Actuaries Institute Australia

LIFE INSURANCE AND RETIREMENT VALUATION

MODULE 9: VALUATION OF RETIREMENT FUNDS

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Module 9

VALUATION OF RETIREMENT FUNDS

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9. Valuation of Retirement Schemes

The focus of this module is an analysis of the valuation approaches used to value defined benefit (DB) funds and defined contribution (DC) funds. The process developed in Module 5 (Life valuation) with the purpose of the valuation driving the chosen method, assumptions and model is applied in the retirement context in this module. Wider issues such as fund design are discussed in the Life Insurance and Retirement Product Development subject and the Retirement Applications subject.

It is important to remember the fundamental idea discussed in depth earlier in this subject that assets are required to pay liabilities when they are due. The variety of valuation approaches for DB funds must all eventually fund the same amount of assets to pay for the same liabilities. The pace at which assets build up to the required amount to fund the liabilities is a key point of difference between various funding methods and is a key feature of this module.

Item	Unit/Key Performance Objective/Learning Objective
3.3	**Suggest and evaluate an appropriate valuation method, model and actuarial basis for retirement products**
3.3.1.	Critique the principles guiding the selection of valuation approaches
3.3.2.	Analyse various valuation methodologies, including cash flow projection versus formula and prospective versus retrospective
3.3.3.	Distinguish between different valuation methodologies and consider the circumstances where each might be applied
3.6.	**Describe the different pace of funding associated with different valuation approaches and recognise that valuation methods do not affect actual experience**

9.1. Valuation of DC funds

The purpose of a valuation of a DC fund is to determine the value attributable to each member. There is no question about determining contributions as these are defined. Nor is there a discussion on solvency as assets should match liabilities, by definition, as the liability for each member is the current accumulated value of the contributions they or their employer have previously made to their fund.

The method implicit in a DC liability valuation is the accumulation method. Assets are notionally allocated to each member and the value, net of all insurance charges and fees, is typically determined each working day. There is no need for a basis and the design of DC funds preclude the need to calculate non-unit reserves that were discussed in Module 5 (Life valuation). The model is essentially a deterministic system that relies on current unit prices or member crediting rates.

In a DC fund, the assets and liabilities are strongly related to each other and the fund's financial position is secure, provided that contributions are accurately allocated to members, investment earnings are accurately distributed, and adequate provisions are made for tax and expenses. The main risks are therefore operational. Many operational risks are similar to those faced by life companies, such as unit-pricing errors, failures in computer systems, poor performance of the management team and fraud. These operational risks are discussed further in Module 13 (Risk management) and Module 14 (Capital). There are additional risks in DC funds as there can be complicated administration arrangements between various parties, such as employers, investment managers and administration providers, to manage the fund. The management of, and the determination of the size of, operational risk reserves for DC funds is in its relative infancy.

9.2. Valuation of DB funds

9.2.1. Life companies vs. DB retirement funds

Table 9.1 contrasts some of the key issues in the valuation of DB retirement fund liabilities compared to the valuation of life insurance liabilities.

Table 9.1: Life Insurance and DB Schemes

Issue	Life Insurance	DB Scheme
Premiums vs. contributions	Premium rates are set at policy commencement and are expected to be fixed throughout. Policy terms and conditions may permit adjustment of premiums in specific circumstances and indexation of premiums may apply.	The employer contribution rate varies depending on the funding method, valuations at regular interviews and the funding status or requirements relevant for local regulatory requirements. Members may also be required to make contributions towards their benefits.
Minimum Solvency	Life companies must be solvent always and regulators require additional shareholder capital to be held for adverse contingencies. Regulators do not allow life companies to anticipate future inflows of additional external capital.	DB funds often aim to hold assets at least equal to vested benefits (i.e. benefits due to members on immediate withdrawal). Some local regulators impose conditions on funds that have assets less than vested benefits, but some regulators do not. Other funding and solvency levels can also apply and have different trigger requirements.

Issue	Life Insurance	DB Scheme
Solvency standards	Often subject to local legislative solvency requirements. Risk-based solvency requirements are discussed in Module 14 (Capital).	Solvency requirements are substantially less than those for life companies.
Reinsurance	An insurer's liabilities may be offset to some extent by reinsurance.	A DB fund generally externally insures some or all of the benefits payable on death and disablement. Self-insurance may also be possible, where the additional death/disability benefits are allowed for in the employer cost.
Obligations	For a proprietary life company, the shareholders are ultimately responsible for meeting obligations under policies.	Sponsoring employers generally have an obligation or liability in respect of DB fund benefits. The security of member benefits is supported, not only by the assets of the fund, but also by the trustee's right to claim against the employer.

9.2.2. Reasons for valuing DB funds

Broadly speaking, a DB fund is simply the accumulation of member and employer contributions with investment earnings, less tax and expenses. The fund's accumulated assets are then used to meet its liabilities (i.e. the benefit payments) as they arise. In a DB fund, the assets are not allocated to specific members and the benefit entitlement is often based on a formula, generally related to the member's salary in some way.

In a DB fund, it is necessary (and prudent) to value the fund's current and expected future assets and liabilities to assess the fund's current financial position and future funding requirements.

Funding refers to expected future contributions payable by both the sponsoring employer and member. Note that a member's contribution, if any, is generally fixed. The sponsoring employer's actual contribution is likely to vary from those initially expected as actual experience and benefits paid will dictate the required contributions. Funding methods will be discussed in detail in Section 9.3.

Valuations are required for a range of reasons including:

- to meet regulatory or trust deed requirements to assess the ongoing solvency and funding requirements (called a funding valuation);
  - these are usually required on a regular basis as specified in relevant legislation (typically every three years or annually for pension plans);
  - valuations may be done more frequently if circumstances indicate this is appropriate, such as when there is a significant change to the funding status of a fund;
- to meet accounting and disclosure requirements to determine the current financial position and expected cash flow requirements of a fund, which are reflected in a sponsoring company's own accounts (called an accounting valuation);
  - these are generally required on at least an annual basis, more frequently if company accounts are updated, say, quarterly;
  - it may be necessary to value assets and liabilities to meet the requirements of the fund's own accounting requirements;
- in other specific circumstances, such as during corporate mergers, divestments or takeovers, fund mergers, fund wind-ups, consideration of benefit improvements and legislative changes;
  - depending on the specific circumstances, the financial position of the fund and its ongoing funding requirements may influence the broader corporate or fund decisions.

In each case, the fund valuation will need to include a valuation of both the assets and the liabilities to determine the financial position and funding requirements.

9.2.3. Liability valuation considerations

As described in detail in Module 5 (Life valuation), the purpose of the valuation will drive the method, assumptions and models. The purpose will thus affect the values placed on assets and liabilities. Examples of how the purpose affects the methods and assumptions chosen are:

- the actuarial methods and/or assumptions used for accounting valuations may be prescribed by regulation;
- for a corporate merger or acquisition, the actuarial basis may be negotiated between the parties involved; and
- for a funding valuation, the actuary may take into account longer-term considerations in setting the actuarial basis (e.g. ensuring consistency between investment returns and salary growth over long periods).

Irrespective of the purpose of the valuation, it is clearly important that any legislative, professional or other requirements are considered and followed.

A professional approach involves documentation of the judgments, methodologies and assumptions applied, including any qualifications or limitations. This may also be required for disclosure purposes in published reports. Issues of materiality need to be considered, such as the relative impact of individual assumptions on the overall result.

9.2.4. Models

Traditionally, actuarial cash flow modelling and funding or solvency projections have been carried out on a deterministic basis (based on some assumptions regarding future investment returns and inflation), incorporating some sensitivity testing to indicate how results may change if the deterministic assumptions are changed. The output of a deterministic model is often focused on the expected present value of the relevant variables, rather than a period-by-period recording of cash flows.

Deterministic modelling can give an indication of expected future financial outcomes, provided that the underlying assumptions are appropriately selected. However, assumptions are rarely borne out in practice and deterministic modelling does not give an indication of the likelihood of certain outcomes occurring, nor does it give any indication of how appropriate the investment strategy is to the liabilities (i.e. how likely it is that liabilities will be met, given the current investment strategy).

The most material items that give rise to differences between actual and expected experience are those relating to economic experience, such as investment returns and salary inflation. Therefore, asset-liability management naturally invites a stochastic approach to the modelling process, as asset returns cannot be predicted with certainty in advance, and defined benefit liability growth also has an element of variability. In addition, there is generally some correlation between the drivers of asset and liability growth within a retirement fund (usually through core price inflation).

The preceding paragraphs suggest deterministic modelling is insufficient, yet stochastic models are only used for very large funds. The discussion misses the judgement aspect of the professional advisor. The fund actuary will have detailed knowledge of a particular fund under investigation and experience of many other funds. These ideas are discussed further in the Retirement Application subject.

9.2.5. Assumptions

As per the valuation of life insurance liabilities, an actuary needs to adopt assumptions about a range of future events and factors that will influence the future liabilities (benefits and expenses) and future contributions payable.

The assumptions for valuing DB fund liabilities can be grouped into the following main categories:

- financial assumptions:
  - future earnings on assets (either in total or for specific asset sectors);
  - expected future salary growth due to general wage inflation;
  - expected future price inflation (which may influence pension indexation); and
  - relevant rates of taxation;

- demographic assumptions (relating to the membership group itself):
  - mortality rates (both active member and pensioner);
  - morbidity rates;
  - resignation and retirement rates and voluntary withdrawal rates;
  - salary growth above wage inflation due to promotional scales; and
  - other assumptions that impact benefit amounts or terms such as proportions married or with dependants (depending on the fund's benefit design), age of spouses and dependants, and proportions making various member choices (such as selecting pension or lump sum benefits);
- expenses:
  - administrative and compliance costs;
  - the cost of insurance cover where insurance is used; and
  - investment management costs (may be reflected in future earnings on assets or may be modelled separately).

Assumptions, both financial and demographic, can be made about both short-term and long-term experience. For example, it may be expected that 5% of members leave the employer's service each year in the long term but that over the next three years 15% leave each year due to a retrenchment program that is underway. Similarly, it may be that high investment returns are expected on assets over the next year but after that, a lower long-term asset return is assumed. This may be one way to adjust for current asset valuations that are considered to be above or below the long-term expected norm, without making an explicit adjustment to the asset value.

Ideally, demographic assumptions will be obtained from the past experience of the fund itself. However, where funds are too small to provide statistically reliable experience, or the period of past experience is too short, actuaries may be required to base their assumptions on data from other sources. This 'other' data may be supplemented by actual fund experience over time, if such experience is statistically reliable. Where a fund is very small (e.g. only has a handful of members) it may be inappropriate to make any assumptions at all and target funding of vested benefits (i.e. benefits that would be paid if a member leaves the fund) may be more appropriate.

Other sources of data include population mortality and morbidity tables, government salary and price inflation forecasts, market expectations of investment firms and the past experience of other similar funds (similar in both size, occupation and membership profile). Information about future salary increases may also be available from the employer, who will probably have budgets in place for such costs. The employer's intentions for the fund may also affect the demographic assumptions. For example, the employer's intentions may include closing a fund, downsizing the workforce or providing additional benefit options under the fund. Judgement is particularly important in selecting assumptions to reflect an employer's intentions. This requires consideration of how likely the employer is to carry out their intentions and the likely impact of these actions on the memberships' demographics.

Generally, financial assumptions are based on long term expectations for investment markets, applied in a way that reflects the fund's investment mix. For some valuations with a focus of three years or less, a shorter-term perspective is appropriate.

When setting assumptions, an actuary considers the purpose of the valuation and therefore the type of assumptions to be adopted, the impact that variation in the assumptions may have (e.g. if experience is different to that assumed, whether this has a significant funding impact) and any professional or legislation requirements regarding the assumptions. Where benefits have a significant cost impact, it is sometimes preferable to be conservative with the assumptions affecting that benefit (i.e. overestimate the financial impact). Where benefits have a neutral impact, the basis chosen is less relevant. The degree of conservatism to be used is determined by a range of issues, including the purpose of the valuation, the attitude of the employer to funding risks, the current financial position of the fund and, of course, professional or regulatory requirements or guidance.

Exercise 9.1

List examples of benefits that have a significant cost impact or a neutral cost impact or a low cost impact if valuations assumptions are not met.

Accounting standards often specify how the earnings, discount or inflation rates may be determined, which in some instances may be provided by the sponsoring employer to the actuary for approval.

Where the valuation of assets or liabilities is sensitive to a particular assumption, it is important that the actuary advises the relevant parties of the degree of sensitivity and hence the reliability of the valuation. For some funds, stochastic valuations are appropriate as they provide a range of outcomes (e.g. funding levels and contribution rates) with certain probabilities attached to each. However, this complexity of calculation is generally only adopted for larger funds.

Whilst the assumptions are used to place a 'value' on the benefit liabilities at a point in time and to estimate future cash flows of the fund, it is important to remember that the actual cash flows and cost of providing the benefits is determined by actual experience. As the actual experience unfolds, variation from the assumptions will produce funding excesses or shortfalls to be managed under the funding method.

Finally, it is important to regularly review the adopted assumptions to make sure they continue to be reasonable. Part of this analysis requires a comparison of actual and expected experience at regular funding valuations and identifying how the difference has contributed to surplus or shortfall. If the experience has varied significantly, the actuary should look for a reason for the variation and determine if that reason is continuing or simply a short-term variation around those assumptions. It may be that experience over several valuation periods builds up to a required change in assumptions.

9.2.6. Valuation of assets

Valuation of assets and evaluation of investment strategies is covered in Module 11 (Assets). Key elements in relation to the valuation of assets for a DB fund are:

- the need for consistency in valuation methodologies and assumptions for assets and liabilities;
- the importance of 'Fair Value';
- the evaluation of asset/liability matching strategies;
- Legislative, regulatory or professional requirements, including tax considerations; and
- any notional or actual attribution of assets within a fund, which can be important in recommending future employer funding rates.

9.3. Funding methods

9.3.1. Funding ratios

Funding of a retirement fund is defined by the Organisation for Economic Co-Operation and Development (OECD) as "… the act of accumulating assets in order to finance the pension scheme." The OECD also defines the Funding Level as "… the relative value of a scheme's assets and liabilities, usually expressed as a percentage figure" and the Funding Ratio is the funding level expressed as a ratio.

The purposes to which a Funding Ratio will be put might affect the actual measures used for both the value of assets and the value of the actuarial liabilities. For example, a Funding Ratio might be used in the wind-up of a fund, in which case asset values are usually reduced by all reasonably expected costs involved in the wind-up and liabilities may be measured using any defined benefits that are due on wind-up. Alternatively, a funding ratio used in the ongoing management and funding of a retirement fund might look at an actuarially adjusted value of assets (i.e. a smoothed value of assets discussed in Module 11 (Assets)) and measure liabilities as the actuarial present value of accrued benefits. It is therefore important to understand and clarify the purposes for which the Funding Ratio and other actuarial results will be used.

9.3.2. Pace of funding

It is theoretically possible that a DB fund be funded by a once-off contribution from an employer, sufficient to meet the benefit liability when it falls due (advance funding). Alternatively, the contribution could be delayed and not paid until immediately prior to the benefit, once its value is known (terminal funding). While advance funding and terminal funding are possible in theory, in practice they are not used, with the exception being that some government institutions may use terminal funding. Instead, an actuarial funding method is a systematic method of establishing the amount to be contributed by the sponsor over time. The use of such an approach recognises that:

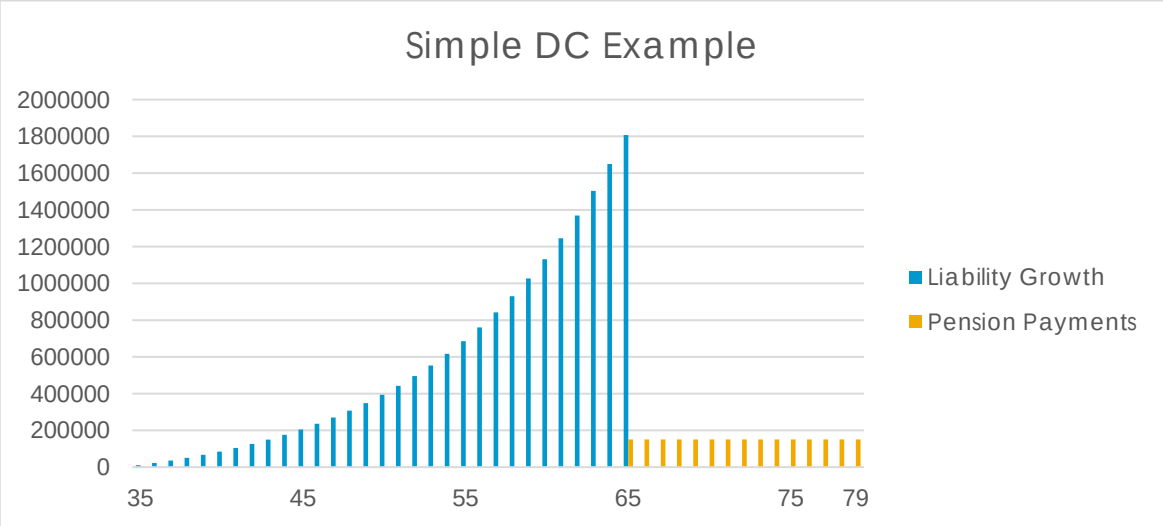
- government regulations can constrain the amount that can be contributed in any one year;
- the benefit value is not known until the actual date of payment and so flexibility to adjust contributions over time is useful;
- it is prudent to have assets covering benefit liabilities that have already accrued but there is less need to cover future liabilities to accrue, which are much less certain;
- deficits and surpluses both create problems in the event of changing employer circumstances, such as acquisition, divestment, downsizing and insolvency;
  - keeping accrued liabilities adequately, but not excessively, funded avoids these problems; and
- employers have business plans that mean material increases to contribution requirements are not easily made and take time to arrange, so stability in contributions is valuable.

The range of funding choices may be viewed by considering a simple DC example, and then thinking as if this were a DB example.

Suppose an individual, aged 35 exact, has an annual salary of $100,000, which is expected to grow by 3% per annum. Suppose contributions are 10% of salary and investment returns are 8% per annum. Assume the individual retires at age 65 and the accumulated amount is converted to a pension using an assumed annuity rate of 12 (i.e. $12 purchase price buys $1 of annuity for life).

Figure 9.1 shows the expected growth of the liabilities, which exactly match the growth in assets.

Figure 9.1: Simple DC example



We could re-express this as a DB fund as follows:

- the benefit at retirement is an annual income for life
- each year of service gains credit of 0.1/12 of salary in that year (i.e. the 10% contribution rate and annuity conversion factor of 12)
- each credit is inflation adjusted to the retirement date, where the inflation adjustment is actual investment returns (assumed to be 8% per annum)
- the retiree receives the sum of the credits as their annual income

For the DB example, the payment choices to provide a benefit of $150,612 for life from age 65, assuming the annuity conversion factor is always 12, are:

- pay the present value of the maturity proceeds, $179,615, today;
- pay 12% of salary for 15 years, reducing to 5.54% for the remaining period;
- pay 10% of salary each year (as used to calculate the above figures);
- pay 5.54% for 15 years and then 18.7% for the remaining period;
- pay the maturity proceeds at age 65 of $1,807,339 as a lump sum to an annuity provider; or
- pay the annual benefit of $150,612 each year from the fund.

There are a range of advance payment options, with the obvious conclusion being that paying more upfront means paying less in future years, assuming investment returns exceed salary inflation. The latter conclusion is based on constant expected investment returns. In reality, the volatility of actual returns makes it impossible to make such statements.

9.3.3. Types of funding

The fundamental principle (that applies to both DB and DC funds) is that the value of actual contributions made to a retirement fund plus investment earnings on the assets must equal the actual value of benefit payments plus taxes and expenses.

Different funding methods simply involve different paces at which those contributions are paid to the retirement fund to meet the expected (or projected) benefit liabilities. In practice, this requires a calculation of the expected value of the fund's future assets and liabilities (including tax and expenses).

On the liabilities side, the present value will include two components:

- a value relating to past service of members (VPS); and
- a value relating to expected future service of members (VFS).

On the assets side, the present value will also reflect two components:

- a value relating to the fund's existing assets (VEA); and
- a value relating to expected future contributions (VFC).

The fundamental equation therefore becomes VPS + VFS = VEA + VFC

In other words, the (present) value of all liabilities must equal the (present) value of all assets (including allowance for the present value of future contributions).

The liability for future taxes and other expenses can be either added to benefit liabilities or, if suitable, deducted from future contributions. The approach adopted in most circumstances will not matter greatly, as long as taxes and expenses are properly recognised. In extreme cases (such as for a fund with a very large surplus) there may be no need for future contributions at all. In practice, expenses are typically added to the liabilities measure and contribution taxes (if any) are deducted from future contributions, meaning the gross contribution required increases.

There are two broad classes of funding method: accrued benefit and projected benefit. In this module, we discuss the following five methods:

- accrued benefit funding method;
  - projected unit credit (PUC) method;
  - current unit credit (CU) method;
- projected benefit funding method;
  - attained age normal (AAN) method;
  - entry age normal (EAN) method; and
  - aggregate (AGG) method.

PUC, AAN:
- Both methods assume VFC = VFS at a scheme level (i.e. AL = VPS).
- Both methods consider every member.
- The difference between these two methods lies in the calculation of the SCR to fund VFS, and therefore the resulting contributions and asset build up in future years will differ.
- PUC looks at the additional accrual over next year to determine SCR (accrued benefit) ; while AAN considers VFS and VFC to determine SCR (projected benefit)
- PUC SCR is redone every year, AAN SCR need not be.

Accrued benefit funding methods specifically target an asset value equal to the accrued benefit liability and calculate contributions accordingly. The most commonly used accrued benefit funding method is the Projected Unit Credit (PUC) method, as accounting rules in many jurisdictions specify this method. A less common method is the Current Unit Credit (CU) method.

Accrued benefit funding methods do not value the benefit arising from future service by fund beneficiaries beyond that required to calculate the given year's contribution.

Projected benefit funding methods calculate the value of liabilities based on service already completed (accrued) **and** service expected to be completed in the future. Projected benefit funding methods include Attained Age Normal (AAN), Entry Age Normal (EAN) and Aggregate (AGG). Note, the word 'Normal' in the title refers to the use of one contribution rate applied to the group as a whole rather than determining individual member rates, which would be impractical.

The combination of a method and basis leads to an expected contribution rate, called the Standard Contribution Rate (SCR), that is designed to fund future benefits. The method and basis also define the quantum of assets that should be held in respect of accrued service: the Actuarial Liability (AL). Note that the methods have different assumptions and hence the SCR and AL are different under different methods. However, all methods lead to the 'correct' amount of assets required at the due date of the retirement benefit.

When valuing a fund, past experience (e.g. actual investment returns, salary growth, pattern of retirement) won't have matched expected experience and hence adjustments are required to the amount payable in the future. This past experience creates a surplus or deficit in the fund. The actual amount an actuary will recommend for payment will be the SCR adjusted for the surplus or deficit. These adjustments may be corrected immediately, spread over a fixed period or over the remaining working lifetime of the members and is discussed further in the Retirement Applications subject.

The followings sections consider five particular funding methods and develop simplified formulae to calculate the SCR and AL under each method. The formulae are based on simplified assumptions in order to draw out the main points on how the methods are defined and to aid comparisons across methods. These simplified formulae need to be altered for use in practice.

The examination for this subject may involve spreadsheet manipulation and may use more complicated examples than those presented in the subsequent sections. In particular, you should ensure you are comfortable manipulating multiple decrement tables.

9.3.4. Projected unit credit method

The projected unit credit (PUC) is an accrued benefit funding method. Thus, the focus is on maintaining the AL at its expected level. This is done by setting the SCR so that the AL at the start of the year plus the SCR, adjusted by expected experience, is sufficient to meet the AL at the end of the year. This is directly analogous to the change in a life insurance liability over a period.

The AL for this method is defined as the value of benefits accrued to the valuation date in respect of past service, projected to retirement age using expected salary growth and discounted back to the valuation date using the assumed investment return.

To aid in understanding this and subsequent methods, we'll consider a simple defined benefit fund that pays a regular income from an individual's 65th birthday. Pre-retirement decrements are ignored. The formulae utilise the following symbols:

- k = accrual rate (i.e. the rate at which benefits build up each year);
- P = number of years of past service (assumed to be an integer);
- x = current age (assumed to be an integer);
- S = pensionable salary that is assumed to coincide with actual salary;
- e = salary inflation;
- i = investment return; and
- a_{65} = present value of benefits payable from age 65.

The AL represents what has accrued as at the valuation date:

(9.1) $$AL_x = kPS\left(\frac{1+e}{1+i}\right)^{65-x} a_{65}$$

The SCR represents the rate that the present value of benefits will accrue in the year following the valuation date, allowing for future salary growth. Under the assumption that the salary is payable just before the valuation date, the rate is:

(9.2) $$SCR = k\left(\frac{1+e}{1+i}\right)^{65-x-1} a_{65}$$

If we add one year's interest to 9.1 and apply 9.2 to the end year salary, S(1+e):

$$kPS\left(\frac{1+e}{1+i}\right)^{65-x} a_{65} * (1+i) + kS(1+e)\left(\frac{1+e}{1+i}\right)^{65-x-1} a_{65}$$
$$= k(P+1)S(1+e)\left(\frac{1+e}{1+i}\right)^{65-x-1} a_{65} = AL_{x+1},$$

which is the expected Projected Unit Credit AL one year later.

Formula 9.2 shows that the SCR is dependent on the term until retirement. If investment returns are greater than salary growth (i > e), the cost of a further year's accrual of benefit increases with the age of the active member. One year's accrual for a young member has a substantially lower present value than a member close to retirement. Thus, the standard contribution rate for the fund depends on the age, gender and salary distribution of the active members in the fund. The salary distribution is required as the simplified formula above is for a member and the actual SCR will be weighted by the actual salaries in the fund. If new entrants join the fund in a way such that the age, gender and salary distribution of active members is stable over time, and the experience of the plan follows the actuarial assumptions, then the standard contribution rate will also be stable.

9.3.5. Current unit credit method

The current unit credit (CU) is also an accrued benefit funding method. Thus, as per the PUC method, the focus is on maintaining the AL at its expected level. This is done by setting the SCR so that the AL at the start of the year plus the SCR, adjusted by expected experience, is sufficient to meet the AL at the end of the year. It differs from the PUC method as there is no allowance for inflation of earnings between the valuation date and date of benefit payment.

When a member leaves a defined benefit fund before retirement their status changes from an active member to a deferred member. In many jurisdictions, deferred members' benefits are adjusted to allow for some inflation protection between the leaving date and retirement date. This is called statutory revaluation. Note that the revaluation is usually at a fixed rate and subject to a maximum rate of actual CPI. In anticipation of a discussion comparing the CY SCR and the PU SCR, we'll assume that statutory revaluation is lower than expected salary inflation.

The AL for this method is defined as the value of benefits accrued to the valuation date in respect of past service, projected to retirement age using zero salary growth, or statutory revaluation if applicable, and discounted back to the valuation date using the assumed investment return.

The formula below assumes there is no revaluation of benefits from the valuation date to retirement. In many jurisdictions, there is a statutory revaluation of benefits.

The AL represents what has accrued as at the valuation date:

(9.3) $$AL_x = kPS\left(\frac{1}{1+i}\right)^{65-x} a_{65}$$

The SCR is defined so that the AL at the end of the period is correct. Remember that in this simple setting, we are applying the SCR to the end year's salary, S(1+e). Since the AL does not allow for revaluation of salary (ie salary inflation), an additional term must be added to the SCR to reflect this unanticipated salary growth:

(9.4) $$SCR = k\left(\frac{1}{1+i}\right)^{65-x-1} a_{65} + \mathrm{e}\,\frac{(1+i)AL}{(1+e)S}$$

If we add one year's interest to 9.3 and apply 9.4 to the end year salary:

$$kPS\left(\frac{1}{1+i}\right)^{65-x-1} a_{65} + kS(1+e)\left(\frac{1}{1+i}\right)^{65-x-1} a_{65} + e\,kPS\left(\frac{1}{1+i}\right)^{65-x-1} a_{65}$$
$$= k(P+1)S(1+e)\left(\frac{1}{1+i}\right)^{65-x-1} a_{65} = AL_{x+1},$$

which is the expected Current Unit AL one year later.

A natural question is to consider the relationship between the SCR for the Current Unit method and the Projected Unit method. We'll ask similar questions when we develop other methods.

The key to thinking about comparisons is to think across time and remember that the methods do not directly affect the cost of funding.

Exercise 9.2

What does it mean that the methods do not directly affect the cost of funding?

Both methods discussed so far aim to meet the same ultimate payments. The presentation has looked at individual members, but we need to think about how a DB retirement fund changes over time. As the fund changes from a new fund to a mature fund, or runs off as a closed fund, this will have implications on the SCR.

The PUC method allows for full salary revaluation compared to none, or only statutory revaluation, for the CU method. The AL adjustment to the CU SCR will alter its size relative to the PU SCR. We can make the following observations:

- for a new fund with no past service, the PU SCR will exceed the CU SCR as there is no AL at the start and the PU SCR salary allowance exceeds the CU SCR salary allowance; and
- for a mature fund with stable demographics, or a closed fund, the CU SCR will exceed the PU SCR as the CU AL is lower than the PU AL.

Exercise 9.3

What is meant by a 'mature fund with stable demographics'?

Similar to the PU SCR, if new entrants join the fund in a way such that the age, gender and salary distribution of active members is stable over time, and the experience of the plan follows the actuarial assumptions, then the standard contribution rate will also be stable.

The CU method is exposed to differences in any statutory revaluation assumptions and actual salary growth, whereas the PU method is exposed to the difference between expected and actual salary growth. Consequently, the CU SCR is less stable than the PU SCR.

9.3.6. Attained age normal method

The attained age normal (AAN) is a projected benefit funding method.

The attained age standard contribution rate is that required to fund the future service benefits of current members.

(9.5) $$SCR = \frac{k\,(65-x)\left(\frac{1+e}{1+i}\right)^{65-x} a_{65}}{a_{65-x}^{i-e}},$$

where the summation is over all active members and the annuity factor in the denominator is an annuity certain for 65 – x (= F, say) years at rate (i – e).

The AL is the same as that for the Projected Unit method:

(9.6) $$AL = kPS\left(\frac{1+e}{1+i}\right)^{65-x} a_{65}.$$

Expression 9.6 can be derived by calculating the total benefit (past and future) and subtracting the value of future contributions:

$$AL = k(P+F)S\left(\frac{1+e}{1+i}\right)^{65-x} a_{65} - SCR * \left(Sa_{65-x}^{i-e}\right) = kPS\left(\frac{1+e}{1+i}\right)^{65-x} a_{65}.$$

Assuming earnings inflation is less than investment returns and there is more than one year until retirement, the SCR under the AAN method exceeds that under the PUC method. Thus, the AAN SCR will overfund its AL, if experience is as expected. The paradox is resolved as the AAN SCR is only appropriate for a closed fund and where the SCR is calculated at closure and not thereafter. If the SCR is recalculated as the membership ages then the method will produce a surplus, assuming experience is in line with expectations. In practice, it is recalculated and the actual contribution is adjusted for the surplus or deficit that naturally arises due to actual experience.

An obvious conclusion is that the AAN SCR exceeds the CU SCR for those scenarios where the PUC SCR exceeds the CU SCR. When the CU SCR exceeds the PUC SCR, there are no general rules that determine the level of the CU SCR compared to the AAN SCR.

The AAN SCR is stable when all assumptions of this method are met, including that there are no new entrants to the fund.

9.3.7. Entry age normal method

The entry age normal (EAN) is a projected benefit funding method which targets an SCR that applies to the age of a typical new entrant who joins at age EA:

(9.7) $$SCR = \frac{k\,(65-EA)\,\left(\frac{1+e}{1+i}\right)^{65-EA} a_{65}}{a^{i-e}_{65-EA}}.$$

The AL is defined as the total benefits for all members of the fund less the SCR multiplied by the present value of pensionable salaries of the actual membership.

(9.8) $$AL_x = k(P+F)S\left(\frac{1+e}{1+i}\right)^{65-x} a_{65} - SCR * \left(Sa^{i-e}_{65-x}\right).$$

Adding one year's interest to 9.7 and applying the SCR in 9.8 to the end year's salary leads to the expression:

$$k(P+F)S\left(\frac{1+e}{1+i}\right)^{65-x} a_{65}(1+i) - SCR * \left(Sa^{i-e}_{65-x}\right)(1+i) + SCR\,S(1+e)$$

$$= k(P+F)S(1+e)\left(\frac{1+e}{1+i}\right)^{65-x-1} a_{65} - SCR\,S(1+e)\,a^{i-e}_{65-x-1} = AL_{x+1},$$

which is the expected AL at the end of the year.

The EAN AL for a new plan will start at zero in the unlikely situation that all members are at the assumed entry age. The calculated EAN SCR will then equal the AAN SCR and exceed the PUC SCR, which in turn will exceed the CU SCR. In all other circumstances, the EAN AL is greater than zero.

The AAN SCR will exceed the EAN SCR, provided the fund's average age exceeds the assumed entry age. Under that condition, assuming the investment return exceeds salary inflation, the EAN AL will exceed the AAN AL.

EAN:

- EAN equates VFS and VFC for a single entry age to determine the SCR to apply for the life of the member, projected benefit method

- This SCR is applied to every member

- As this entry age won't actually apply for all members, the resulting VFS will not equal VFC for every member.

- AL for the whole scheme has to be determined as VPS + VFS - VFC by summing over all the members

- EAN SCR need not be redone every year

It is possible to make some further comparisons between the EAN SCR and the PUC SCR. Examining the simplified formula for their respective SCRs, we can calculate the ratio:

(9.9) $$\frac{EA\ SCR}{PU\ SCR} = \frac{F}{a'_F}\, v'^{x-EA},$$

where F represents the future service for a new entrant, and the primed functions are calculated at a rate of $(1+i)/(1+e)-1$. For example, with i = 7%, e = 5%, entry age = 30, the expression 9.9 is less than 1 when x is 45 or more. It's likely that the PUC SCR exceeds the EAN SCR in the majority of situations, including a new fund, with no immediate past service, and where members' ages are distributed across all ages above the assumed entry age. We can then use the logic that a lower SCR implies a higher AL to compare PUC AL and the EAM AL.

Not unsurprisingly, for the SCR to be stable, this method requires stability in the assumed entry age and gender distribution. This implies that new members, split appropriately by gender, join at the assumed entry age.

9.3.8. Aggregate method

The aggregate (AGG) method is a projected benefit funding method based on calculation of the rate that the employer should pay until the final member leaves. The rate takes into account the deficit or surplus at the valuation date. The rate will not change if the valuation assumptions emerge in practice. The rate is solved for by equating the value of assets and future contributions with the value of benefits plus expenses and tax. No allowance is made for new entrants.

9.3.9. Relative advantages of different funding methods

The relative advantages of the funding methods depend on the objectives of the trustees, members and employer sponsor. The PUC method tends to produce a rate that gradually increases over time, unless there is a constant source of new entrants keeping down the salary-weighted average age. For a closed fund, the PUC rate will therefore rise over time. The method results in partial deferral of liability funding, hence the rising rate over time. With the CU method, this shortcoming is exaggerated.

The AAN, EAN and AGG methods fund more quickly than the PUC and UC methods. If the amortisation period is shorter than the term of future liabilities, then EAN and AAN will fund more quickly than AGG. Funding more quickly means establishing a reserve asset that is then used to keep the contribution rate constant, even though the actual cost of benefits is increasing.

While stability in contribution rate is an advantage for budgeting and associated issues, a stable contribution rate that generates surplus is at risk of being viewed as wasting shareholders' funds. In addition, there are sufficient legal cases that make the ownership of surplus a contentious issue, such that employers are unwilling to commit surplus assets to DB funds in case of changing circumstances and fund wind-up.

Maintaining an asset value that is just enough to cover liabilities is what PUC and CU do better than the projected benefit funding methods. However, this also creates greater volatility in the rate.

9.3.10. Experience versus assumptions

To determine the standard contribution rate and standard fund (i.e. assets equal in value to the Actuarial Liability) for any funding method requires actuarial assumptions, such as those for investment returns, salary growth and mortality. In a deterministic actuarial valuation, these parameters are normally assumed to be constant over time, but for a real plan they will vary in an unpredictable manner. This means that the actual fund (AF) will generally differ from the standard fund (SF), so that

$$AF - SF \neq 0$$

The actual fund minus the standard fund is called the surplus/(deficit). Note that because the standard fund depends on the chosen funding method, so does the size of the surplus or deficit.

A natural way of dealing with surpluses and deficits is to adjust the contribution rate over a temporary period to restore the actual fund to the standard fund. This attempt is unlikely to be entirely successful, as the experience of the plan is again likely to deviate from that assumed over the period of amortisation. However, the process of driving the fund towards the standard fund ensures that the surpluses and deficits stay within reasonable limits.

The standard fund, therefore, becomes a target at which the plan is continually aiming. The fact that the plan may never actually hit the target is not important; what matters is that we have a method of deciding when the contribution rate needs to be increased or decreased relative to the standard contribution rate. It follows that the actuarial valuation should be viewed as a system for decision making and control, rather than an exercise with the sole objective of reporting on the financial position of the plan.

9.3.11. Other issues

A number of factors need to be considered in the selection of an appropriate funding method. The method adopted should be suitable when considering issues such as the fund's short-term financial position (e.g. solvency) and the expected volatility of the overall contribution rate for the group of members.

One significant factor is the level and value of the benefit applying on immediate cessation of service (the 'vested benefit'). If the vested benefit follows a path which falls below the level of the assets of the fund, then the funding level is likely to be considered satisfactory, at least by members, trustees and regulators. If the vested benefit is higher than the level of assets of the fund then the funding level is likely to be considered unsuitable, as immediate benefit entitlements will generally not be covered by assets. The latter situation is most likely to occur when there is not a significant difference between the withdrawal benefit and the retirement benefit.

This topic is discussed further in the Retirement Applications subject.

9.4. Key learning points

- In a DC fund, the assets and liabilities are strongly matched, therefore the fund's financial position is secure and the main risks are operational.
- The key reasons for valuing a DB fund are to assess the fund's current financial position and future funding requirements.
- Key stakeholders in a DB fund are the members, the sponsoring employer, trustees and regulators.
- Key economic assumptions are investment returns, wage inflation and price inflation (which impacts pension indexation). Key demographic assumptions are resignation rates and salary promotional scales.
- It is important that the actuary provides advice on key sensitivities of results to particular assumptions.
- When modelling future employer funding rates, there needs to be consistency in valuation methodologies and assumptions for assets and liabilities.
- A funding ratio measures the relative value of a fund's assets and liabilities. It may be used in the ongoing management and funding or in the wind-up of a fund.
- Accrued benefit funding methods target an asset value equal to the accrued benefit liability and calculate contributions accordingly.
- Projected benefit funding methods calculate the value of liabilities based on service already completed (past service) *and* service expected to be completed (future service).
- Different funding methods involve different paces of funding and it is possible to deduce relationships among the different funding methods.
- If the vested benefits fall below the level of the assets, the funding level is likely to be considered unsatisfactory.

9.5. Answers to exercises

Exercise 9.1:

List examples of benefits that have a significant cost impact or a neutral cost impact or a low cost impact if valuations assumptions are not met.

Answer:

Three examples of a significant cost impact:

- Pension payments if the number is higher than expected.
- Defined benefit lump sum payments if asset returns are lower than expected.
- Death benefits if the DB scheme self-funds (i.e. pays death benefit from assets rather than purchasing insurance.

Three neutral impacts:

- Transfer value to another provider if payment is the cash value of benefits foregone.
- Commutation of lump sum to pension if on a fair basis.
- Insured death benefits

Low cost impacts:

- Practically anything where experience did not deviate too much from assumptions.
- Benefits with a low expected take-up e.g. children's benefits payable post retirement.
- Any alternative benefit that is close in value to the principle benefit.

Exercise 9.2:

What does it mean that the methods do not directly affect the cost of funding?

Answer:

The direct cost of funding is dictated by the actual experience, not by the pace at which assets are set aside to pay for benefits.

Exercise 9.3

What is meant by a ‘mature scheme with stable demographics’?

Answer:

New entrants balance exits such that the age/sex/salary distribution is stable.

About the Actuaries Institute

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