INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

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**Chapter Name:** Liabilities and determining its value

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# 1 Valuation Methods

***Introduction***

The two distinct methods of **valuing assets and liabilities** are;

- The **discounted cashflow method** based on long term assumptions about the interest rate, timing of the cashflows, the level of cashflows etc
- The market related or **fair value** approach

Irrespective of the approach chosen for the valuation, it is important that both the assets and liabilities are valued in a **consistent manner**. For example, if a discounted cashflow method is used to value the assets, then a consistent discount rate must be used to value the liabilities.

# 1 Valuation Methods

***Traditional discounted cashflow method***

For many years, actuaries valued future liabilities using **discounted cashflow techniques** where long-term assumptions are set.

A key long-term assumption is the **future investment return** expected. The future cashflows arising from the liabilities are discounted to a **present value** using this rate. For consistency with this approach, assets are also valued by discounting future cashflows using long-term assumptions.

A major criticism of this approach is that it places a different value on the assets from the market value, which introduces an additional element of **risk**.

Consequently, methods that value liabilities on a basis that matches that underlying the market value of the assets have been developed.

# 1 Valuation Methods

Example: ABC benefit Scheme – Traditional Discounted Cashflow Method

***Value of Assets***

Here we consider the value of the equity holding is the present value of the expected future dividend that the company pays, also assuming that these dividends are reinvested in the same equity.
Dividends are assumed to be paid annually in perpetuity, with dividends growing at the growth rate g

So, the equity is valued at :$MV\ x\ D\ x\ \left\{\frac{1}{1+i}+\frac{1+g}{(1+i)^2}+\frac{(1+g)^2}{(1+i)^3}+\ \ldots\right\}$

Here D is the prospective dividend yield

In other words: $\frac{MV\ x\ D}{i\ -g}\ =\frac{950{,}000\ x\ 0.03}{0.08\ -0.06}=1{,}425{,}000$

# 1 Valuation Methods

***Value of Benefits***

Benefits are valued using the same long-term discount rate and a long-term assessment of future price inflation p:

$$125{,}000\ x\ \ddot{a}_{12}, calculated\ at\ a\ rate\ of: j = \frac{1+i}{1+p} - 1\ ; \frac{1.08}{1.055} - 1 = 2.37\%\ pa$$

= $1,323,000

So, the scheme's funding level = $\frac{Value\ of\ Assets}{Value\ of\ Benefits} = \frac{1{,}475{,}000}{1{,}323{,}000} = 111\%$

# 1 Valuation Methods

***The move to market-based or fair value approach***

In recent years there has been a move to market-based or fair value methods of valuation.

Insurers, benefit providers, financial institutions have shifted from a **discounted cashflow** method which relies heavily on long term assumptions to a market-based approach.

These methods seek to place a **market value on the liabilities**. Two definitions of fair value are:

1. the amount for which an **asset** could be **exchanged** or a **liability settled** between knowledgeable, willing parties in an arm's length transaction

2. the amount that the enterprise would have to pay a **third party** to take over the liability.

In some cases, a fair value of a liability is straightforward. If a contract provides that it can be terminated at various points in time for predetermined values, with no discretion on the part of the product provider, then those values are necessarily the **fair values of the liability**. This approach might particularly apply to unit-linked investment contracts.

# 1 Valuation Methods

As there is no **liquid secondary market** in many of the liabilities that actuaries are required to value, the identification of fair values from the market is not practical.

As a result, **fair values of liabilities** need to be estimated using **market-based assumptions**.

One approach to estimating fair values is to consider the liabilities as a series of **financial options**, and to use option pricing techniques to assess a value.

Another approach to obtaining a fair value of liabilities is to use a **'replicating portfolio**'. Market-value based approaches are being increasingly adopted globally.

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# 2 Fair Valuation

***Introduction***

Here assets are valued at **market value**.

Hence it is necessary for liabilities to be valued in a **market-consistent manner**. However, it is practically tedious to determine the market value of liabilities, since there are no markets for liabilities. Hence, models and assumptions need to be used to determine the price.

The assumptions are set in the **discounting rate** chosen for the valuation of liabilities and it needs to reflect the **market price of the liabilities**, i.e. it needs to be consistent with the amount an investor in the market would require to be paid in order to be willing to take over the responsibility of meeting those liabilities.

# 2 Fair Valuation

***Replicating portfolio methods***

Using a **'replicating portfolio'** approach involves taking the **fair (ie market) value of the liabilities** as the market value of the portfolio of assets that most closely replicates the duration and risk characteristics of the liabilities. The replicating portfolio can be established by using **stochastic optimization techniques**, ie a form of asset / liability modelling. This approach is the basis of the following two methods:

Approach 1: Mark to market method

Approach 2: Bond yields plus risk premium

# 2 Fair Valuation

***Replicating Portfolio Method 1: Mark to Market Method***

This method is derived from **financial economics**.

Here we try to identify the **assets** that are the most **identical replicas** of the **future liability outgo**, so that the price of these assets would be the market price of the liabilities in the market.

The **inflation rate**, **discount rate** and **related assumptions** are derived from market information as follows:

- Assets are taken at **market value**.
- **Liabilities** are discounted at the **yields** on investments that match the liabilities – often bonds.
- The bond yield may be based on **government bonds** or **corporate bonds** – the latter will allow for credit risk. A government bond giving a yield of 5% pa and a corporate bond of a similar nature giving a yield of 6.5% pa. the extra 1.5% pa on the corporate bond is to allow for credit risk and marketability risk.

# 2 Fair Valuation

- A better, but more complicated, approach would be to use **term-standard discount rates** that vary over time to reflect the shape of the yield curve.

- The **market rate of** inflation is derived as the difference between the yields on suitable portfolios of fixed-interest and index-linked bonds.

A **fair valuation** approach will only be successful if all the assumptions used are **market related** and thus **consistent**. For example, if a salary increase assumption is needed to value a pension scheme benefit then it should be derived from the market.

# 2 Fair Valuation

***Replicating Portfolio Method 2: Bond yields plus risk premium***

This method starts with using a **discount rate** based on **bond yields** as in the mark to market method, but then **adjusts** it to take account of the returns expected on other asset classes as follows:

- Assets are taken at **market value**.
- Liabilities are valued using a **discount rate** that is found by adjusting (usually increasing) **bond yields** by the addition of either a **constant** or a **variable equity risk premium**.
- Where a **constant equity risk premium** is used, the result is the same as for the mark to market method (ie valuing an asset to reflect its current market levels) except that, all other things being equal, the value of the liabilities is (usually) lower. This is because liabilities are now discounted at a higher rate.
- It is more common to use a variable risk premium, which is derived by a combination of **market information and actuarial judgement**.

There is a school of thought that taking account of the extra return from equities is unsound unless account is also taken of the extra risk associated with equities. As a result, some actuaries argue that liabilities should only be valued using a risk-free rate of return (ie government bond yields).

# 2 Fair Valuation

***Asset based discount rate***

A further way of obtaining a **fair value for liabilities** is to value them using an **asset-based discount rate**, where:

- Assets are taken at **market value**.
- An implied **market discount rate** is determined for each asset class, eg for fixed-interest securities it may be the gross redemption yield, for equities it involves estimating the discount rate implied by the current market price and the expected dividend and/or sale proceeds.
- The liabilities are valued using a **discount rate** calculated as the **weighted average of the individual discount rates** based on the proportions invested in each asset class.

The discount rate could be determined using the **distribution of the actual investment portfolio** or the **scheme's strategic benchmark** (if the current asset allocation is not representative of the scheme's usual investment strategy). For government bonds it is easy to obtain the discount rate as it is objective and readily available in the market. However, for other asset classes the discount rate tends to be subjective and difficult to determine.

# 2 Fair Valuation

This approach can be termed as a **market-based approach** because it uses the **market value of assets** and a **liability valuation discount rate** related to the current market yields. However, it is debatable since it does not completely represent the fair value of the liabilities as it depends on the assets actually held.

A **fundamental principle** of the fair value method is that the value of liabilities should be independent of the assets backing those liabilities.

This is because a fair value for a third party would be an amount he would be willing to pay based on his investment strategy and the assets held by him, which may not always be the same as those on which the liabilities are based.

***Estimating fair values***

Here we use a **discount rate** that represents a **risk-free rate**.The risk-neutral market-consistent value is the present value based on discounting future liability cashflows at the pre-tax market yield on risk-free assets. In the UK, swaps are now often referred to when considering risk-free assets. In other countries **government bond** yields may be used instead.

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# 3 Valuing Options and Guarantees

***Introduction***

In general, when setting the terms for **options** or **guarantees**, a **cautious approach** is taken. However, a cautious valuation basis will not automatically produce cautious terms for an option or a guarantee.
For instance, members have the option of transferring their cash value of the benefits to a defined benefit pension scheme.

A **cautious basis** assuming light mortality and low investment returns assumptions to calculate the cash value would result in a high cash value being placed on the benefits. However, offering the member a high cash value does not represent cautious terms for the scheme, as it would result in the scheme transferring an amount which is generous compared with its best estimate of what the member would have received had the member remained in the scheme.

The scheme will have no way of **clawing back any excess amount transferred**, should investment return and mortality rate experience turn out to be higher than that assumed in the calculation. Options and guarantees are **not independent**. Some guarantees may make options more valuable in certain scenarios.

# 3 Valuing Options and Guarantees

A life insurance company offering a with-profit product may provide the option of converting the lumpsum maturity benefit into an annuity at a guaranteed minimum rate. This option therefore combines with the guaranteed minimum maturity value (sum assured plus any bonuses) offered by a with-profit contract.

## *Valuing options*

Introduction

In some circumstances, policyholders may choose to knowingly **exercise an option** when the alterative may have been financially better for them. An example of this is a life assurance policyholder who chooses to surrender early, rather than keeping the policy to maturity. In this case, the policyholder may receive materially less on surrender than they would have received had they kept the policy to maturity, even after adjusting for future premiums that won't be paid. Policyholders surrender for many reasons, the main one being that they have a better immediate use for the money, as far as they are concerned.

Insurance companies will consider **persistency rates** when product pricing and setting reserves. **Risk-based capital calculations** will need to check that an unexpectedly large number of surrenders and lapses doesn't have an adverse effect on unit costs and future management expenses because there will be fewer policies across which to spread overheads. Other options will move in and out of the money over time depending on market conditions.

# 3 Valuing Options and Guarantees

Option Exercise Rate Influences

It is important that assumptions about the **proportion of member exercising** the option are in place when valuing liabilities.

In placing a value on options when setting provisions, it may be appropriate to assume that the **highest cost option** is always exercised.

In other words, it could be assumed that the holder of an option will always exercise an in the money option and will never exercise an out of the money option.

This may, however, build too much **caution** into the valuation. An option with a very high cost may be one that is unlikely to be the most valuable for the individual or chosen the most.

Many options are significantly dependent on the **option holder's behavior** in the sense that some option holders may fail to exercise an in the money option and others may exercise an out of the money option.

# 3 Valuing Options and Guarantees

*Example 1 – The Attraction of Cash*

The option holder's behavior may be influenced by the option that is immediately financially advantageous, rather than an option that may be of greater value, but where the benefit is realized in the future.

A guaranteed annuity rate to convert the proceeds of a pension fund into an annuity may be significantly in the money. However, the experience is that policyholders who have the option to take their pension fund in cash at retirement are likely to select this option, rather than the more advantageous approach of taking the guaranteed annuity rate applied to the pension fund. The policyholder perceives immediate cash to be of more benefit than a higher value pension annuity.

Cash in hand has a powerful influence on a person's choices because of the 100% liquidity benefit. Even if the option is in the money enabling them to receive a better annuity rate than that available in the open market, the member may choose not to exercise it.

They may choose to take the cash lumpsum to pay off an outstanding loan, for a holiday, or establish a level of capital.

# 3 Valuing Options and Guarantees

*Example 2 – Tax Benefit*

A member may wish to not exercise an option despite it being in the money for tax benefits.

A pension policy that provides a guaranteed rate for conversion of the policy proceeds into an annuity at retirement should normally be valued using the guaranteed rate if the option is or is close to being beneficial to the policyholder.

However, if there is also an option to take part of the value of the policy as a tax-free lump sum, this latter option may be more valuable to most policyholders, so that the majority choose it, even though they are forgoing a financial benefit by not taking all the proceeds in the form of an annuity at the guaranteed rate.
In this case it may be that the take-up rate of the option may be less than 100%.

Furthermore, the take-up rate may be different depending on the purpose of the valuation and the level of prudence required.

# 3 Valuing Options and Guarantees

Selection

With options there is a **risk of selection** against the provider.

- **Term assurance** – If a term assurance comes with an option of renewing the contract after the end of the specific period without further medical underwriting, then there is a case of anti-selection, where policyholders in worse than average health will exercise the option. This requires using heavier than average mortality rates to value the option.

- **Household insurance** – an option to have a new for old cover rather than one which is one indemnity basis, may result in a higher proportion of fraudulent claims by policyholders looking to replace worn out goods

This selection risk can be guarded against in setting eligibility criteria for the option or by setting terms that favor one option over another.

Give examples of eligibility criteria that might be applied at outset in respect of a 10-year term assurance contract that offers the option to renew after 10 years without the need to demonstrate continuing good health.

# 3 Valuing Options and Guarantees

**Other Factors Affecting the Value of Options**

Contract values are highly **sensitive** to **option pricing methods and assumptions**. The aim is to value an option by finding a market option that will close out the option in the policy.

A **derivative** such as a call or put option replicates the option in the liability, then the value of the policy option can be taken as the market value of that derivative.

In case there is no such derivative present, then a **theoretical derivative** can be formulated which replicates the option in liability and its value can be found using the Black-Scholes formula.

The assumptions used when valuing an option will depend on, among other things:

- the **state of the economy**, and hence must be scenario specific
- **demographic factors** such as age, health and employment status
- **cultural bias**
- **consumer sophistication**

# 3 Valuing Options and Guarantees

These **sensitivities** may change over time, for example, as consumers become more aware of options and improve their ability to evaluate the relative merits of electing options.

When using **deterministic** and **closed form** (eg Black-Scholes) methods to value guaranteed options, the traditional approach has been to assume that the take-up rate reflects the financial value of the option only – in other words a high take-up rate is used. If solvency and capital requirements are assessed on a risk-based approach, a best estimate option take-up rate will be used, and capital will be held against the risk of the actual rate departing from the estimate.

***Guarantees***

For example, a **defined contribution pension scheme** promises the members a minimum guaranteed benefit amount, to protect them from the risk of poor investment returns and hence insufficient benefit amount.

With guarantees there is a **risk** that the guarantee will apply and so the **costs** will be greater than would otherwise have been the case. Unless all the guarantees are in the money, providing for the **worst-case scenario** for every contract will mean that unnecessarily large provisions are made.

# 3 Valuing Options and Guarantees

**Factors Affecting the Value of Guarantee**

Guarantees may become more or less onerous for the provider over time, depending on how experience develops.

The **value of guarantees** and their influences on consumer behaviour will vary widely according to the economic scenarios and the sophistication of the market.

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# 4 Sensitivity Analysis

The assumptions used for **setting provisions** are **estimates of future experience**, taking any requirements for solvency capital into account. They are the expected values plus risk margins for adverse future experience. **Sensitivity analysis** can be used to determine these margins.

**Sensitivity analysis** could also be used to assess the extent of any global provisions that may need to be set up to cover potential future adverse experience.

When carrying out sensitivity analyses, it is important to **change the assumptions singly**, in a logical manner. Normal practice is to start with a central set of assumptions, and then to vary each item in turn, to quantify the effect of assumption changes.

It is then also necessary to test the effect of **multiple assumption change**. In most cases the assumptions will be neither **fully independent** nor **fully correlated**, and the result of applying two tests simultaneously will be greater or less than the sum of the individual results.

# 5 Different Methods of Allowing for Risk in Cashflows

*Allowance for Risk in a Traditional Discounted Cashflow Valuation*

**Best Estimate and Margin**

An approach to the uncertainty surrounding **benefit costs** and **asset returns** may be taken by using assumptions that do not reflect an actuary's '**best estimate**' of future experience. A **risk margin** is built into each assumption by using 'best estimate' assumptions together with an **explicit margin for caution**.

In some cases, a **prudent measure** would be an addition to the best estimate approach where mortality rates are taken to be higher than the best estimate mortality rates, as in the case of term assurance. Whereas in others, deducting the mortality rates would be a prudent approach to the best estimate rates, as in the case of annuities.

Assessment of the necessary **margins** depends on the risk involved, and its **materiality** to the final result. Where a risk factor has been stable over many years and is not exposed to economic events, it may be reasonable to add a simple percentage loading. An example might be mortality risk for lives aged between 30 and 55 in developed countries.

# 5 Different Methods of Allowing for Risk in Cashflows

In other cases, a more detailed analysis of experience for various sources, perhaps using a **stochastic approach**, may be needed to determine a margin consistent with the risk appetite.

However, one must ensure that the overall effect of introducing margins by having **small margins** in several assumptions does not lead to the cumulative effect of the basis being stronger than desired.

**Contingency Loading**

This approach is to increase the **liability value** by a certain percentage. The choice of this '**contingency loading**' is effectively another assumption and should ideally reflect the degree of uncertainty that exists. It would, therefore, be expected to increase with the value of the liabilities but not in a proportionate manner.
Given the analysis tools now available, this approach is excessively arbitrary.

# 5 Different Methods of Allowing for Risk in Cashflows

**Discounting Cashflows at a Risk Premium**

This is the **traditional discounted cashflow** approach where the cashflows are assessed on a **best estimate basis** and then discounted at a rate of return that reflects the **overall risk** of the project or liability.

If **risk discount rates** are high, they can affect the near and the remote cashflows disproportionately to the actual risk of the cashflows.

To allow for **prudence**, the discount rate must be reduced. This is because a high discount rate leads to lower relative weights on cashflows arriving later in the future, when they might actually have the highest risk and uncertainty.

# 5 Different Methods of Allowing for Risk in Cashflows

*Allowance for Risk in a market-consistent or fair valuation*

**Financial risk**

Financial risk associated with the liability cashflow is normally allowed for in a **market-consistent manner** either by a **replicating portfolio** or through **stochastic modelling** and the use of a suitably calibrated asset model.

The risks associated with the **general mismatching of assets and liabilities** are on the whole **excluded** from fair value calculations. This is because inclusion of this risk would be inconsistent with the general principle that the fair value of liabilities should be independent of the assets held to meet the liabilities.

**Non-financial risk**

The adjustment for non-financial risks can be achieved either by adjusting the **expected future cashflows** or by an adjustment to the **rate** used to discount cashflows. Alternatively, an extra **provision** or a capital requirement, such as the **risk margin** under Solvency II, can be held for non-financial risks. These adjustments will depend on the **amount of risk** and **cost of the risk implied by market risk preferences.**

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# 6 Different Methods of Calculating Provisions

*Statistical analysis*

If the **population exposed to a risk** is large enough, and the consequence of a risk event is approximately **normally distributed**, then a mathematical approach to establishing a provision for the risk will give a valid answer.

A company establishing a **provision** for notified theft claims under a household contents policy might simply provide for the number of notified claims multiplied by the average cost of a claim in the last year. This would give a **best estimate provision**.

To establish a **prudent provision** that would be sufficient at a ruin probability of any given percentage, a simple analysis of the normal distribution will generate the required result.

# 6 Different Methods of Calculating Provisions

***Case-by-case estimates***

If the insured risks are **rare events** and also have a **large variability** in outcome, then statistical analysis may break down.

For example, in establishing a provision for notified motor accident personal injury liability claims, there is little alternative but to carry out a case-by-case examination of the claim files to assess the extent of injury, the prognosis, and hence the likely claim amount. Even this approach still leaves risk of injury award inflation that a court might grant.

The case-by-case examination involves the claims assessor **examining each individual claim file** for the reported claims and assessing the likely cost of settling each claim.

# 6 Different Methods of Calculating Provisions

***Proportionate approach***

An alternative approach, especially in making **provisions** for risks which a provider has accepted but where the risk event has not yet occurred, is to set a provision on the basis that the premium charged is a fair assessment of the cost of the risk, expenses, and profit.

If a premium basis allows for 25% of the premium to cover expenses, commissions and profit, then one approach to establishing a provision for the unexpired part of a year's cover is to assume that 75% of the premium covers risks equally through the period of the policy. A provision for the unexpired duration can be set by a simple proportion of this 75%.

If a portfolio is such that there is no method of assessing a required provision with any degree of confidence, this suggests that the risks ought to be transferred elsewhere.

# 6 Different Methods of Calculating Provisions

***Equalization reserves***

An example of the issues discussed in the previous slides occurs where a product provider might wish to exhibit **stable results** from year to year, but where the portfolio contains **low probability risks** with a large and highly volatile financial outcome. In years where such an event occurs the company may show a **significant reduction in profits**; where no event occurs, profits will be **greater than the long-term average**.

To smooth results, a company may establish a **claims equalization reserve** in years when no claim arises, with a view to using the reserve to **smooth results** when a claim does occur. These reserves do not fit with the definition of a provision but nevertheless are used in some jurisdictions for general insurance.

Note that not all regulatory regimes recognize **equalization reserves**; for example, these reserves do not exist under Solvency II. **Tax authorities** are often not prepared to take such reserves into account in computing profits. Equalization reserves are seen as a way of **deferring profits and hence tax**.

# Topics covered

**Valuation methods**

- Traditional discounted cashflow method
- Move to market-based or fair value approaches

**Fair valuation**

- Replicating portfolio methods
- Asset based discount rate
- Estimating fair values

**Valuing options and guarantees**

**Sensitivity analysis**

**Different methods of allowing for risk in cashflows**

**Different methods for calculating provisions**