

Class: M.Sc. Sem 3

Subject : Actuarial Practice 1

Chapter: Unit 3 Chapter 4

Chapter Name: ALM and Actuarial Technique

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

Using a model to determine investment strategy

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

Using a model to determine investment strategy

1 Interaction Between Assets and Liabilities

- Providers of financial benefits will invest the **contributions** received for those benefits in order to deliver the benefits. A key decision for the provider is whether to invest in such a way that the **expected cashflows** from the **assets** held **match the expected cashflows** from the **liabilities** it has taken on.
- If the decision is taken to match the assets to the liabilities, then the **optimal matched position** will need to be determined.
- **Matching of assets and liabilities** is a significant activity given the uncertainties in the future cashflows of different liabilities and the uncertainties associated with assets
- If the investor decides not to match the assets to the liabilities, then additional capital will need to be held to cover the possibility that assets are insufficient to meet the liabilities as they fall due. Establishing the level of **extra capital** needed is not trivial.
- The availability of **free assets** acts as a **cushion** against the worsening of market movements. If the level of additional capital needed is established correctly, then there are sufficient assets to meet the liabilities as and when they fall due, even if there is a fall in the value of assets

2

Principles of Investment

The **principles of investment** for a provider of benefits on future uncertain events can be stated as follows:

- A provider should select investments that are appropriate to the :
 - Nature
 - Term
 - Currency
 - Uncertainty

Of the liabilities, and

- Subject to above, the investments should also be selected so as to maximise the overall return on the assets, where overall return includes both income and capital

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

Using a model to determine investment strategy

3

Liability Cashflows - Identification

Assessing the **timing and amount** of future cashflows i.e. sums of money which are paid or received at different times is important.

For example, a health club will

- Receive the annual membership fees from their members
- Will receive donations
- Will have to spend on the upkeep, repairs and maintenance of the club and management of the club
- Will have to pay out salaries to the employees.

Similar cashflows arise in every business. In some businesses, such as insurance companies, positive cashflows (**premiums**) are received before negative cashflows (**claims and expenses**) arise.

These are available for investment, and will generate investment income, which is in turn another positive cashflow. Part of the premium earned is used in meeting expenses associated with the policy and fixed expenses, and part is invested

3

Liability Cashflows - Identification

Where there is uncertainty surrounding the **amount** and **timing** of cashflows, one actuarial technique is to assign **probabilities** to both the **amount** and **existence of cashflows**.

Examples of Cashflow Scenarios

A Repayment Loan (Mortgage)

This loan is repayable by a series of amounts, each of which includes partial repayment of the loan capital in addition to the interest payment.

If the interest rate is fixed, the payments will be of fixed equal amounts, paid at regular known times
The cashflows are similar to those of annuity, except that their number is fixed in nature, and not dependent on survival.

An added complication would be having a varying interest rate, or if there is an option of early loan repayment. It is also possible that the regular repayments could be specified to increase or decrease with time.

3

Liability Cashflows - Identification

With a repayment loan the breakdown of each payment into **interest** and **capital** changes significantly over the period of the loan:

- The **first repayment** will consist almost entirely of **interest** and only a small proportion would be dedicated to **capital repayment**.
- The **final repayment** will consist almost entirely of capital and will have only a small interest content.

This is how the capital loan amount reduces throughout the term of the mortgage. At the start the outstanding amount is high, which makes the interest accumulated on it high, and as time passes and capital loan amount is repaid, the interest accrued decreases, so the mortgage repayment at the end has a high capital repayment proportion and low interest proportion.



Identify the cashflows of a deferred and immediate annuity.

4

Liability Cashflows – Categorisation by Nature

The **net liability** outgo consists of:

Benefit Payments

- + expense outgo
- premium/ contribution income

In practice, the actual liability outgo in any year, or month, depends on:

- The **monetary value** of each of the constituents
- The **probability** of it being received or paid out



Give examples of why these three types of outgo might not be certain.

4

Liability Cashflows – Categorisation by Nature

Benefit payments

The benefit payments can be subdivided into four categories:

1. Guaranteed in Monetary Terms

Consists of payments where the amount is **certain in monetary terms**. For example, the benefit amount payable in an endowment assurance.

2. Guaranteed in Terms of an Index of Prices, Earnings or Similar

Consists of benefits whose value is directly **linked to an index**

The index may not necessarily be a national one. For instance, benefits payable under a benefits scheme, which may increase in line with the employee's salary.

4

Liability Cashflows – Categorisation by Nature

3. Discretionary Benefits

Consists of any payments payable at the discretion of the provider, eg future bonus payments under with-profit contracts or pension increases in excess of guaranteed amounts

4. Investment Linked

Here the benefit amount is directly determined by the value of the underlying investments
For example, a mutual fund whose value is directly linked to the value of the underlying investments

Expense outgo

Expenses tend to **increase over time**. The natural rate of increase is likely to fall somewhere between **price and earnings inflation**.

In addition, there may be certain items which may be either expenditures or cost savings.

For the purpose of investment, it may be adequate to treat expenses as being linked to prices or earnings. Hence, they can be included with benefit payments guaranteed in terms of an index of prices or similar

4

Liability Cashflows – Categorisation by Nature

Premium/contribution income

Premium/contribution payments may :

- Be **fixed** in monetary terms
- Increase in line with **an index or inflation**

The existence of contracts where the client can vary the premium amount each year does not invalidate this.

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

Using a model to determine investment strategy

5

Selecting Assets by Nature of Liabilities

Guaranteed in money terms

- Pure Matching

A provider will want to invest so as to ensure that the **cashflows** from the investments will meet his **guarantees**, i.e. the assets will produce income that matches his liabilities in terms of both amount and timings.

This will involve taking into account the term of the liability outgo and the probability of the payments being made, so as to indicate the term of the corresponding assets.

- Approximate Matching

Except for certain liabilities, it is impossible to find assets that **exactly match** the **expected liability** outgo. In particular, the terms of the available fixed-interest securities may be much shorter than the corresponding liabilities, specifically in the case of long-term pension liabilities.

5

Selecting Assets by Nature of Liabilities

The existence of **options** in either assets or liabilities also means that **full cashflow matching** is not realistically possible.

A **best match** can be achieved by investing in **high quality fixed-interest bonds** of a term suitable to match the expected term of the liability outgo.

Derivatives could be used to produce asset flows that match liability outgo. However, this strategy being expensive often offsets the benefits

Guaranteed in Terms of a Prices Index or Similar

Matching liabilities associated with a price index is also difficult.

The closest match would be **index-linked securities**, that would ideally match the expected term of the liability outgo



Discuss how good a match equities would be for liabilities linked to a price index

5

Selecting Assets by Nature of Liabilities

Discretionary benefits

If **discretionary benefits** are to be provided, the main aim of the provider will be to maximize these and hence the investment strategy should therefore also aim to do that. This means **investing in assets** that will produce the **highest expected return**. However, this would also mean accepting **higher risks**.

Investment linked

The benefits are **guaranteed** to the extent that their value can be determined at any time in accordance with a definite formula based on the value of a **specified fund of assets or index**.

The provider can avoid any investment matching problems by investing in the same assets as used to determine the benefits

However, it can prove to be costly, as replicating the market index would involve holding a large number of small holdings. One way to avoid high costs would be to choose **collective investment schemes** or a derivative strategy to achieve this

5

Selecting Assets by Nature of Liabilities

Currency

Liabilities denominated in a particular **currency**, should be matched with **assets** in the **same currency**, so as to reduce any currency risks.

For example, if the investor owes rent for a property in a foreign country, it is better to invest in the equity market of that country or in treasury bills issued by the government.

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

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6 Mismatching

The purpose of taking the **risk of mismatching** assets and liabilities is **maximising returns**. Factors influencing the balance between risk and return are:

- The extent of free assets available
- Any regulatory constraints

Free assets/surplus

The existence of **free assets or surplus**, gives the **freedom** for mismatching as there is enough **cushioning** in case of assets being insufficient in matching liabilities. Also allowing to depart from the matching strategies in the hope for **higher returns** thus benefiting other stakeholders as well such as:

Clients – by means of higher benefits or larger coverage or lower premiums

Shareholders – by providing higher dividends

It goes hand in hand that assets with higher returns come with a higher variance of returns as well

6 Mismatching

Guaranteed benefits

When assets are invested with the only perspective of **earning higher returns**, and hardly any consideration being given to the nature of liabilities, the **probability** of proceeds from assets being **inadequate** in meeting the liabilities is **high**.

The existence of **free assets**, can help cover any **shortfall** in these circumstances, but without them or when they are not enough, this approach can lead to insolvency.

A **deterministic approach** can be used to assess an appropriate level of assets required to cover the mismatching of assets and liabilities, that is, to calculate a **mismatching or resilience reserve**:

- Assets are selected to match the value of liabilities exactly
- Specified time zero changes in the value of these assets and in economic factors such as interest rates are assumed, and the value of assets and liabilities recalculated.

6 Mismatching

Here, it is assumed that there may be changes in key **economic factors** such as interest rates, taxation, inflation, etc which will impact asset values. Likewise, the value of liabilities is also recalculated on the basis of changes in asset values.

- The excess of liabilities over assets, is the provision required

The main technique used to determine how much of the free assets/surplus is needed as a cushion to reduce the **probability of insolvency** to an acceptable level is the same as that used to assess a **risk-based capital** requirement against market risk.

This involves running a **stochastic simulation** of the markets in which funds are invested using an economic scenario generator.

The capital required to just prevent insolvency at any desired probability can be determined by inspecting the **tails** of the output from the stochastic simulations.

6 Mismatching

This often means that the opportunities to depart from a matched policy for the guaranteed liabilities are limited.

When allocating free assets to support a mismatched investment policy it is necessary to take into account that the investments in which the free assets are invested will also be affected by market value changes. For example, if £3m of capital is needed to protect a portfolio against a 25% fall in equity values, and the free assets are invested in equities, £4m of free assets needs to be earmarked to provide this capital, after the market fall.

6 Mismatching

Discretionary benefits

When benefits are discretionary, where their level is being decided by the provider, it can be argued that **matching** assets and liabilities becomes irrelevant, as the provider's only requirement would be to invest in assets providing the **highest expected return**.

However, the beneficiaries will have certain expectations such as a **minimum level** especially in the case of with-profit bonus policies.

As a result, the provider needs to hold **few surpluses** or adopt a limited matching strategy to ensure that the probability of discretionary benefits falling below a minimum level remains within an acceptable limit.

6 Mismatching

Investment linked

It could be argued that it is a reasonable use of the free assets/surplus to mismatch investment-linked benefits if by so doing the company can expect to achieve a higher return.

If this is done any return achieved above that on the 'matched' assets will not accrue to the beneficiaries of the investment-linked contracts but to the provider.

In the case of risk-averse investors, matching of assets and liabilities is prioritized moreover achieving higher returns, especially when benefits are investment-linked than guaranteed.

In many territories, **mismatching investment-linked benefits** is disallowed by law or regulation.

6 Mismatching

The regulatory framework within a country may limit what a provider may be able to do in terms of investment. The following controls may be implemented:

- restrictions on the **types of assets** that a provider can invest in
- restrictions on the **amount** of any particular type of asset that can be taken into account for the purpose of demonstrating solvency
- a requirement to **match** assets and liabilities by currency
- restrictions on the **maximum exposure** to a **single counterparty**
- **custodianship** of assets
- a requirement to hold a certain **proportion** of total assets in a particular class – for example government stock
- a requirement to hold a **mismatching reserve** and a limit on the extent to which mismatching is allowed at all.

6 Mismatching

Where a mismatching reserve is required, the regulations are usually framed so that the more a company decides to invest in return-assets, the **higher any resulting reserve** will be. This increases the value of the liabilities and reduces the available free assets/surplus.



- i. Give two reasons why there might be restrictions on the amount of any particular type of assets that can be taken into account for the purpose of demonstrating solvency.
- ii. Give an example of an asset class that might be subject to such restriction.

Table of contents

Understanding the interaction between assets and liabilities

Selecting assets on the basis of liabilities

Understanding principles of investment

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7 Investment Matching

Pure matching

In its purest form **matching** of assets and liabilities involves **structuring the flow of income** and **maturity proceeds** from the assets so that they **coincide** precisely with the net outgo from the liabilities under all circumstances.

This requires the **sensitivity** of the timing and amount of both the asset proceeds and the net liability outgo to be known with **certainty** and to be identical with respect to all factors.

However, liability cashflows are hardly matched, making **pure matching rarely possible**

Unless risk-free zero-coupon bonds can be used, it is rarely possible to achieve **pure matching**, although a close approximation to a perfect match may be possible for certain life insurance products, such as guaranteed income bonds

A further problem is that for some funds the term and size of the liabilities may be such that complete matching is unattainable because suitable assets are not available

7 Investment Matching

Liability hedging

Liability hedging is where the assets are chosen in such a way as to perform in the same way as the liabilities. It involves hedging against any adverse and unpredictable changes in the value of liabilities as a result of changes in factors affecting liabilities.

- Approximate Liability Hedging
 - Hedging liabilities with respect to all factors affecting it is not always possible, hence hedging is only carried out with respect to a **few prioritised factors**.
 - Familiar forms of hedging include **matching by currency** and the consideration of the **real or nominal** nature of liabilities when determining the choice of assets.
 - However, these examples only relate to a particular form of hedging, whereas liability hedging aims to select assets that performs exactly like the liabilities in all events

7 Investment Matching

- Full Liability Hedging
 - Full liability hedging is usually possible in the case of **unit-linked liabilities**
 - When choosing assets to hedge unit-linked liabilities, the normal approach is to establish a portfolio of assets, determine a **unit price** by reference to the value of the asset portfolio, and then use this price to value the units and hence the liabilities. This means that the value of the liabilities is determined by that of the assets

8

Using a Model to Determine Investment Strategy

- An investor's **objectives** will normally be stated with reference to both **assets and liabilities**.
- In setting an investment strategy to control the risk of failing to meet the objectives, a method that considers the **variation in the assets** simultaneously with the **variation in the liabilities** is required.
- This can be done by constructing a model to project the **asset proceeds** and **liability outgo** into the future.
- The model can help in selecting assets to invest in, which solves a particular purpose.
- The model can be used to set objectives that include a quantifiable and measurable performance target, such as:
 - Maximizing the expected solvency level at the end of a four-year period subject to the probability of insolvency being $<0.05\%$ any time during that period.

The outcome of a particular investment strategy is examined with the model and compared with the investment objectives. The investment strategy is adjusted in the light of the results obtained and the process repeated until the optimum strategy is reached.

8

Using a Model to Determine Investment Strategy

- Modelling can be either **deterministic** or **stochastic**.
- In case of a deterministic model, the **parameters** are set in advance and results in a **single outcome** when the model is run. The model needs to be run a several times to get a range of results, in order to check the robustness of the model.
- Using a **stochastic model** is a better option as it allows for the **uncertainty** and **volatility** of the assets and liabilities. Here one of the parameters is derived from a **probability distribution**, and the model is run many times to generate a distribution of outcomes
- An advantage of stochastic modelling is that it encourages investors to formulate explicit objectives. The objectives should include a quantifiable and measurable performance target, defined performance horizons and quantified confidence levels for achieving the target.
- The success of the strategy is monitored by means of **regular valuations**. The valuation results will be compared with the projections from the modelling process and adjustments made to the strategy to control the level of risk accepted by the strategy, if necessary.

Topics Covered

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Understanding principles of investment

Mismatching of assets and liabilities

Identifying cashflows arising from liabilities

Investment matching

Categorizing liability cashflows on the basis of their nature

Using a model to determine investment strategy