Actuaries Institute Australia

LIFE INSURANCE AND RETIREMENT VALUATION

MODULE 2: A FRAMEWORK FOR VALUING CASH FLOWS

Education Program
ACTUARIES INSTITUTE

Education that Counts

Fellowship Program

Module 2

A FRAMEWORK FOR VALUING CASH FLOWS

Education that Counts

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2. A framework for valuing cash flows

This module covers the following learning objectives:

Item	Unit/Key Performance Objective/Learning Objective
1	Describe the overarching framework for valuing uncertain future cash flows
1.1	Describe the actuarial approach to valuing cash flows
1.2	Outline the probabilistic nature of actuarial models
1.3	Explain, in general, actuarial models, their inputs and outputs, and how they are affected by professionalism and the external environment
1.4	Recognise the qualitative aspects of providing actuarial advice

2.1. Introduction

The Institute of Actuaries of Australia has published an Actuarial Capabilities Framework (ACF) that provides explicit statements of the core skills members need to practise successfully as an actuary. One of the eight key skills in the ACF is valuing uncertain future cash flows, which is defined as:

> *The provision of reasoned, relevant and justifiable projected cash flows and the application of professional judgment in analysis, communication, reporting, monitoring and advising clients.*

This definition appears to have the following elements:

- an actuary has agreed to provide advice to a client, who may be your manager, on a topic dealing with future random events;
- the scope of the engagement has been agreed, albeit implicitly if the work is for your employer;
- 'reasoned' suggests a well thought-out argument;
- 'relevant' suggests the advice is pertinent to the agreed scope;
- 'justifiable' suggests that one needs to demonstrate the argument is reasonable;
- 'projected' implies the future and all future events are unknown;
- 'application of professional judgement' suggests a blend of techniques and experience; and
- the control cycle is embedded in the definition as it suggests specifying the problem, developing a solution, monitoring and communicating the result.

This subject discusses a variety of different cash flow projections that are used in actuarial practice. As you read through this textbook you should reflect on the above definition. It is important to realise that professional actuarial work is about advising decision makers on the implications of their choices in addition to performing calculations. You need to develop a detailed understanding of why a method is chosen for a particular problem and learn to question if the underlying assumptions are valid, or at least justifiable.

2.2. Actuarial approach to valuing cash flows

There are five broad cash flow problems addressed in this subject:

- estimating the liabilities for contracts sold to individuals or groups;
- measuring the profitability, or surplus, arising;
- assessing the funding of defined benefit retirement funds;
- considering whether sufficient capital is held to withstand deviations from what is expected; and
- evaluating the value of an entity to its owners.

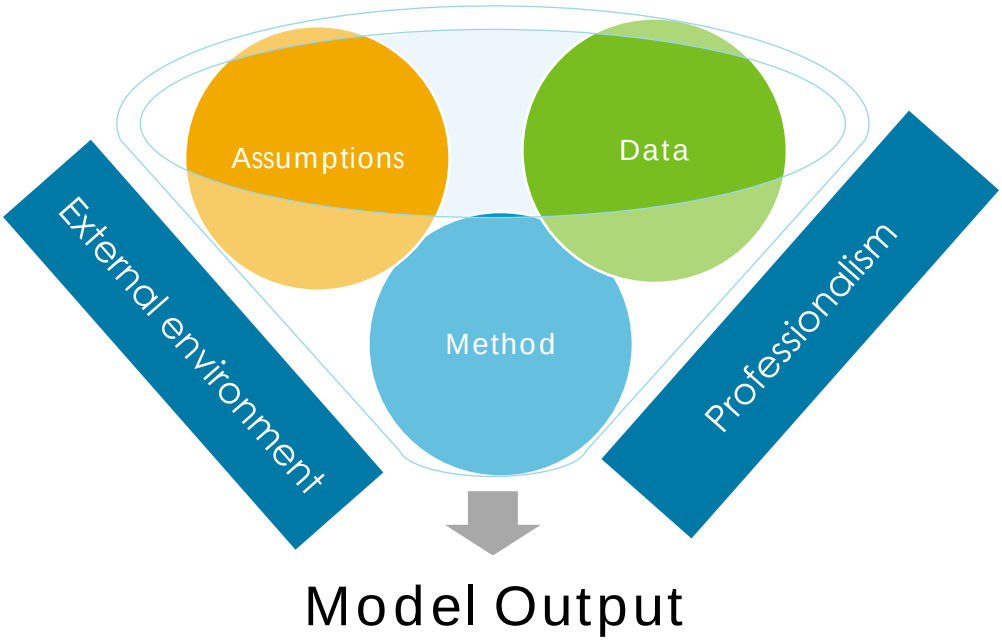
Whilst there are many technical differences to consider when solving the problems above, there is an overarching framework which applies to them all. A valuation of uncertain cash flows requires:

- data;
- a method that defines how to calculate the cash flows;
- assumptions about the future;
- a model that can perform the calculations;
- output of the results;
- a comparison of what was expected and what actually occurred;
- communication of results;
- a feedback mechanism to update assumptions; and
- management of the valuation process.

The above framework is used in subsequent modules of this textbook.

Many of the above elements are linked together. For example, a valuation of uncertain future cashflows will require a model to capture the timing and size of the cashflows. Figure 2.1 shows how a model is affected by assumptions, data and method, but must also consider professional requirements and the external environment.

Figure 2.1: Modelling environment



The general concept of modelling forms part of the Associateship subjects. We recap this concept by briefly discussing below each of the influences on a model, as shown in Figure 2.1.

2.2.1. Models

A model is a mathematical representation of a real-world phenomenon and therefore must involve making simplifying assumptions about the real world. The model needs to be calibrated against the phenomena it is supposed to represent. Testing the accuracy of the calculations is necessary, involving both technical review of the model and peer review for materiality and sense-checking. The degree of simplification will depend on the purpose of using the model. For example:

- investigating the retirement fund sponsored by a company likely to be acquired shortly through an M&A process will necessarily be high-level, unless there are features that warrant further investigation;

- building a model to advocate a new and complicated product line, such as variable annuities, will involve extensive, multiple models;
  - a detailed investigation into each model's sensitivities to the parameters would be required; and
  - detailed communications on how to manage investment guarantees is essential to help decision-makers to decide whether to proceed with the proposed product;
- a valuation model may use some broad assumptions compared with a pricing model that is investigating whether new features should be added to a product.

Modelling the future necessarily means that randomness needs to be considered. In one sense, all actuarial models are stochastic as the future is uncertain and events are random. However, many actuarial models appear to be deterministic as the model has been appropriately simplified. It has become standard actuarial terminology to refer to these 'simplified' models as deterministic.

For example, we often model mortality by stating the probability of death for a male aged 40 as being 0.1 per mille (i.e. per 1,000). This is standard actuarial terminology, but it is actually shorthand for the more cumbersome expression: "the probability of death for a male aged 40, conditional on reaching age 40, is from a probability distribution with a mean value of 0.1 per mille". The variance of the underlying distribution is often assumed to be small, or is of no interest, to the specific purpose of the investigation.

The randomness of outcomes tends to be captured through stress testing of 'deterministic' models to show their sensitivities to the assumptions adopted. There are two complementary approaches used to test sensitivities. One approach is to use a fixed percentage stress to each assumption to test the sensitivity of results to each assumption. The second approach is to stress material assumptions in line with the uncertainty in those assumptions.

All models require parameters (assumptions) and data. The quality of the output from the model depends on the quality of the data and assumptions. Working life always imposes restrictions on resources (time, labour, IT systems) and the actuary needs to be clear to the user of the results if there are implications on the deliverables arising from any restrictions.

2.2.2. Method

The **method,** shown at the bottom of the funnel in Figure 2.1, refers to the particular valuation procedure used. There are a variety of different methods that actuaries use. These are discussed in Module 5 (Life valuation), Module 6 (Profit) and Module 9 (Retirement valuation).

2.2.3. Assumptions

Assumptions are described in Module 8 (Assumptions) and the Product Development subject. The control cycle is evident when considering assumptions:

- the parameters (i.e. assumptions) of the model are identified through a mixture of factual knowledge (e.g. examining a Product Disclosure Statement and historical data) and experience;
- the assumptions are quantified as arising from statistical distributions and either a single value is selected for 'deterministic' models or the full distribution is retained for a stochastic model;
- the quantification process involves considering:
  - the purpose of the valuation;
  - government intervention via prudential regulations, taxation or other legislation;
  - the quality of data available;
  - the materiality of an assumption;
  - how the future will differ from the past, especially by considering the external environment and how that may change;
- assumptions may be changed as experience is obtained; and
- experience may suggest that other assumptions are required.

For example, a model of a defined benefit retirement fund that pays a lump sum on retirement will need to consider factors that affect the likelihood and amount of the sums to be paid at retirement, including:

- fund rules that define the potential benefits;
- returns on assets;

- inflation rates;
- salary promotional scales;
- mortality pre and post retirement;
- withdrawals; and
- other items, such as the proportion of married (or de facto) members or those with dependants.

The above-defined benefit factors impact:

- the likelihood of a benefit being paid at retirement, earlier death, ill-health or withdrawal;
- the amount of payment, primarily driven by inflation and promotional rises; and
- the value of the assets;

and are used to produce a present value of the cash flows.

Similar thought processes apply to any cash flow projection. Sometimes, models are constructed that use implicit assumptions. Care is needed to accurately record what has been assumed.

The uncertainty of assumptions will depend on the purpose of the valuation. Example sources of uncertainty about whether assumptions are appropriate for a stated purpose include:

- values for assumptions are deduced from an observed sample and not the population; and
- assumptions are derived from data collected during a time period, and then adjusted to apply to a future time period, where there may be uncertainty regarding both the size and direction of the adjustments.

The uncertainty related to assumptions depends on the degree of confidence required when selecting an assumption. Valuations for life insurance companies and retirement funds are often chosen to represent mean outcomes but some models require confidence at the 99.5% level.

2.2.4. Data

Data is critical to actuarial work. Many valuation regulations require the actuary to comment on data issues, notably that adequate policy records have been kept.

Data quality and quantity are discussed in the Core Actuarial Management subject and practical techniques for assessing and improving data quality are introduced in the Core Data and Statistical Analysis subject. The focus in this subject is on valuations, which implies the need to know about the current state of policy owners or members (number of lives at the valuation date, recent salary history, etc.) as well as sufficient information to describe the random future. Data is discussed in Module 10 (Process) and will be revisited in depth in the LI&R Product Development subject.

2.2.5. Professionalism

All actuarial work should be completed in adherence with the local actuarial standards and expected professional behaviours. Some of these behaviours are explicitly stated and some may be implicit. A good question to ask when undertaking all actuarial work is how comfortable you would be defending your work in a court of law.

Valuation work may appear to be less customer focused, and more technical, than product development. The work may feel abstract but may have significant effects on other stakeholders. This subject is focused on the solvency of a company or defined benefit retirement fund and, where relevant, profitability. The (March 2020) Australian Code of Professional Conduct requires the communication of results to have regard to, inter alia, the intended audience, the purpose the communication, and the significance to the audience.

Another aspect of professionalism relates to competency to complete the requested work. An actuary will ensure that they have appropriate level of knowledge and skills in the relevant area in order to provide services competently and with care (or that they are working with a person that has the appropriate level of knowledge and skill, or working under the direct supervision of another actuary taking responsibility for the services).

Exercise 2.1

You work as a valuation actuary in respect of life insurance products. Your company has a small business division that provides actuarial services to defined benefit schemes and has one actuary who signs off on reports. He has recently taken six months' parental leave. You have been asked to transfer to the business division to provide sign-off on defined benefit valuation reports. Discuss your choices.

2.2.6. External environment

The need to consider the external environment was covered in the Core Actuarial Management subject. For example, actuarial work must fit in with applicable regulations and taxation rules. Actuarial work must also consider wider issues on trends in society. As an example of the external environment, this section provides a brief introduction to **social risk**[1].

Social risk is defined as the risks to a business that come from changing social attitudes and norms underpinned by new social capabilities. *Social capabilities* refers to applications such as Twitter, Facebook, Instagram, Google, Change.org, and cameras on street corners and in every pocket. All of these empower the everyday person in ways unimaginable not long ago.

This risk appears to be on the fringe of actuarial work in everyday circumstances but can have a significant impact on a practicing actuary. It is not obvious how to allow for changing societal attitudes when setting assumptions about future claims and this is discussed below.

[1] Laughlin, I, 2018 "Social Risks – for a financial services business", Actuaries Institute (available CPD Hub)

When determining assumptions, we are trying to determine what will happen in the future. We are often guided by what has happened in the past and then attempt to manipulate the raw statistics (e.g. claim inception rates from injury type X) to be appropriate to the future experience. Relying on past experience to estimate the future was described in Section 2.2.3 as an assumption risk, and both the size and direction of the risk need to be considered. It is necessary to alter assumptions derived from the past to allow for emerging trends, as described in Module 14 (Capital).

How does one alter the past data to allow for new, or emerging, conditions that may give rise to claimable events? The issue is made more difficult when considering contracts that depend on the health of an individual, in an environment where significant medical advances occur constantly. Societal pressures also change over time and this will affect claim rates. There is necessarily a time-lag between emerging experience and setting assumptions.

An example in Australia is Income Protection business. Society is much more tolerant when discussing mental health and it is no longer a source of shame. Lawyers have helped individuals to claim on their income protection policies. Whilst increased mental health claims are not the only source of increased claims in income protection, insurance companies did not anticipate the emergence of this source of claim at the level they have occurred.

Reflection

Pricing is discussed in detail in the Product Development subject, but think about how you would convince a senior manager of your belief that an emerging risk will have a much bigger effect on profitability than anticipated.

2.3. Qualitative aspects

The Foundation (Part I) subjects focus on techniques that can solve well-defined problems. Essentially, the assumptions in the modelling of the underlying problem are over-simplified to allow students to gain stylised experience of the fundamental concepts underpinning actuarial work.

In practice, an actuary as a professional advisor must consider not just quantitative techniques ('what' and 'when' questions) that deliver numerical answers but also answer qualitative questions ('why' and 'how' questions). These questions are developed in Module 5 (Life valuation).

A qualitative approach is often necessary since it's often not clear if the past events will be replicated in the future. For example:

- the sample data may be too small to build a credible statistical distribution for the assumptions; and
- the law of large numbers may be used to show the sample mean converges to the true underlying mean, but that assumes stability in the 'true' underlying probability distribution. The stability assumption is often false in practical actuarial work as changes in the external environment invalidate the concept of a unique distribution. The situation is worsened in pricing, as discussed in the Product Development subject, as the target consumers may have different characteristics to past consumers.

Financial models place a value, or potentially a distribution of possible values, on a quantity. Models assume that probabilities can be measured.

Frank Knight in 1921[2] proposed a distinction between risk and uncertainty. Risks were defined as applying to situations where the outcome is unknown but the probability of the outcome is definable. Uncertainty applies when we are incapable of having sufficient information to formulate a probability.

[2] Knight, F. (1921). Risk, Uncertainty, and Profit. Boston: Houghton Mifflin. (Book available for purchase online)

The above definition would suggest that valuation of long-term insurance and retirement funds may fall into the uncertainty category. But values must be placed on liabilities, with appropriate caveats, and we will have past data to formulate probabilities. These probability values can be updated throughout time as experience emerges.

Practical actuarial work requires us to produce numbers using models, but the implications of these numbers need to be carefully explained to the decision makers. You should reflect on how you would explain the methods developed throughout this subject to a non-actuarial audience.

2.4. Key learning points

- The provision of reasoned, relevant judgement in preparing projected cash flows and providing advice thereon is a core skill within the actuarial capabilities framework.
- A model is a mathematical representation of real-world problems and involves simplifying assumptions that must be calibrated against the real world.
- Even if results are sometimes presented as a single deterministic outcome, actuarial models are stochastic because the future is uncertain and events are random.
- Data is critical to actuarial work and the actuary must consider the accuracy of data and comment on data issues.
- Assumptions need to be appropriate to future experience. In setting assumptions, historical data and experience and the interpretation of emerging trends are important.
- All actuarial work should be completed professionally and in accordance with required standards and expected behaviors.
- An actuary as a professional advisor must consider not just quantitative techniques and the delivery of numerical answers, but also answer qualitative questions. The implications of the numbers you produce must be carefully explained to the decision makers. Actuarial work must also consider relevant wider issues and trends in society.
- Risks can be defined as applying to situations where the outcome is unknown but the probability of the outcome is definable; and uncertainty as applying where we cannot have sufficient information to formulate a probability.

2.5. Answers to exercises

Exercise 2.1

You work as a valuation actuary in respect of life insurance products. Your company has a small business division that provides actuarial services to defined benefit schemes and has one actuary who signs off on reports. He has recently taken six months' paternity care. You have been asked to transfer to the business division to provide sign-off on defined benefit valuation reports. Discuss your choices.

Answer:

It depends on your competency to complete the requested work.

You may feel comfortable completing the reports, but do you have enough experience /awareness of legislation, current practices, and history of the schemes to sign-off reports?

Providing sign-off is placing your name in a report and a client may sue or accuse you of professional misconduct. If you have sufficient experience in DB valuations, then you would be in a much stronger position to defend your actions. In some jurisdictions, the signing actuary has to demonstrate DB valuation competency to the local actuarial body on an annual basis and cannot sign-off if they do not hold the relevant certification.

Thus, your choices appear to be to:

- refuse if you feel you are not professionally competent;
- agree if there is training to take you up to the competency level although the assignment is only for 6 months so this feels unlikely;
- agree if you believe you are competent to complete the work; and
- refuse as you do not like the prospect of working in the DB valuation area or you may feel it is a poor career move or some other reason.

There may be consequences if the last point is executed but the question is asking for a description of your choices, not the potential ramifications.

About the Actuaries Institute

The Actuaries Institute is the sole professional body for actuaries in Australia. The Institute provides expert comment on public policy issues where there is uncertainty of future financial outcomes. Actuaries have a reputation for a high level of technical financial skills and integrity. They apply their risk management expertise to allocate capital efficiently, identify and mitigate emerging risks, and to help maintain system integrity across multiple segments of the financial and other sectors. This expertise enables the profession to comment on a wide range of issues including life insurance, health insurance, general insurance, climate change, retirement income policy, enterprise risk and prudential regulation, finance and investment and health financing.

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