the reserves established by the insurer's actuarial/reserving team on a best estimate basis. In this context, the term "best estimate" is intended to represent the mean (i.e. the average or the expected value) of the range of potential outcomes for future claims. Although this is the intended meaning used in this book, in certain markets or contexts, different definitions of best estimate or central estimate might be used. See Chapter 21 of Friedland (2013) for some alternative examples.

The best estimate will usually be above the median (i.e. the 50/50 value) and the mode (i.e. the most likely value) because the distribution of potential outcomes for the future claims tends to be positively skewed (sometimes referred to as "skewed to the right" or "long-tailed") and such distributions often (but not always) have this relationship between the mean, median and mode. In practice, depending on the reserving methods used, it may not be possible to demonstrate that the selected reserve represents the best estimate as defined in this way. However, the definition is still helpful, as it effectively expresses the intent of the practitioner when selecting the reserve estimate. The booked reserve can be referred to as the Booked Reserve, Carried Reserve or Management Best Estimate (or "MBE" Reserve). If the MBE exceeds the ABE then the difference might be referred to as a management loading or margin. The margin can be regarded as an additional amount to introduce a degree of prudence into the booked reserves, to allow for example for the inherent uncertainty involved in the reserve estimation process and/or to represent an explicit buffer against adverse developments in respect of identified and unidentified sources.

The context in which reserves are being established can influence certain aspects of the reserving process. A common context will be the determination of financial results of the insurer, for management, statutory or regulatory reporting purposes. Other important contexts include transactional (e.g. Sale or Purchase in a Merger/Acquisition), Pricing, Business Planning, Tax reporting, reinsurance purchasing and input to capital modelling. The context may also define or influence the "basis" that is used in the reserving exercise. For example, in some countries the regulations require reserves to be established at a certain level of confidence (e.g. 75th percentile in Australia) and in some regulatory contexts there can be specific requirements related to the margin that must be held in excess of a best estimate (e.g. in a European context, Solvency II requires a risk margin to be determined using a defined approach). Other aspects of the basis that can be influenced by the context include whether or not the reserves are discounted for the time value of money. In some contexts, the purpose of the reserving work is to provide a formal opinion on the reserves, usually for regulatory purposes. If this is the case, then the relevant regulations will usually define the basis of this opinion (e.g. whether the reserves are "reasonable" or whether they are at least as large as a best estimate) and this can influence the scope of the reserving work.

In most parts of this book, the subject of a reserving exercise is usually referred to as an insurer. This is intended to mean any relevant risk-bearing entity, which can include a reinsurer, Lloyd's syndicate, captive insurer, self-insured entity, insurance/reinsurance pool, mutual, Protection and Indemnity Club or government body.

1.2 Elements of a Reserving Exercise

Any reserving exercise involves far more than simply applying one or more technical methods to a dataset. The key elements involved are summarised in Table 1.1. This is set out in the approximate sequence of a typical exercise, although in practice there will inevitably be a degree of iteration between the different stages. In addition, the steps involved will depend on the purpose and scope of the exercise; this summary assumes the aim is to produce a single point estimate for the reserves.

A high-level summary of these elements is given below. The purpose of setting this out here is so that the additional detail in the subsequent chapters can be seen in the overall framework of a reserving exercise. In practice, the procedure will vary significantly between

Table 1.1 *Key elements of a reserving exercise*

Element	Key stages
Background	Understand context Understand the business Gather background information Discuss with key personnel Determine basis of exercise Planning
Data	Determine availability Determine suitability Determine reserving categories Process data Check data
Analysis	Select method(s) Initial data review Apply methods Review results – numerical Review results – graphical Actual vs Expected Select results
Reporting	Summary tables Graphs Presentation Reporting

exercises. Chapter 5 contains more detail on applying reserving methods in practice and Chapter 7 provides a summary of the particular features of reserving for a selected range of reserving class/country combinations.

Background

The first task will be to understand the context for why the reserving exercise is being carried out. For example, there could be a particular regulatory requirement that is being met, or there could be a potential transaction for which a view on the reserves of the target is required. This context will affect issues such as the timing and whether a best estimate or other basis is appropriate for the exercise.

Understanding the business that is subject to the reserving exercise is also critical at an early stage of the process. As far as is practical, this can involve matters such as the underlying process that gives rise to claims and the key drivers that influence the frequency and severity of claims, together with consideration of whether this has changed over time. This will help determine key issues such as whether standard reserving methods will be appropriate or not and the approximate length of the development tail. The extent to which historical data is appropriate for predicting future claims, and hence reserves, can also be considered at this stage. Gathering relevant background information, such as previous reserving reports, underwriter commentaries on the business and market-wide reports can also be helpful in understanding the business. There can rarely be a substitute, however, for meeting with relevant staff at the insurer, such as underwriting, claims and finance. This is the case even with a regular reserving exercise, as there can be underlying changes that need to be allowed for. Interaction between the relevant staff and the reserving practitioner at regular points will further enhance the overall reserving process.

Most reserving exercises of any scale will usually involve an element of planning before the detailed work is carried out, in order to determine timescales, review and sign-off stages etc. Where relevant, the impact of any applicable professional standards on the work will often be considered as part of this planning phase, so that any particular requirements (e.g. such as peer review perhaps) can be built into the work programme.

Chapter 5 contains additional detail on the background stage, including examples of approaches that can be used to gain an understanding of the business, and a discussion of other topics relevant to this stage, such as governance and compliance with professional and regulatory requirements.

Data

Consideration of the data will initially involve establishing the data that is available for the relevant insurer within the required timescales, as well as deciding upon the most appropriate type of data to collect, taking into account the nature of the business and the type of reserving method(s) that will be used. In practice, a compromise may be necessary, taking into account these sometimes opposing factors. This determination will include defining the categories by which the reserving exercise will be carried out. In practice, these categories will depend on the specific reserving exercise, but in general terms, examples of the categories which can be used to group the data include:

- Class of business: e.g. Property, Liability, Motor, Household etc.
- Size of claim: e.g. in size band groupings or split between Attritional, Large and Catastrophe.
- Type of claim: e.g. Property damage, Third Party Liability, Latent etc.
- Gross, Net or Reinsurance.
- Premiums, Claims and/or Commissions.

The above categories are not mutually exclusive – for example, some classes of business might be subdivided by claim type. The goal in determining these groupings will be to establish homogeneous categories, with sufficient volumes of data, to which appropriate methods can be applied.

Often there will be an obvious default type of data to collect, and hence corresponding reserving method(s) to use, based, for example, on the previous reserving exercise. However, it will usually be advisable to review this periodically to assess whether that default approach is in fact still the most appropriate.

Within any chosen grouping, a decision will need to be made on whether to collect claim amounts (including whether Paid, Outstanding and/or Incurred Claims) and/or claim numbers (including whether settled, reported, including nil claims etc.) and/or premiums and/or commissions.

For most reserving exercises, there will usually be some form of existing estimated ultimate claims (and premiums, if relevant) that would be collected at an early stage of the process. The source of these estimates will vary depending on the context, but will include the booked estimates derived from the previous valuation and estimates made by internal or external actuaries at different points in time.

As well as considering the data that is available from the specific insurer or entity that is the subject of the reserving exercise, consideration of available external or benchmark data at an early stage can also be beneficial. Such data can include industry data derived from regulatory returns, published reports and analyses from industry commentators/consultants/market bodies or data collated by consulting firms. This is discussed further in Section 6.9.1, which includes examples of possible sources for selected types of business.

Once the data that will be used has been determined it is processed and checks carried out to ensure that it is reasonable. Such checks include considering matters such as the explanation for any unusual movements (e.g. particularly large or small increases or decreases in claims over recent time periods), comparison to the data from previous exercises and reconciliation to other sources such as finance systems.

Chapter 2 discusses data in more detail.

Analysis

This is the element that many would regard as the core of a reserving process, and, although it should ideally involve the most amount of time, in practice other elements such as dealing with data issues can unfortunately sometimes take up disproportionate time.