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IAA Risk Book
Asset Liability Management
Techniques and Practices for
Insurance Companies

Insurance
Regulation
Committee

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IAA Risk Book
**Asset Liability Management Techniques
and Practices for Insurance Companies**

**This Risk Book chapter has been developed and approved
by the Insurance Regulation Committee of the IAA**

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Comments and feedback

Comments and feedback on Risk Book chapters are welcomed.

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Introducing the IAA Risk Book

The actuarial profession has contributed significantly to the development of risk management tools and processes, in insurance, pensions and related industries. Actuarial skills are also increasingly being applied in new and developing areas of knowledge.

Actuarial practice continues to improve the understanding, measurement and communication of risk and risk events and their implications through the development of tools and increasingly processes to manage the future uncertainty of risks in a sustainable and transparent way. These tools and processes trace, manage and mitigate the acceptance and transmission of the uncertain outcomes of risks.

The Risk Book is intended to provide high-quality reference materials to support a better understanding of the risks and inherently uncertain future outcomes that need to be managed when delivering financial services products – whether they involve insurance, investments or retirement incomes, or more broadly. The Risk Book is written to be accessible to a wide range of readers, many of whom may not be actuaries or experts in the areas discussed but may be decision-makers in those areas. Consequently, the Risk Book should provide insight into the ideas and concepts behind actuarial topics and concepts. It is therefore focused on being descriptive rather than being formal and mathematically precise.

All the Risk Book chapters are publicly available on the IAA website and are periodically updated. See www.actuaries.org and follow the path to '*Knowledge / Publications / IAA Risk Book*'. A discussion of their structure and relationships is provided in the chapter "Introduction – Using the Risk Book."

The Risk Book is intended to be a dynamic and evolving resource, updated over time, reflecting new areas where actuarial expertise can add value, experience and advances, and topics of current interest and importance. It is electronically distributed to support ongoing updates. Risk Book chapters will be reviewed periodically at least every five years and more frequently if significant changes or developments occur.

The development and maintenance of the Risk Book is managed by the Risk Book Editorial Board of the IAA Insurance Regulation Committee.

Many people, mostly actuaries, have contributed to the Risk Book. Contributors are listed on the website.

To submit comments or questions about this Risk Book chapter, or to report any problems with the website, please email riskbookcomments@actuaries.org. To express interest in becoming involved with the Risk Book, please go to the website and provide the requested information.



1 Executive Summary

This chapter provides the reader with practical insights into asset liability management (ALM) techniques and practices for insurance companies. Key messages include:

1. Insurance companies face various financial risks associated with assets backing liabilities.¹ How these risks are managed varies by company and jurisdiction and is largely influenced by the regulatory environment.
2. ALM is a fundamental element of life insurer strategy and operations. It is also important to the operations of other types of insurers. The importance of ALM to life insurers results from insurance being primarily a liability-driven business with assets purchased to match,² in a risk-efficient manner, the estimated insurance obligation cash flows. These cash flows may be uncertain for a number of reasons, including policyholder options and the inherent uncertainty in the insurance decrements.
3. Life insurance companies and other types of insurers with long-duration liabilities can be exposed to significant interest rate risk exposure. Inadequate ALM, ignoring the economic risk exposure and/or using only simple risk metrics such as duration has resulted in, and will continue to result in, insolvencies. For life insurance companies with long liability durations, it is important to understand the multiple dimensions of the interest rate risk exposure. General insurance companies with short liability durations have less exposure to interest rate risk, and the focus is more on managing liquidity. However, some general insurance companies with long-duration liabilities can be exposed in a similar way to life insurance companies.
4. In some jurisdictions, there may be significant currency or inflation risk, where policies can be denominated in currencies other than the local one or where benefits are indexed to inflation.
5. One of the greatest challenges faced by life insurance companies selling contracts with long-duration liabilities was the prolonged extreme low-interest rate environment

¹ On an economic basis, this is the risk associated with the net cash flows. On an accounting basis, it is the risk associated with assets and liabilities (i.e., insurance reserves), and on a regulatory basis, it is the risk associated with capital and required capital.

² Note that it may not be necessary or even possible – as in the case of uncertain liability cash flows – to exactly match the asset and liability cash flows. ALM strategies often seek to match the sensitivity of the value of the assets to the value of the liabilities to changes in a given financial variable such as interest rates based on expected liability cash flows. It should be noted that on most long-tailed liabilities, insurers can only match the expected cash flows. If and when the expectations change so the expected cash flows change, this will result in the assets not being as well matched as they were previously.



- experienced in the early decades of the 21st century.³ Traditional guaranteed products with long durations that embed higher assumed returns than available at current fixed interest rates were difficult to immunize with available fixed income assets.
6. For life insurance companies with investments well matched against their liabilities' guarantees in expected scenarios, there is a risk that an increase in interest rates will make the guarantee no longer attractive to policyholders. As a result, they may decide to partially or totally withdraw, causing the insurance company to sell assets at a loss.
 7. Many insurance company portfolios are suboptimal. For a given level of risk, the financial objectives are not maximized/minimized. There is an opportunity for insurance companies to improve the risk efficiency of their portfolios; in some cases, simultaneously increasing portfolio yield, increasing net income and adding positive convexity⁴ to the portfolio while decreasing risk. Asset management approaches that manage assets separately against a benchmark rather than directly against the liabilities, or ignore the impact on capital requirements if they are risk-sensitive, often do not support effective ALM.
 8. Effective governance is a key part of ALM, one of the most vital functions related to many insurers' long-term financial health. Effective governance provides a clear objective for the ALM function and ensures that there is a framework in place for making decisions, the organizational structure supports effective ALM, there is accountability in respect of taking market views, and senior management and/or the board are aware of and fully understand the risk exposures and uncertainties associated with the assets and liabilities.
 9. ALM requires a variety of expertise and should be performed by professionals knowledgeable in the characteristics of both the assets and liabilities. Based on their expertise and knowledge of both, actuaries play key roles in ALM.
 10. Many of the large losses and failures suffered by insurance companies with long-duration liabilities could have been avoided by applying basic ALM techniques. Failures and near failures of life insurance companies as a result of asset liability mismatches continue today.

³ Low-interest rate environments are not as material a challenge for general insurers, as witnessed by their continued profitability and satisfactory returns on equity. This is because their business model is not dependent on investment income – if investment return expectations are low then the price goes up accordingly. The low-interest rate environment is only a risk to the extent that liabilities have longer tails than the available asset durations.

⁴ See Appendix A for a definition of convexity and other technical terms.



2 Introduction⁵

The aim of this chapter is to provide the reader with practical insights into asset liability management (ALM) techniques and practices for insurance companies. One of the first things a decision-maker or risk professional comes to appreciate when first encountering ALM is that practices vary widely by company, by industry and by jurisdiction, and that textbook theory does not provide the answers to many of the questions facing insurance companies implementing ALM.

Company culture, the nature of the liabilities, and the regulatory and accounting regime all influence how the financial risks associated with the assets and liabilities are measured and managed. An important distinction should be made between ALM for general insurers and ALM for life insurance companies, given the different characteristics of their liabilities. For life insurers with longer-duration liabilities, while the scope of ALM includes all financial risks associated with the assets and liabilities, interest rate risk is often the focus of ALM. This has been mostly due to the fact that life insurer portfolios are often heavily weighted with fixed income securities because of the greater certainty provided by these asset cash flows.

General insurance companies, which normally have shorter-term liabilities, have less exposure to interest rate risk and more exposure to catastrophes, mispricing and misestimating claim liabilities. For general insurers, ALM has historically tended to be very focused on maintaining a certain level of liquidity, given the uncertainty of the cash outflows (as to both amount and timing). With more general long-tail liabilities in jurisdictions such as the UK,⁶ and the advent of discounted liabilities and risk-based capital (RBC) requirements, ALM with a focus on interest rates is becoming more important in those jurisdictions.

2.1 Definition of ALM

The Society of Actuaries ALM Principles Task Force provided the following definition for ALM:

Asset Liability Management is the ongoing process of formulating, implementing, monitoring, and revising strategies related to assets and liabilities to achieve financial objectives, for a given set of risk tolerances and constraints.⁷

While managing the risks associated with the assets and liabilities remains a key focus of ALM, the task force recognized that ALM had a more strategic role to achieve the financial objectives of an entity. This contrasts with the view of ALM as solely a compliance exercise where the only goal is risk mitigation. The European Solvency II Directive explicitly recognizes ALM as part of risk management (cf. Article 44 of the Directive). Actuaries/practitioners may

⁵ Definitions of various technical terms are provided in Appendix A.

⁶ UK motor insurance exposes general insurers to the risk of periodical payment orders – lifetime benefits for those permanently disabled as the result of an automobile accident.

⁷ Principles Underlying Asset Liability Management © 2004 Society of Actuaries. All rights reserved.



want to consider whether regulatory requirements differ from practical implementation when setting up/defining the scope of an insurer's ALM function.

2.2 Relative Risk

The risk exposure of an insurer is a function of all the assets and the liabilities. ALM is less concerned with absolute risk than relative risk. For example, consider a highly volatile asset portfolio whose market value is subject to large swings. On a standalone basis, this portfolio may have a high absolute risk. However, if this portfolio is backing liabilities whose value changes by the same amount for a given change in a financial variable, then the relative risk associated with the assets and liabilities is what matters. This is the reason why an "asset-only" asset management approach for insurance portfolios is inappropriate.

One ALM strategy, which can be executed on many different bases, is immunization. The concept of immunization is to rebalance the asset portfolio as necessary so that the change in the value of the assets will be equal to the change in the liabilities within some tolerance level. Immunization is only possible for those liabilities that are predictable and largely impacted only by the same financial variables that impact the assets.

2.3 Key Elements of ALM: Measurement and Management of Risk

Two key elements of ALM include: (1) measurement of the risk exposure and (2) management of the risk exposure.

Measurement of the risk exposure can be done in a number of ways:

1. Calculating the sensitivity of the assets and liabilities⁸ to changes in financial variables. This can be done using traditional ALM metrics such as duration and convexity, the Greeks⁹ or scenario testing.
2. Calculating the risk distribution of the assets and liabilities.¹⁰ This is often done using stochastic simulation and can be expressed using various measures such as value at risk (VAR) and conditional tail expectation (CTE).

In some jurisdictions where the capital requirements are risk-sensitive, the impact on those requirements would also be considered. This is not always intuitive, as it may be that interest rate risk, or market risk, may diversify against the capital required to be held against other risks, and hence the aggregate capital required may be insensitive to increasing risk exposure until the diversification benefit is used up.

⁸ This can refer to the market values, present value of cash flows or financial statement impact on reserves, net income, capital ratio, etc.

⁹ See Appendix B for a description of the Greeks.

¹⁰ Note that calculating the risk distribution for some liabilities is problematic (e.g., no one yet has a reliable risk distribution for US asbestos liabilities).



The above ways of measuring risk can be classified as either measuring the sensitivity to a change in a financial variable at a point in time or measuring the sensitivity to a change in a financial variable over time. For example, duration, convexity, delta, gamma and rho all measure the exposure to an immediate shock in the financial variable on the price of the underlying asset or present value of a series of cash flows and assume that shock persists indefinitely into the future. Scenario testing and stochastic simulation can also look at future economic scenarios over time and test the impact under the ALM strategy or reinvestment assumption.

Monitoring of the risk can be performed intra-day, weekly, monthly or quarterly – often depending on how volatile the results are and the extent of surplus funds available to absorb any mismatch. Measurement of the risk exposure and the impact of potential ALM strategies provides valuable decision support to an insurer.

Management of the risk exposure involves formulating and executing ALM strategies. Many companies use traditional ALM metrics such as duration and convexity to manage the risk exposure, set risk limits and rebalance the portfolio, and then measure the resulting risk distribution using stochastic simulation.

2.4 Influence of Regulatory Regime on ALM Practice

Supervisory and financial reporting trends that value elements of the balance sheet independently may not sufficiently consider ALM exposures driven by dependencies between these elements. Accounting rules have sometimes encouraged mismanagement of risk due to a disconnect between the accounting treatment and economic reality.

Many of the large losses and failures suffered by insurance companies with long-duration liabilities could have been avoided by applying basic ALM techniques. Failures and near failures of life insurance companies as a result of asset liability mismatches continue today. Accounting rules¹¹ in some jurisdictions have encouraged mismanagement by ignoring the economic risk exposure and rewarding companies for taking mismatch risk. In jurisdictions where the reserve and capital requirements do not reflect the economic interest rate risk exposure associated with a mismatch of the asset and liability cash flows, insurers may have had less motivation to implement effective ALM. This may have also been the case where

¹¹ In the US, accounting rules played a major role in savings and loan crises in the 1980s and 1990s. Assets were valued at cost and reinvestment risk associated with short-term deposits backed by longer-term mortgages was ignored. When interest rates increased in the 1980s, the earned rate on the longer-term mortgages was less than the rate paid on short-term deposits. This was exacerbated by severe disintermediation and weakening of the portfolios consisting of assets that were held at book values higher than their market value. US Generally Accepted Accounting Principles do not capture the interest rate risk exposure of life insurance companies, and economic losses due to interest rates are not immediately revealed.



there has been a large disconnect between the exposure on an accounting basis and risk exposure on an economic basis.

2.5 Unique Considerations and Challenges for Insurance Companies in a Low-Interest Rate Environment

ALM for life insurers can be complex due to a number of factors:

1. The long-term nature of some product guarantees (e.g., for the lifetime of the insured/annuitant) extending beyond the term to maturity of available fixed income assets
2. The presence of optionality in either or both of the asset and liability cash flows (e.g., resets, ratchets in variable annuities with guarantees)
3. The presence of adjustable features in some products (e.g., participating insurance with dividends)
4. The dependence on demographic or client behavior (such as lapse or partial withdrawals rates) assumptions, which can undermine the matching as assumptions change

One of the greatest challenges faced by life insurance companies was the prolonged extreme low-interest rate environment experienced in some parts of the world in the early decades of the 21st century.¹² Life insurers who held short-duration assets were not able to earn the returns assumed in pricing the liabilities. This resulted in lower earned rates on insurer portfolios, decreased investment income, higher reserves, spread compression on products offering minimum credited rate guarantees and reduced ability to support dividend scales. Even those insurers who were immunized on a duration basis and remained within their board-approved risk limits found themselves offside as a result of their convexity exposure (see Appendix A). As interest rates declined, the duration of liabilities increased by a greater amount than the duration of assets. Many of these insurers started chasing yield, decreasing the credit quality of their portfolios and increasing the allocation to riskier asset classes. The resulting pressure for higher yield resulted in more risk being taken.

In this environment, traditional guaranteed products with long durations were difficult to immunize with available fixed income assets. Many insurers constructed portfolios to back liabilities that had shorter duration than the corresponding liability, either because longer-duration fixed income assets were not available or because they did not want to invest in long-term, low-yielding bonds and lock in losses. Insurers who elected to take a market view that the likely direction of future interest rate changes would be upward, and did not lengthen

¹² The sustained low-interest rate environment has not hurt most general insurance companies without long-tail business, as they can adjust prices for new business in accordance with the change in interest rates.



their assets to match the duration of the liabilities, essentially took a bet that interest rates would not remain low in the medium to long term.

Life insurers who wanted to immunize their portfolio on an economic basis were faced with the prospect of having to rebalance their portfolios to lengthen the duration of their assets by purchasing longer-term bonds and locking in unattractive yields in a low-rate environment. As an example of regulatory/accounting effects, because of a disconnect in Canada between the accounting and economic results, some Canadian insurers were further penalized with an increase in reserves if they immunized their portfolio on an economic basis by lengthening fixed interest asset durations.

There have been three main ways that insurers have sought to increase the yield on their portfolios:

1. Add credit spread.¹³ This is achieved by decreasing the credit quality of the portfolio and taking on more credit risk exposure, and often aiming to capture the illiquidity premium, where the intent is to hold assets to maturity.
2. Increase expected return. This is achieved by increasing the allocation to riskier asset classes such as equities, real estate and other non-fixed income (NFI) assets.
3. Increase yield to maturity in an upward-sloping term structure. This is achieved by selling shorter assets that have a lower yield to maturity and buying longer assets that have a higher yield to maturity. In some cases, for life insurance companies that have assets shorter than the liabilities to begin with, this increases yield and decreases the interest rate risk. Albeit the insurance company is giving up both the downside risk if rates fall and the upside gain if interest rates rise.

European insurers have looked to transfer risk to new policyholders in low-rate environments by replacing sales of traditional guaranteed products with unit-linked products. This has principally been driven by recognition of the cost of guarantees in Solvency II (as well as earlier versions of RBC in jurisdictions like the UK), although the RBC approach of Solvency II has typically resulted in the increased asset risk increasing capital requirements for guaranteed products. Low interest rates have served to emphasize those costs.

Life insurance products with minimum crediting rate guarantees represent an embedded option in the liabilities. As interest rates fell, spread compression or margin squeeze resulted from the portfolio earned rate falling below the crediting rate plus the required margin. Few insurance companies outside of the UK hedged these guarantees explicitly using dynamic hedging or by purchasing interest rate floors. Once interest rates fell, the guarantees became prohibitively expensive to hedge. If the hedging of the guarantee is managed explicitly, it may be possible for the liabilities to be immunized as if the cash flows were fixed. Otherwise,

¹³ Companies may use risk-adjusted yields but may, for example, seek to exploit the illiquidity premium.



insurance companies will look to immunize the effective duration and effective convexity that take into account the interest rate sensitivity of the cash flows.

It should also be noted that there are ALM issues associated with high interest rates due to hyper-inflation, such as seen in Venezuela or Argentina.



3 Objectives for the ALM Function

At its most fundamental level, the goal of ALM is to manage the financial risk exposure associated with the assets backing liabilities.¹⁴ While this seems straightforward enough, several basic questions need to be answered before ALM can be properly performed. For example:

- What sources of financial risk should fall within the scope of ALM?
- Which risk exposures matter, and which do not?
- On what basis should risk be measured and managed?
- What assets and what liabilities should be included, and which, if any, should be excluded?
- At what aggregation level should ALM be performed?

Getting any of these basic questions wrong can have significant negative impacts for a financial institution.

Once the insurer has defined what risks will be managed, it needs to determine how this will be done. Before this question can be answered, the objectives for the ALM function need to be determined. In some insurance companies, ALM is primarily viewed as a risk mitigation exercise and the objective is simply to ensure all risk exposures are within the board-approved risk limits. Other insurers have integrated ALM within their broader enterprise risk management (ERM) to be executed as a strategic decision-making framework to run the company by formulating, implementing and executing investment strategies related to the assets and liabilities that achieve the financial objectives, and setting this up as an optimization program. The objectives for the ALM function will determine how asset management is performed. Other objectives for the ALM function may include:

- Demonstrating to internal and external stakeholders that the company is being well managed
- Minimizing capital requirements, especially RBC
- Determining how much interest should be credited to policyholders
- Determining impact on account items that have immediate impact on earnings

One complication that arises in RBC regimes, such as Solvency II, is that interest rate and market capital requirements interact with the capital arising from other risks when they are

¹⁴ While many insurance companies manage the interest rate risk associated with all the assets and all the liabilities, some of them do not care about the interest rate risk exposure of the surplus assets per se and manage the surplus account on a total return basis.



aggregated. Another complication is the increasing need to look at the future liability and capital requirements in the Own Risk and Solvency Assessment (ORSA), rather than simply looking at the current balance sheet.

3.1 Strategic Decision-Making Framework

In practice, some insurance companies execute ALM as a risk mitigation exercise where the goal is simply to keep the risk exposure within the specified risk limits. For other insurance companies the goal is not to eliminate or minimize risk, but to formulate ALM strategies to achieve the financial objectives subject to the risk tolerances and constraints.

The ALM definition presented in the previous section contemplates that ALM will be executed as a strategic decision-making framework to achieve financial objectives subject to risk tolerances and constraints.¹⁵

3.2 Multiple Bases¹⁶

The risk exposure can be measured on different bases. There is a wide range of practice within the insurance industry globally regarding the basis on which the risk should be managed. One of the first steps in defining the ALM objectives is to determine what interest rate risk to manage. Is it the interest rate risk associated with the long-term future cash flows, the market value of the assets and liabilities, the financial statement results (either accounting or statutory) or regulatory required capital?

3.2.1 Economic Basis

The fundamental objective of every insurance company is to ensure that the assets together with future reinvestment will be sufficient to pay out the liabilities under all but very extreme future interest rate scenarios. This ultimately is a question of the actual asset and liability cash flows that are realized in the future along with future reinvestment and disinvestment. Performing ALM on an economic basis seeks to measure and manage the reinvestment and disinvestment risk associated with a set of best estimate asset and liability cash flows. Since exact cash flow matching is rarely possible, performing ALM on an economic basis (as opposed to a market-value basis) involves measuring and managing the sensitivity of economic surplus (defined as the present value of asset cash flows minus the present value of liability cash flows) to changes in interest rates. Here, the goal is not to value the assets or

¹⁵ European regulatory framework Solvency II defines ALM explicitly as part of the risk management system (Article 44 of the Directive).

¹⁶ It is worth noting that contrasting between market value and economic value is somewhat contentious. Firms face multiple reporting bases that all claim to be market-consistent but differ in respects such as the definition of risk-free curves, allowance (or not) for illiquidity premiums in discount rates, treatment of contingent items such as future investment or new business margins, deferred tax assets, contractual service margins and so on. In other words, many insurers, particularly international insurers, face multiple conflicting reporting bases, but these are not easily classified as economic versus market versus accounting.



liabilities. The discount rate used to calculate the present value is often the risk-free rate that will result in a present value of assets greater than the market value of assets. Economic surplus should not be confused with economic value.¹⁷ It does not need to be reported and does not directly impact profits or capital. All that matters is that on the last liability payout date, economic surplus is not negative. Because of this, the interest rate risk exposure of economic surplus is not always managed in practice.

3.2.2 Market-Value Basis

While economic surplus and market value can both be thought of as economic measures, the present values of cash flows are actually calculated using different discount rates. An insurance company may be equally or more concerned about the risk exposure of the market value of the assets and liabilities than the reinvestment and disinvestment risk associated with the future cash flows, for a variety of reasons (e.g., merger and acquisition versus long-term going-concern perspectives).

3.2.3 Accounting and/or Statutory Basis

For many insurance companies, the primary financial objective is based on accounting results such as profit and loss (P&L) and/or net income under the applicable accounting standards. The interest rate risk exposure on an accounting basis refers to the risk of negative P&L or net income due to changes in interest rates.¹⁸

3.2.4 Regulatory Required Capital Basis

Capital efficiency and stability are important financial objectives. The interest rate risk exposure on a regulatory basis refers to the risk of decreases in the capital ratio as well as the risk of increases in volatility in the capital ratio due to changes in interest rates.

In general, it will not be possible to manage the risk exposure on all these bases perfectly. Insurance companies must choose on what basis the risk will be managed. Best practice is to measure the exposure on multiple bases and use this to inform decisions regarding risk/reward trade-offs.

A challenge for insurance companies that can threaten solvency, and the financial health of the company, occurs when there is a disconnect between the economic and accounting or regulatory results. Many insurance company executives will say that they are focused on the long-term economic value. However, they are reluctant to immunize the interest rate risk exposure on an economic basis (e.g., lengthening duration) when that creates losses on the financial statement basis used for accounting and/or regulatory reporting. In some situations,

¹⁷ "Economic value" has no universally unique definition.

¹⁸ International Financial Reporting Standard 17 (IFRS 17) Income Statement may be particularly affected by the discount rate methodology and, hence, an ALM approach focusing on IFRS 17 measurements needs to reflect the respective impact on the interest rate risk, which consists of both risk-free rate risk and credit spread risk.



such disconnects can encourage the whole industry to systematically take on interest rate risk.

The basis for managing interest rate risk will determine which yield curve¹⁹ should be used for calculating present values of cash flows and the various ALM metrics such as duration, convexity and so on.

One challenge facing insurance companies wishing to manage the economic risk exposure is that the very-long-term end of the yield curve may not be observable or be available for investment.

¹⁹ For example, government yield curve, swap curve, credit curve.



4 Scope

4.1 Sources of Risk

The scope of ALM varies from company to company. While historically, at least for the life insurance industry, ALM has been focused on interest rate risk management, there are many financial risks associated with the assets and liabilities, including liquidity risk, credit risk, market risk, currency risk and inflation risk. For some insurers, the scope encompasses most if not all sources of financial risk associated with the assets backing the liabilities.

4.1.1 Interest Rate Risk

Interest rate risk manifests itself in many ways, including:

- Market value risk associated with the market value of the assets and liabilities
- Economic risk associated with the present value of the asset and liability cash flows
- Accounting risk associated with the financial statement value of assets and liabilities

Ultimately the interest rate risk will be a function of the gains and/or losses on reinvestment and disinvestment of the actual cash flows that are realized in the future. This is what measuring the economic risk exposure by projecting best estimate cash flows and calculating economic surplus²⁰ seeks to capture. Best estimate cash flows may include investment expenses,²¹ expected asset defaults, margins for adverse deviation and future income taxes, depending on various considerations.²²

Risk limits for interest rate risk can be expressed in terms of duration,²³ cash flow match analysis and worst case²⁴ scenario testing.

²⁰ Economic surplus or excess assets equals the difference between the present value of the asset cash flows and the present value of the liability cash flows.

²¹ The level of investment expenses may also differ, depending on whether these already form part of the market value of assets and, hence, should be adjusted to avoid double counting. For Solvency II valuation purposes, the European Insurance and Occupational Pensions Authority (EIOPA) issued some general guidance in its Guidelines on Valuation of Technical Provisions, revised in July 2022. For Germany, the regulator BaFin further specified these requirements in July 2022 for German life insurers.

²² For example, whether the interest rate risk is managed on an accounting or economic basis, or whether income taxes are paid from the corporate surplus account or the assets backing the liabilities.

²³ In North America, “dollar duration” is commonly used. DV01 is also becoming increasingly popular in Europe, where Macaulay Duration is commonly widespread. For further definitions, see Appendix A.

²⁴ “Worst case scenario” refers to the scenario resulting in the largest loss for a given set of deterministic scenarios. These scenarios are typically defined by management and usually cover a range of “plausible” changes in the shape and level of the yield curve.



As part of the ALM strategy for life insurance companies, the net dollar duration exposure may be managed at a total company level, possibly including surplus assets. Risk limits may include:

$DD_A - DD_L$	<	X% of present value of assets
Partial duration sensitivity	<	Y% of present value of assets at all points along the yield curve
Worst case scenario	<	Z% of present value of assets

But even if a company were perfectly matched on both a first- and second-order basis (duration and convexity), this would not be sufficient to protect against non-parallel shifts in interest rates.²⁵ For example, it could be possible for an insurance company to realize the same loss from a 7 basis point tilt in the yield curve (short rates up 7 basis points, long rates down 7 basis points) as from a 100 basis point decrease across the yield curve. Companies wishing to protect against non-parallel changes in the yield curve would immunize on a partial duration²⁶ basis. However, even being perfectly immunized on a partial duration basis would not be sufficient to protect against interest rate changes where there are embedded options in the assets or liabilities and/or other interest-sensitive cash flows. Insurers wishing to protect against the interest rate risk associated with interest-rate-sensitive cash flows would either explicitly hedge the embedded option or immunize on an effective-duration and effective-convexity basis. Unfortunately, this too would not be sufficient to protect against all possible changes in interest rates. Other techniques, including stochastic simulation, VAR, economic capital and principal component analysis, will measure the extent to which all the multiple dimensions of the interest rate risk exposure are effectively managed. See Table 1.

In addition, these instruments can be used to set risk limits based on reasonable key performance indicators (KPIs) so that by reflecting the risk appetite there is only a limited (and therefore possibly cost-effective) need for hedging and immunization.

²⁵ If a company were perfectly matched on duration (i.e., first-order) basis, this would only protect against small parallel shifts in the yield curve. If a company were also perfectly matched on a convexity (i.e., second-order) basis, this would protect against larger parallel shifts in the yield curve.

²⁶ Key rate duration, which measures the exposure to changes in the zero-coupon bond yields or spot rates rather than the changes in market yields, is a similar metric that is also used.



Table 1: Risk Metrics Measure Multiple Dimensions of Interest Rate Risk

Risk Metric	1 st Order	2 nd Order	Point in Time	Over Time	Embedded Options	Large Changes	Non-Level Shifts
Duration	✓		✓				
Effective Duration (deterministic)	✓		✓		✓	✓	
Effective Duration (stochastic)	✓		✓		✓	✓	
Partial Duration	✓		✓				✓
Dollar Duration	✓		✓				
Convexity		✓	✓			✓	
Effective Convexity (deterministic)		✓	✓			✓	
Effective Convexity (stochastic)		✓	✓		✓	✓	
Partial Convexity		✓	✓			✓	✓
Dollar Convexity		✓	✓		✓	✓	
Deterministic Scenario Testing	✓	✓	✓	✓	✓	✓	✓
Stochastic Simulation	✓	✓	✓	✓	✓	✓	✓

4.1.2 Liquidity Risk

Liquidity risk is the exposure to the illiquidity of the assets and liabilities. An insurance company could have no interest rate risk exposure if all the assets and liabilities were held to maturity, but could be exposed to loss in the event that illiquid assets needed to be sold to



cover a demand liability or meet the mark-to-market cash flow requirements of a derivatives position.

Liquidity risk is managed by maintaining some level of liquid assets or cash so that liquidity risk exposure is not material or is tolerably low. This is commonly managed by the Treasury function.

4.1.3 Credit Risk

Credit risk is the exposure associated with the default of principal and/or coupon payments and/or the decrease in market value resulting from an increase in credit spread.²⁷

Credit risk can be quantified using a Basel approach (i.e., Probability of Default, Loss Given Default, Exposure at Default) or a “spread risk plus downgrade” approach. The former is usually applied for non-traded loans, while rated corporate and risky-government bonds are typically addressed using stress tests to spread curves and downgrade transition rates.

In addition to the risk of loss, there is also the impact on the interest rate risk exposure due to the impact on the cash flows. There are various approaches for taking into account the credit risk exposure in the asset cash flows. One approach is to adjust the cash flows for credit risk, if a best estimate is used for expected defaults. However, the present value of the resulting risk-adjusted cash flows discounted using a risk-free interest rate curve will tend to be greater than the market value of the instrument. If the adjustment to the cash flows is solved so that the resulting present value is equal to the market value, the cash flows will not reflect the actual expected asset cash flows. Another approach is to use an interest rate curve that reflects the credit spread for discounting. This will help ensure the present value of the cash flows equals the market value but ignores expected defaults in the cash flows. To the extent that the assets are matching liability cash flows, there is debate regarding how to adjust the cash flows for credit risk and take credit for the illiquidity premium.

The oversight of credit risk is sometimes a contentious issue for insurance companies. While the investment department has the expertise to analyze credit quality and credit risk exposure, a best practice is to have oversight of credit risk as part of the scope of ALM in order to ensure monitoring of the risk is independent from the area that is taking the risk.

4.2 Market Risk

A measure of market risk is the sensitivity of net assets to a stress test. For example, insurers may look at the effect of a 50% fall in stock markets, including not only the asset side but also any offsetting effect on valuation of participating liabilities. Many insurers regard interest rate risk as a subset of market risk. Market risk associated with equities and other NFI asset

²⁷ This latter item is a risk only if the asset would need to be liquidated before maturity. Credit risk is tied to liquidity risk and interest rate risk.



classes – especially when these asset classes are backing insurance liabilities – includes not just the exposure to losses in market value but also the mismatch risk associated with backing insurance liabilities with NFI assets. Market risk associated with variable products, including variable annuity or segregated funds, tends to be managed as part of an insurance company’s dynamic hedging program. In practice, these dynamic hedging programs tend to be separate functions and should be considered part of the overall scope of ALM.

4.2.1 Non-Fixed Income Assets Backing Liabilities

Many insurance companies, for example in Canada, back insurance liabilities with both fixed income and NFI assets. Backing insurance liabilities with NFI assets introduces mismatch risk arising from the market risk of the NFI assets and the interest rate risk associated with the liability cash flows. It can result in higher financial statement volatility or higher capital requirements, and reserves could be higher or lower. NFI assets may also introduce illiquidity risk as well (e.g., real estate, especially home offices). The expected return on NFI assets such as equities and real estate is generally thought to be higher than fixed income assets over the long run. However, it is critical for insurance companies to explicitly measure their exposure including the effect on capital, and have a strategy in place to appropriately manage this risk.

For any strategy involving NFI assets, accurate measurement of the interest rate risk exposure is complicated by the existence of NFI assets along with liability cash flows that may vary with interest rates and equity returns. The resulting exposure calculation is a function of the approximation methods and assumptions used. Companies need to take this into account when making ALM and trading decisions based on the duration of the assets and liabilities.

Some companies project cash flows for NFI assets corresponding to an assumed “buy and hold” strategy, and will rebalance and immunize the portfolio based on the resulting interest rate sensitivity that is calculated for these assumed fixed cash flows. Some companies have modelled real estate and equities as 30-year strip bonds with a fixed equity risk premium when calculating duration. While the value of equities has some correlation to interest rates, assuming that equities have a duration other than zero can be misleading and distort the duration results. Duration specifies the change in the price of an asset for a given change in interest rates. The change in the price of equities will not necessarily move in the direction predicted using duration.

Another practice is to assume NFI assets have no interest rate sensitivity (i.e., a duration of zero), model the cash flows as cash, and perform sensitivity analysis for various combinations of interest rate and equity return scenarios.

A third approach is to project the NFI assets and liability cash flows using a stochastic model that generates economic scenarios for all financial variables under question (e.g., yield curve, credit spreads, equity returns, real estate gains), and analyze the resulting risk distribution.



In contrast to notionally backing long-term liability cash flows with NFI assets, many life insurance companies in Canada explicitly carve out the long-term liability cash flows after a certain number of years and back these with real estate and equity assets. An immunization or other matching strategy is typically used for the shorter-term cash flows using fixed income securities.

4.2.2 Carve-Out Strategy

A carve-out strategy whereby the long-term liability cash flows after a certain number of years are carved out and backed with NFI assets will enable an insurer to explicitly measure and manage the risk exposure associated with using NFI assets to back insurance liabilities, and will enable the insurer to assess whether the company is comfortable with the associated mismatch and market risk to ultimately meet the future insurance obligations.²⁸

The first step in a carve-out strategy is to determine the carve-out point and/or amount of NFI assets. In general, one of the following methods is used.

In the first method, the carve-out point is determined first, immunization is performed up to the carve-out point and then the remaining amount of assets is invested in NFI securities.

In the second method, the amount of equities or other NFI assets is determined first (either as a dollar amount or percentage of assets); the carve-out point is then determined based on how many years of cash flows the fixed income and NFI assets can support, respectively; and finally, immunization is performed up to the carve-out point.

The amount of NFI assets backing insurance liabilities varies from company to company based on many factors, including impact on reserves and capital ratio, potential earnings volatility, and overall comfort with the amount of equity and interest rate risk being assumed. Once the desired amount of NFI assets is determined, some companies use a stochastic approach to determine the confidence level at which the current amount of NFI assets will be sufficient to provide for the present value of the long-term cash flows after the carve-out point.

In the first method described above, the carve-out point is typically determined by looking at the latest date where all of the liability cash flows up to that point can be effectively immunized using available fixed income assets. The remaining assets in the segment are then invested in NFI assets.

²⁸ This can be done using deterministic scenario testing or by performing a stochastic analysis for the NFIs backing the carved-out liabilities, projecting both NFI returns and interest rates under a large number of future return and interest rate scenarios. A shortfall measure can be used to determine the amount of NFI assets that would be required to meet carved-out liability cash flows under a variety of scenarios, and to measure the likelihood and severity of a shortfall. In addition to the ultimate risk of shortfall, companies need to also assess the volatility of the projected economic surplus for the carved-out assets and liabilities over key projection horizons, such as one and five years.



In the second method described above, the carve-out point is solved for based on the liability cash flows that can be immunized with the remaining amount invested in fixed income assets.

It is typical for the carve-out point determined above to be in the range of 30 to 45 years, depending on the amount of NFI assets and the liability cash flow profile.

A company using carve-out strategies can perform stochastic analysis to assess the sufficiency of its NFI assets to meet the long-term liability cash flows, as well as the ongoing risk associated with its allocation to NFI across various scenarios.

Under the Matching Adjustment (in European Solvency II valuations as well as Solvency UK) in which a portfolio of matching fixed income assets is carved out to meet annuity liabilities, the effect of the carve-out is a more generous allowance for illiquidity premiums.

4.2.3 Variable Annuities and Segregated Funds

Risks associated with guaranteed minimum benefits provided by variable annuities and segregated funds are often managed using dynamic hedging programs. The aim of dynamic hedging is to rebalance the hedge portfolio so that the sensitivity of the embedded options in the liabilities to changes in financial variables such as underlying stock price, implied volatility surface and term structure of interest rates is matched by the sensitivity in the hedge portfolio. This is done using price sensitivity metrics similar to those used in ALM related to interest rates called Greeks. See Appendix B for a definition of the Greeks.

4.3 Currency Risk

Currency risk associated with backing liabilities with assets in a different currency has usually been avoided. It generally is impossible to “completely” hedge this risk unless the liability duration is short. However, in the search for yield, insurers increasingly consider taking on this risk while attempting to hedge the foreign exchange rate risk as far as possible.



5 Governance and Framework

Governance is a vital part of effective ALM. Best practices with respect to ALM governance start with the organizational structure:

- The board and senior management demonstrate a strong commitment to ALM, are involved in it and actively promote a risk management culture.
- The ALM Committee has a senior composition and is a forum for strategic decision-making.
- The person responsible for ALM has the necessary professional expertise.
- There are adequate levels of resources and well-trained professionals dedicated to the ALM function.
- Roles and responsibilities are well defined with clear accountability for the ALM function.
- The ALM policy statement and procedures are well documented and approved by the board.
- There is measurement and monitoring of exposure; reports clearly communicate the risk profile that supports decision-making.
- Risk is consolidated at the total company level and understood by board and senior management.

5.1 Board of Directors

The board of directors is ultimately responsible for the risk management of an insurance company and ensures that key elements required for effective governance are in place, including an organization structure that supports the execution of ALM, a senior-level ALM Committee with a board-approved mandate, a board-approved ALM Policy with clearly defined roles and responsibility, risk limits and an ALM Conceptual Framework.²⁹ The board should also be satisfied that there is a strategic decision-making framework in place for ALM, and that suitable accountability is in place for any management decisions to take market views or interest rate bets.

For life insurance companies where ALM issues are material, boards of directors and other decision-makers of insurance companies need to be well educated on ALM. Simplistic yet popular duration-matching strategies are not enough to protect insurance companies writing long-duration contracts from the multiple dimensions of the interest rate risk exposure they

²⁹ In some jurisdictions, such as the European Union due to the Solvency II regime, the issuance of corresponding policies and guidelines by the management may even be mandatory.



face. This was illustrated by the recent fall in interest rates leaving insurance companies that were perfectly duration-matched offside regarding their risk limits due to large convexity³⁰ exposure. Other life insurers who thought they did not have interest rate risk found themselves having to explain to equity analysts why they had such a loss due to interest rates when rates barely moved. Insurers with significant portfolios of poorly hedged variable annuities or segregated funds with guarantees found that the size of their in-the-money guarantees during the 2008 global financial crisis posed a significant risk to their financial position. In these conditions, the role of ALM is more important than ever, to provide effective decision support.

5.2 ALM Policy

The ALM Policy that is reviewed and approved annually by the board is an important governance tool for the board.

5.2.1 ALM Conceptual Framework

This forms part of strong governance for the ALM function. Insurance companies who try to execute ALM without having a formal framework in place lack a proper decision-making framework to manage the risk exposure and may position themselves in an unintended direction.

Financial objectives, risk tolerances and constraints define the conceptual framework for ALM. This is part of a strategic decision-making framework in which ALM serves as a tool to achieve the organization's financial objectives subject to its risk tolerances and constraints.

5.2.2 Financial Objectives

Each insurer will have its own unique financial objectives. It can then seek to maximize (or minimize) these subject to various measures of risk or other bases. This produces a set of efficient frontiers showing the risk/reward trade-offs between the various financial objectives and bases. Companies can then see what the cost is on P&L of reducing their interest rate risk exposure on an economic basis, for example.

Some examples of financial objectives include maximizing shareholder wealth, economic value, embedded value, earnings, statutory/regulatory surplus, Risk Adjusted Return on Capital (RAROC), Return on Equity (ROE) and future earnings. Many insurers use VAR (or other RBC measures) as a denominator for assessing return on capital. That provides an incentive for managers to reduce RBC requirements so that each dollar of profit is reported as a higher percentage return on capital.

One of the key considerations in selecting the appropriate financial objectives is the balance between economic and accounting results (both regulatory accounting and Generally

³⁰ See Appendix A for a definition of convexity and other technical terms.



Accepted Accounting Principles/Practice [GAAP] accounting). This distinction becomes more important the more divergence there is between economic accounting and GAAP/regulatory accounting. Focusing on economic reality (i.e. the actual cash flows) ensures that the organization will ultimately realize superior earnings in future (on any basis). This tends to be a long-term focus. Focusing on accounting results, on the other hand, tends to be a short-term focus. However, these are the results that get reported to shareholders, policyholders, rating agencies, analysts and regulators.

Arguments against focusing on the long-term economic results include:

- Future long-term economic earnings may not be realized due to forced actions caused by violating regulatory or rating agency constraints.
- Economic results depend on future projections that may not be reliable; economic valuations may be more susceptible to speculative assumptions than accounting valuations.
- Long-term interest rates used to discount long-term liability cash flows may not be observable.

Arguments against focusing on the accounting results include:

- This involves a short-term focus.
- Accounting treatment and emergence of earnings may mask interest rate risk and other financial risks.
- Changes to accounting rules may give a very different financial picture and risk exposure.
- Focusing on accounting results can run counter to capital objectives in some regimes.

ALM strategies are formulated to achieve the financial objectives that are specified. It is possible to have more than one financial objective.³¹ A risk-adjusted measure would ensure the financial objectives are defined relative to the amount of risk assumed.

5.2.2.1 Risk Tolerances

Financial institutions such as insurance companies are in the business of assuming risks. In general, only those risks that help the company achieve its financial objectives and for which the company is fairly compensated should be assumed (e.g., if the risk profile is desirable). All other risks should be eliminated or minimized to the extent possible.

³¹ For example, the Minimum Requirements under Supervisory Law on the System of Governance of Insurance Undertakings issued by German supervisor BaFin explicitly require that both the economic and accounting perspectives be taken into account in the ALM objective.



Risk for the insurer is the exposure of its stated financial objectives to changes in financial or other variables. For example, interest rate risk for a company whose financial objective is to maximize economic value is the exposure of that economic value to a change in interest rates. This is also the case when the financial objectives are based on accounting measures, except that the economic impact of a change in a financial variable may be masked or altered by the accounting rules.

The company's risk tolerance is used to establish specific risk limits for each material financial variable. These risk limits should be defined in terms of appropriate risk metrics and analyses that properly capture the true risk exposure on the desired basis (i.e., economic or accounting).

There may be times when an insurer may find itself in breach of these limits; for example, if the cost of eliminating or minimizing an existing risk is too great (e.g. locking in a loss, hedging when implied volatility is trading high) compared to the risk exposure. The board of directors may hereby temporarily issue waivers to individual limits. These should then be specially monitored as part of the ALM. Any breaches or potential breaches of risk limits should be accompanied by appropriate communication with involved supervisors.

5.2.2.2 Constraints

In addition to an insurer's risk tolerances, there may be a number of internal or external constraints that must be considered (e.g., minimum capital ratio, maximum volatility of earnings, various investment guidelines, debt covenants³²).

5.2.2.3 Surplus Management Philosophy

Depending on the ALM objectives, not all assets and liabilities will be included in managing the interest rate risk and/or will be treated differently. In some cases, only general account assets and liabilities are included for purposes of ALM. Separate account assets and liabilities such as segregated fund and variable annuities are managed separately³³ and have separate hedging programs. Some insurance companies include all assets backing interest-bearing liabilities only. Aside from these two decisions, insurance companies must decide whether the interest rate risk that will be managed is:

1. The interest rate risk associated with only the assets backing the liabilities,
2. The total interest rate risk that the company is exposed to including all the assets; that is, including surplus assets, and/or

³² Debt covenants may be triggered by regulatory accounting results that are not severe enough to cause regulator action.

³³ Segregated funds and variable annuities are not always managed separately. Some insurers have internal hedging arrangements to reduce external hedging costs.



3. The interest rate risk associated with the capital requirements.

Many insurance companies manage the interest rate risk associated with the assets backing liabilities only and manage surplus on a total return basis; that is, any interest rate risk exposure associated with the surplus assets is ignored. A key ALM question for all insurers is the treatment of net assets (i.e., surplus) as final cash payments will be higher or lower than the estimate, and new/renewal business may lead to payments higher than premium income for some period. Some insurers do not segment their assets and have one asset portfolio. In this case, the interest rate risk associated with fixed income assets relative to the liabilities is managed. Other objectives/metrics are used to manage NFI assets.

There are two ALM issues that arise in practice that relate to the surplus management philosophy of the company: (1) how to treat excess assets³⁴ and (2) what to do with margins for adverse deviations/risk adjustment that are not in the best estimate cashflows but are included in the projected liability cash flows for valuation purposes.

Some companies implement ALM by requiring that the market value of assets equal the policyholder liabilities in each segment (and do not allocate required surplus to the lines of business). In this case, the present value of the asset cash flows will generally be greater than the present value of the liability cash flows.³⁵ These excess assets in the line of business represent economic surplus. If the strategy is to match the modified duration of the assets and liabilities, the economic surplus in the line will be exposed to changes in interest rates.³⁶ On the other hand, if the strategy is to match the dollar duration of the assets and liabilities, the present value of the assets and liabilities will change by the same absolute amount for a given change in interest rates and the economic surplus will be immunized. This approach has been described as equivalent to immunizing the present value of assets that are equal to the liabilities and investing the excess assets (or economic surplus) in cash (i.e., with a duration of 0).³⁷

The surplus management philosophy becomes an important driver of how interest rate risk will be managed. Appendix C provides an example illustrating this.

³⁴ “Excess assets” or “economic surplus” equals the difference between the present value of the asset cash flows and the present value of the liability cash flows. Excess assets may also be derived net of capital requirements.

³⁵ This is because the risk adjustment under IFRS 17 is a non-cash flow item.

³⁶ This is because the present value of the assets and liabilities will change by the same percentage amount when their (modified or Macaulay) durations are the same. Since the present value of the assets is greater than the liabilities, the assets will experience a greater change in absolute terms.

³⁷ Because of the shape of the yield curve, investing the assets in a lower average duration may result in a higher yield since the yield to maturity (YTM) of a 30-year bond is lower than the YTM of a 25-year bond, for example.



The European Solvency II regulations adopt a whole-balance-sheet approach. This removes any discretion in hypothecating certain assets to certain liabilities, and risky assets attract a capital charge even if they form part of surplus.

5.2.3 Organization Structure

Within an insurance company, where ALM resides is often a function of the organizational structure, the expertise of personnel and what area of the company they work in. It is not uncommon for the ALM function to reside within Actuarial, Investments or Finance or to report to the Chief Risk Officer.

5.2.4 ALM Committee

Some insurers have a formal, board-approved, ALM Committee Mandate that sets out the terms of reference for the committee, which in many cases includes oversight for the risks associated with the assets and liabilities.

5.2.5 Roles and Responsibilities

The ALM process often requires the cooperation of different departments (e.g., Risk, Treasury, Actuarial, Investment). A best practice for insurers is having clearly defined roles and responsibilities in respect of ALM. This also includes ensuring that the cooperation and deliveries of all departments involved are clearly communicated.

5.2.6 Documentation and Reporting

The ALM process is an important tool for identifying, analyzing and managing risks arising from the interaction and (potential) mismatches between an insurer's assets and liabilities. The output can have far-reaching consequences for a company's business and risk strategy. For this reason, an effective internal control system should be implemented in addition to the definition of procedural and organizational requirements. The respective documentation should be maintained and kept up to date.

For decision-making purposes, a report should be available on a regular basis in accordance with the frequency of the ALM assessments that includes the relevant key figures and key underlying assumptions. In addition, a comprehensive report should be prepared at least once a year for model-based valuations, in which the model and uncertainties in the valuation are also addressed. As the addressees of the report may be non-actuaries, the language must be suitable for those making decisions. Actuaries may be guided by the requirements of International Standard of Actuarial Practice 1 (ISAP1).

5.3 Asset Management within an ALM Framework

It is not uncommon within insurance companies for internal conflicts to arise between the execution of ALM and asset management when assets are managed separately, and the portfolio manager's performance is measured against a benchmark. Executing an ALM



strategy to achieve the financial objectives or performing a risk optimization can be met with resistance, and the role of the asset manager versus ALM will be called into question. Many life insurance company CEOs have expressed frustration that, despite having highly skilled investment managers who successfully achieve investment objectives, outperform benchmarks, and stay within specified risk limits and constraints, those managers' actions inadvertently erode value. Specifically, the increase in actuarial reserves often exceeds the growth in investment income, ultimately compromising the company's financial goals.

There are two general approaches used in the insurance industry to manage insurance company assets. One approach is to manage the assets separately against a benchmark within specified risk limits to achieve a specified investment objective. In the other approach, asset management is executed within an ALM framework. ALM drives the investment process. The assets are managed directly against the liability cash flows rather than a benchmark in such a way as to achieve the financial objectives rather than the investment objectives. For some companies, especially general insurers, the ALM process may also include liquidity targets (for both the simplistic approaches and the more sophisticated approaches).



6 Measurement of Risk Exposures

6.1 Interest Rate Risk Metrics

Interest rate risk metrics for longer-duration portfolios include various duration and convexity measures that capture the first- and second-order sensitivity of the present value of the asset and liability cash flows to changes in the level of interest rates, the shape of the term structure of rates and the corresponding sensitivity of the cash flows to changes in interest rates. These metrics may or may not correspond to the interest rate risk exposure the financial institution wishes to manage. Typically, these metrics are also often used to determine KPIs for setting limits in order to take risk tolerance into account. Appendix A provides a description of various interest rate risk metrics used in ALM.

These risk metrics are entirely interest-rate-risk-focused. Scenario testing and stochastic analysis are used for other market risks.

6.2 Scenario Testing

In addition to risk metrics, deterministic scenarios are used to measure the impact of either (1) an instantaneous shock to the yield curve or other financial variable,³⁸ or (2) a change in interest rates or other financial variable over time – along with the impacts of other aspects of the scenario, and in particular their capital impacts.

6.3 Stochastic Analysis

Stochastic simulation is used to generate a risk distribution for the assets, liabilities and capital requirements, using stochastically generated scenarios for interest rates, equity returns and other financial variables.

6.4 Decision Support

ALM is a powerful tool to help run an insurance company. Beyond risk mitigation, ALM can provide valuable decision support to help insurers determine whether they are taking an appropriate amount of risk and whether they are sufficiently compensated for the risk they are taking. Ensuring that the portfolio is risk-efficient is the first step. A portfolio is said to be risk-efficient if the financial objective is maximized for the level of risk taken. The next step is to assess whether the level of risk is appropriate. The amount of risk taken needs to be consistent with the insurer's risk appetite. Taking too little risk may be inconsistent with the risk capacity and risk strategy of the company.

It is important for an insurer to know how much a particular ALM strategy and/or risk limits is/are costing. A horizon-matching strategy whereby cash flows are matched for the first 10 or

³⁸ In some jurisdictions, asset and interest stress tests are also part of the regulatory instruments, so the ALM function may provide support here.

15 years may be taking on more risk and giving up more yield than an immunization strategy that is less constrained.

But even if a risk is within an insurer's risk appetite, it may not be advisable if the insurer is not being compensated for the amount of risk taken. ALM can quantify how much additional income/value can be added for some measure of additional risk.

Insurance companies have a choice in how they implement ALM. It can be implemented primarily as a risk mitigation function. Alternatively, ALM can be executed as part of a strategic decision-making framework by formulating ALM strategies to control risk and achieve the company's financial objectives (see Figure 1).

ALM plays an important role in the derivation of the strategic asset allocation (SAA). This is particularly relevant for life insurance policies where future claim payments depend on the performance of the investments (e.g., participating business). Under supervisory regimes such as the European Union's Solvency II, the SAA is therefore a key input for the valuation of future obligations and is included in the determination of the best estimate liability and the solvency capital requirement. Accordingly, detailed documentation should be maintained to prove that the derivation of the SAA is appropriate.

Figure 1: ALM Executed as Part of a Strategic Decision-Making Framework





7 Execution of ALM Strategies

Most ALM strategies will involve rebalancing of the asset and/or hedge portfolio as needed. Rebalancing can be performed as frequently as daily in real time or as infrequently as monthly or quarterly. The objective of periodic rebalancing is to ensure that the risk exposure associated with the assets backing the liabilities is kept within some target or risk limit. There are transaction costs associated with buying and selling assets, which are sometimes taken into account when deciding how frequently to rebalance the portfolio. Hedging costs are also a function of rebalancing. Delta hedging, for example, is a “buy high, sell low” strategy whose cost stems from the realized volatility and frequency of rebalancing. In periods of illiquidity, it may be difficult or expensive to rebalance as required. The accounting and tax treatment of realized gains and losses often influences rebalancing decisions.

7.1 Segmentation

Portfolio segmentation³⁹ is used to explicitly back a block or segment of liabilities with certain assets. Small life insurers often have either a single portfolio or two portfolios with one dedicated to surplus assets. This can be helpful for profitability measurement and pricing. As noted above, not all general insurers have multiple segments.

Segmentation is suboptimal from an ALM perspective. In the early days of ALM implementation, many North American life insurance companies started by immunizing certain lines of business separately. While they increased in sophistication and succeeded in reducing the interest rate risk exposure on those lines of business, they actually increased the interest rate risk for the company overall as the interest rate risk exposure that was eliminated was offsetting the interest rate risk of another line of business. A best practice is to aggregate risk exposures and manage at a total company or group level.⁴⁰

Comprehensive portfolio segmentation of assets and liabilities can be operationally complex, and therefore is an important consideration in developing the ALM approach.

It should be noted that in some countries, regulations impose segmentation regarding, for example, statutory funds, with-profits funds or other ring-fenced funds.

7.2 Dedication and Horizon Matching

Dedication and horizon matching are both forms of cash flow matching strategies. Insurance companies project the liability cash flows and, usually working backwards, find bonds with maturity and coupon payments to match the projected liability cash flows. Complete cash flow matching is not possible for portfolios with long-duration liabilities. Some insurance

³⁹ Insurance companies may have notional asset segments for ALM purposes.

⁴⁰ Although aggregating and managing at a total company or group level is optimal, where there is a need to allocate profits between notional segments and/or avoid subsidization, risk transfer pricing can be used.



companies will match cash flows within some tolerance level over some shorter-term horizon period, such as five or 10 years.

7.3 Immunization

For life insurance companies, the concept of ALM has been around since the 1950s, when Frank Redington wrote his seminal paper on immunization theory. The basic principle was that if what insurance companies were most interested in was protecting economic surplus, then it was not necessary to exactly match the asset and liability cash flows. For general companies in the US there was no concern regarding interest rate risk until the late 1970s, when rates increased drastically after a long period of relative stability. Many insurers before then had longer asset durations than liability durations to take advantage of higher yields.

7.4 Portfolio Replication

A replicating portfolio is a portfolio of capital market instruments that seeks to replicate either the cash flows or market value of the liabilities for a given set of stochastic scenarios. Instead of re-running an insurer's actuarial models to project the liability cash flows, the replicating portfolio is used as a proxy to predict the change in the value of insurance liabilities under different economic conditions. The goal is for the replicating portfolio to equal the value the liabilities would have under a wide range of economic conditions. If close replication is achieved, then an estimate for liabilities can be calculated more quickly under changing market conditions, stress testing or other deterministic scenarios. The behavior of insurance liabilities will be easier for investment managers to understand and the insurer will avoid the need to re-run actuarial models and will dramatically improve the speed of calculations.

7.5 Carve-Out Strategy

The extent to which mismatch risk can be mitigated depends on the available assets as well as the reliability and accuracy of the projected future liability cash flows. Increasingly, following the quest for yield, insurers are using alternative NFI assets⁴¹ to increase the expected return of the assets backing the liabilities. A robust ALM framework will allow companies to understand how best to reach their financial objectives and maintain portfolio risks within set limits given the assets available.

7.6 Interest Rate Swap Overlay

Interest rate swaps are an effective tool to execute ALM strategies and facilitate risk optimization of a portfolio.

⁴¹ This is not the case for general insurers in the US, as equity investments are usually restricted to a fraction of the insurer's equity. Use of equities may be a function of the available asset markets in the subject currency. Equity investments are more common in the US general insurance market for mutuals and others without ready access to capital markets – hence not because of the liabilities.



An interest rate swap overlay can be used to adjust the interest rate risk exposure and extend the duration beyond what could be achieved using cash assets.

7.7 Reinsurance

Reinsurance is used by some insurers to manage the risks associated with both the liabilities and the corresponding assets. This particularly holds where investment risk is included in the risk transfer (e.g., for asset-intensive reinsurance).

7.8 Dynamic Hedging

Dynamic hedging is particularly important for variable annuities and is also used in Europe to hedge costs of guarantees in profit-sharing funds.

7.9 Taking Market Views

Many insurers have made a management decision not to lengthen an asset portfolio that has a duration shorter than the duration of the liabilities. One reason for this is that the insurer is taking a view on the market and does not want to lock in rates in a low-interest rate environment. In some cases, companies have taken large interest rate bets with no accountability surrounding the decision. One best practice is to measure the gains or losses that result over time from taking any market view/interest rate bet and report this at each ALM Committee meeting.

7.10 Risk Optimization

Many insurance company portfolios may be risk-inefficient. Financial objectives are not maximized for the amount of risk being taken. In some cases, financial objectives are not well defined. As a result, it is not clear what risk should be managed.

A portfolio is risk-efficient if the financial objective is maximized for a given level of risk and set of constraints. Table 2 illustrates three ways to optimize a portfolio.

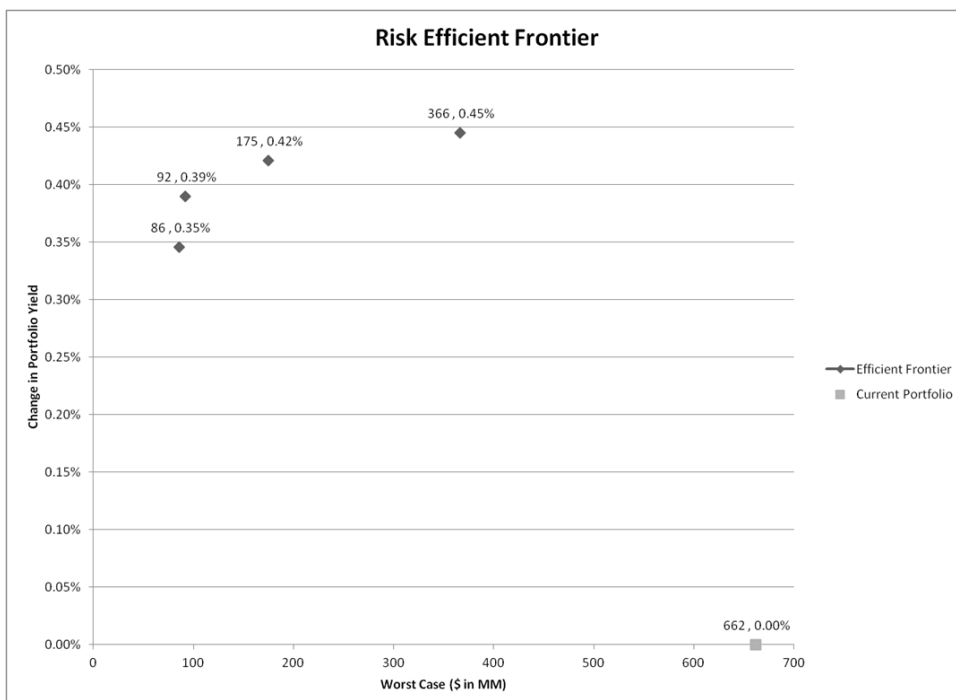


Table 2: Three Ways to Optimize a Portfolio

Optimization Basis	Object	Value Added
Asset Mix	Expected Return	<ul style="list-style-type: none"> Actual return not necessarily maximized High dependency on assumptions Mismatch risk
Credit Spreads	Portfolio Yield	<ul style="list-style-type: none"> Credit risk premia front-ended No “free lunch” – higher credit risk taken in order to get higher yield
Yield Curve	Portfolio Yield	<ul style="list-style-type: none"> Yield maximized on default-free basis Real value added

Figure 2 illustrates the risk efficiency frontier of an insurance company. The frontier measures the increase in portfolio yield above the current portfolio for various levels of risk. Risk can be measured using CTE, VAR, worst case loss and so on. The current portfolio is shown using the gray box.

Figure 2: Risk Efficiency Frontier





In the example above, the insurer can decrease aggregate risk (in this case the worst case scenario) from 662 million to 366 million and increase portfolio yield by 45 basis points. This is accomplished by buying and selling government bonds. Alternatively, an interest rate swap can be used. In either case, the rebalancing is done on a credit-neutral basis.



Appendix A – Interest Rate Risk Metrics and Analytics

This section defines risk metrics and analytics used in measuring the exposure to interest rate risk.

Macaulay duration is the time-weighted present value of cash flows divided by the present value of the cash flows. Macaulay duration gives an indication of the interest rate sensitivity of the present value of a future stream of cash flows, but is rarely used in practice.

Modified duration provides a provides a measure of the interest rate sensitivity in percentage terms of the present value of a series of fixed cash flows assuming a level term structure for a parallel change in interest rates. For example, if the modified duration of an asset is 10, then for a 1 basis point increase in interest rates the market value of the asset will decline by approximately 0.1%. Modified duration can be calculated by dividing Macaulay duration by $1 + i^{(n)} / n$, where n is the compounding frequency.

Effective duration provides a measure of the interest rate sensitivity in percentage terms of the present value of a series of interest-rate-sensitive cash flows assuming a parallel shift in the yield curve. Effective duration can be calculated by shocking the yield curve up and down by some change in interest rates, projecting the cash flows under the shocked yield curves and using a central difference approximation.

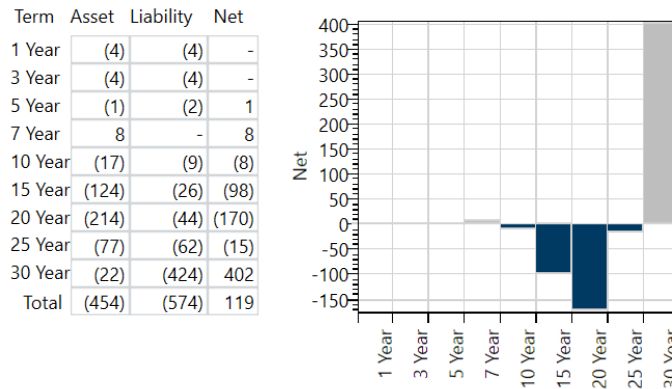
Dollar duration provides a measure of the interest rate sensitivity in dollar terms of the present value of cash flows for a parallel change in interest rates. For example, if the dollar duration of assets is \$100,000,000 greater than the dollar duration of liabilities, then for a 1 basis point increase in interest rates for all terms to maturity across the yield curve, the present value of assets will decrease by approximately \$10,000 more than the present value of liabilities.

Partial duration provides a measure of the interest rate sensitivity in percentage terms of the present value of a series of fixed cash flows for a change in the yield for a given term to maturity. Partial duration is calculated by partitioning the yield curve by term to maturity and for each term to maturity shocking the yield to maturity up and down, linearly interpolating to the next term to maturity and the prior term to maturity. Any interest rate sensitivity in the cash flows can be captured in the partial duration calculation by using a central difference approximation.

The partial duration sensitivity analysis shown in Figure 3 measures the impact on economic surplus for a 1 basis point change in interest rates at each term to maturity along the term structure. This is a valuable tool as interest rates seldom move in a parallel fashion.

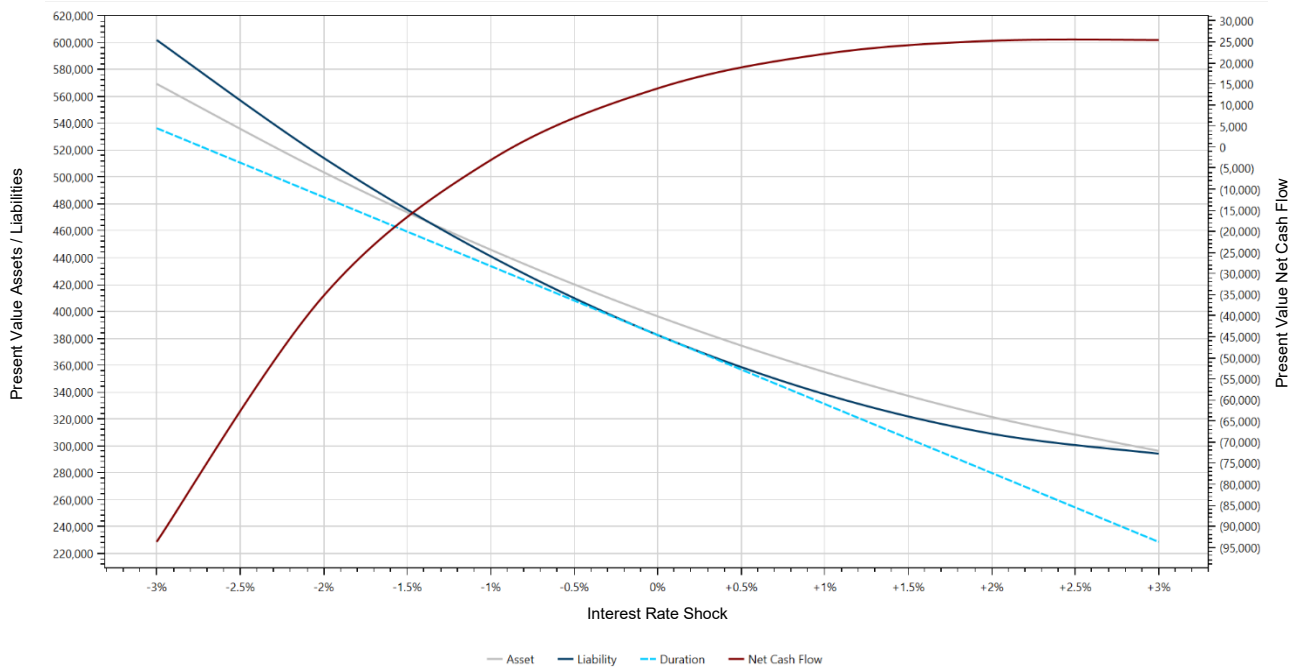


Figure 3: Partial Duration Sensitivity Analysis



Convexity measures the rate of change of duration. Duration only provides an approximation of the price sensitivity to changes in interest rates. The precision of the approximation deteriorates as the change in interest rates increases. Including convexity improves the approximation. In general, assets with greater convexity are more desirable than assets with less convexity. This is because as interest rates decrease, the increase in the market value of the assets increases at a faster rate (see Figure 4). Conversely, as interest rates increase, the decrease in the market value of the assets decreases. It is therefore desirable to have assets that have higher convexity than the liabilities. Convexity is a second-order sensitivity measure of changes in interest rates. It is the rate of change in duration for a change in interest rates. In general, duration provides a good first-order approximation to a small parallel shift in the yield curve. As the change in interest rates increases, duration will understate the increase in present value of cash flows as rates decrease, and overstate the decrease in present value of cash flows as rates increase. Positive convexity results in a higher present value of cash flows than duration alone would predict for an increase or decrease in rates. Negative convexity results in a lower present value of cash flows than duration alone would predict for an increase or decrease in rates.

Figure 4: Convexity Exposure



Scenario testing involves measuring the sensitivity of economic surplus to both parallel and non-parallel yield curve shifts both at a point in time and out into the future. Deterministic scenario testing is a valuable tool to analyze “what if”-type scenarios (see Table 3).

Table 3: Deterministic Scenario Testing

Change in PVCF	Assets	Liabilities	Net
Parallel Shift + 50 bps	(21,732)	(23,815)	2,083
Parallel Shift - 50 bps	23,753	27,458	(3,705)
Flattening to 15Y rate	2,402	3,571	(1,170)
Flattening (short + 50 bps)	(7,773)	(2,557)	(5,216)
Steepening (short - 50 bps)	8,144	2,665	5,480
Steepening (long + 50 bps)	(14,423)	(21,590)	7,167
Inversion (+ 100 / - 50)	15,187	23,948	(8,761)
Steepening (- 50 / + 50)	(14,884)	(21,495)	6,611

B.

Worst case loss refers to the largest loss observed in the scenario testing. Many insurance companies use this to set risk limits on economic, accounting or regulatory bases.

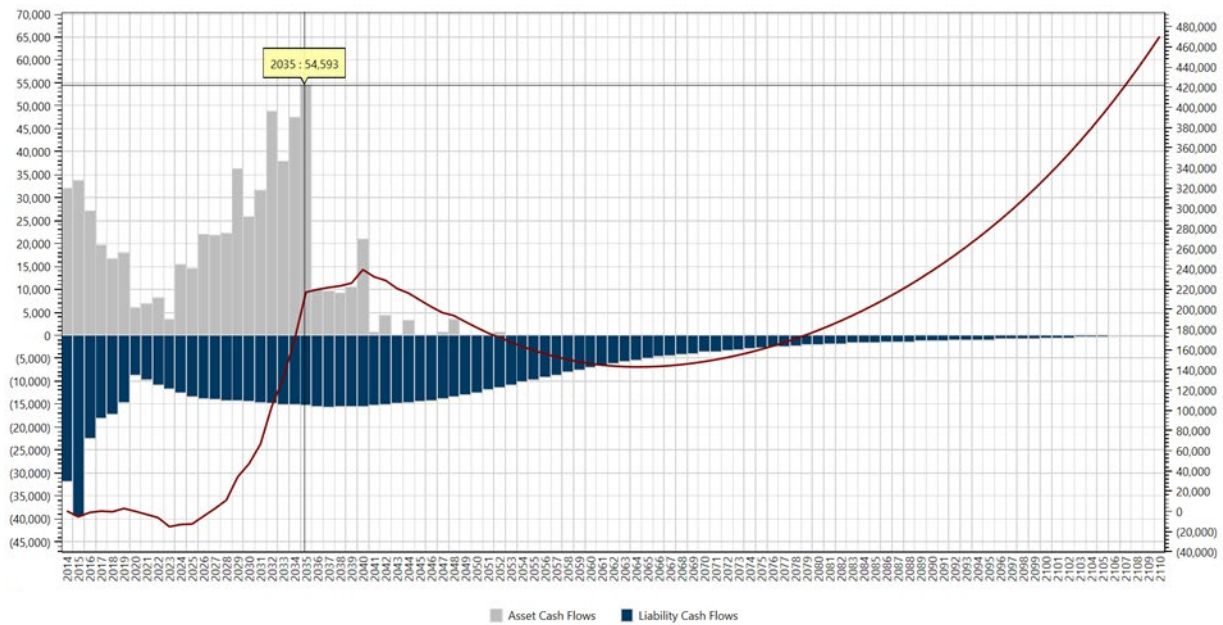
Conditional tail expectation measures the expected value of losses beyond a given percentile. For example, CTE (95) calculates the average of the worst 5% of losses. CTE provides a more comprehensive view of risk by considering the fatness of the tail.

Value at risk measures the maximum loss over a specified time period for a given confidence interval. For example, a 1-month VAR of X at a 95% confidence level means there is a 95% probability that the loss will be no more than X over a 1-month period.

Cash flow analysis examines how well matched the asset and liability cash flows are, and provides insight into the liquidity exposure.

Net cumulative cash flows (see Figure 5) can also be studied after reinvestment under different interest scenarios.

Figure 5: Net Cash Flow





Appendix B – The Greeks

The Greeks are price sensitivity metrics, similar to those used in ALM for interest rate risk.

	Greeks Measure Sensitivity With Respect To			
	Spot Price (S)	Volatility (v)	Risk Free Rate (r)	Time to Expiry (t)
First Order	Delta	Vega	Rho	Theta
Second Order	Gamma	Vomma	Rho Convexity	
Third Order	Speed	Ultima		

	Second Order And Cross Greeks			
	Spot Price (S)	Volatility (v)	Risk Free Rate (r)	Time to Expiry (t)
Delta	Gamma	Vanna DdeltaDvol	DdeltaDr	Charm DdeltaDtime
Vega	Vanna DvegaDspot	Vomma	DvegaDr	DvegaDtime
Rho	DrhoDspot	DrhoDvol	Rho Convexity	DrhoDtime



Appendix C – Surplus Management Philosophy

Consider a company that matches the modified duration of the assets and liabilities. This strategy exposes economic surplus to interest rate risk. Figure 6 shows how an increase in interest rates of 1% results in the same percentage change in assets and liabilities and a resulting decrease in economic surplus from 10 to 7.5 due to the excess present value of assets backing the liabilities.

Figure 6: Immunization on a Modified Duration⁴² Basis

	Book Value	Present Value	Modified Duration
Assets	100	105	25
Liabilities	100	95	25
Difference	0	10	0

A 1% increase in interest rates results in a 2.5 decrease in economic surplus

	Book Value	Present Value
Assets	100	78.75
Liabilities	100	71.25
Difference	0	7.5

A company wishing to immunize economic surplus would immunize on a dollar duration⁴³ basis. Figure 7 shows how an increase in interest rates of 1% results in the same dollar change in assets and liabilities and therefore no change in economic surplus.

⁴² Modified duration measures the first-order sensitivity of the present value of cash flows to a change in interest rates.

⁴³ Dollar duration equals the modified duration times the present value of the cash flows.



Figure 7: Immunization on a Dollar Duration Basis

	Book Value	Present Value	Modified Duration	Dollar Duration
Assets	100	105	22.6	2375.0
Liabilities	100	95	25.0	2375.0
Difference	0	10	-2.4	0.0

A 1% increase in interest rates results in no change in economic surplus

	Book Value	Present Value
Assets	100	81.25
Liabilities	100	71.25
Difference	0	10

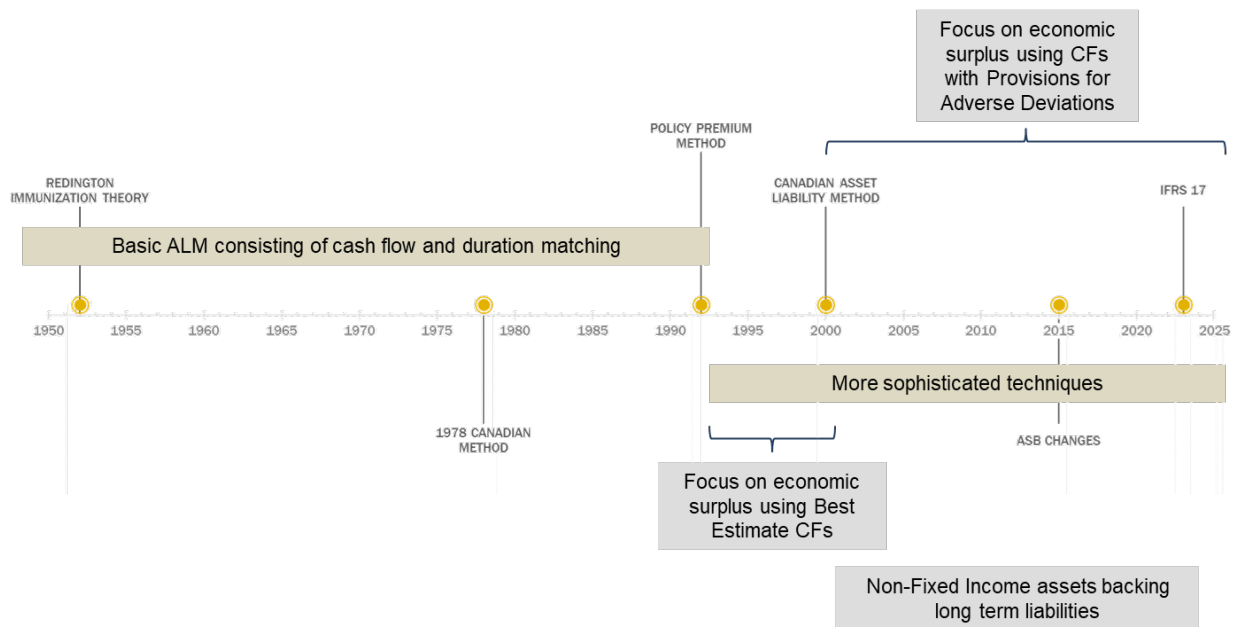
The reader may be tempted to observe that immunizing on a dollar duration basis is equivalent to investing economic surplus or excess present value of assets in cash or some other asset with duration zero, and question whether that is how surplus should be invested. In fact, depending on the shape of the yield curve and the asset liability profile, immunizing on a dollar duration basis in this example could increase portfolio yield. But the underlying question remains, what should the modified duration of surplus be?

Insurance companies are exposed to significant interest rate risk that has multiple dimensions. As we saw in the example above, immunizing on a duration basis is not sufficient to protect economic surplus against a change in interest rates if the present value of assets is greater than the present value of liabilities. Immunizing on a dollar duration basis is also not sufficient. Many life insurance companies with long-duration liabilities were immunized on a first-order dollar duration basis but had negative convexity exposure. As a result, they were not protected against large changes in interest rates. As interest rates fell, these companies found themselves outside of their board-approved risk limits as the duration of the liabilities increased at a greater rate than the duration of assets.

Appendix D – Evolution of ALM Practices

Interest rate risk remains a significant challenge for many insurance companies with long-duration liabilities (see Figure 8).

Figure 8: Historical Timeline for Life Insurance Companies in Canada





IAA Risk Book Chapter

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