October 2023

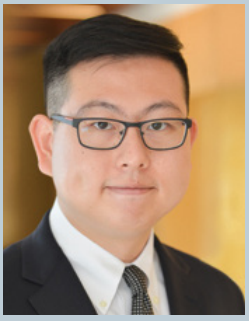
TOPIC OF FOCUS: **INVESTING**

A Consistent Approach for Insurers

Constructing Fixed-Income Portfolios for Asset-Liability Management

Our model provides insurers with a consistent framework to assess potential mismatches between assets and liabilities over long time horizons. We translate generic interest-rate and credit-spread assumptions from actuarial liability scenarios into specific risk factor shocks that impact portfolio securities. This enables us to project default-adjusted cash flows and market values for insurance portfolios under those scenarios. By aligning assumptions for assets and liabilities, our model offers insurers an invaluable tool to optimize portfolio construction and risk management.

Roberto Apelfeld, PhD
Manager of Pacific Rim Portfolio Risk & Head of Client Solutions



Eddie Wang, CFA
Client Solutions Analyst

KEY TAKEAWAYS

- Our asset-liability model is built upon the foundation of consistent assumptions for both assets in portfolios and our clients' liabilities.
- If interest rates and credit spreads change significantly, the value of an insurer's investments may fluctuate in adverse ways, possibly impacting the ability to meet contractual obligations.
- We use Maximum Likelihood Estimation procedures over the time horizon to propagate general interest rate and credit spread changes to specific risk factors that a portfolio is exposed to.
- Our framework offers projections of default-adjusted cash flows and market values for insurance fixed-income portfolios within forward-looking scenarios spanning long time horizons.
- By establishing a consistent connection between the generic actuarial assumptions regarding interest rates and credit spreads commonly employed by actuaries and the asset-specific risk factors that drive portfolio behavior, our model enables portfolio managers to construct portfolios within an asset-liability mismatch risk-aware mindset.

A Consistent Approach for Insurers

Constructing Fixed-Income Portfolios for Asset-Liability Management

By Roberto Apelfeld, PhD, Eddie Wang, CFA

"By integrating assets and liabilities within a single framework, we eliminate the inconsistencies that can arise when managing assets against insurance liabilities using separate models."

Introduction

Western Asset has dedicated considerable efforts and resources toward managing insurance assets. With our extensive expertise and experience in the insurance sector, we have a deep understanding of the unique challenges and requirements insurers face. This specialized knowledge positions us as a trusted partner for insurers seeking to optimize their investment strategies and effectively navigate the complexities of the insurance landscape. Our commitment to providing tailored solutions and delivering exceptional services led to the development of several tools dedicated to better serve our insurance clients.

In this paper, we provide a comprehensive overview of our approach[1] for conducting consistent ALM through scenario analysis, tailored to support the construction of insurance fixed-income portfolios. Actuarial scenarios designed to understand policyholder behavior under different environments are extended to assets, and both liabilities and securities respond to implicit shocks in market variables in a consistent way, using the same set of analytics and assumptions at every point in time. Important metrics for risk management are estimated based on the same set of assumptions for both assets and liabilities. We utilize a range of proprietary analytical tools that enable us to identify and assess the various risks faced by our clients, and provide them with a robust and reliable framework for optimizing their investment strategies in face of market uncertainties. Furthermore, insurers need substantial visibility of their portfolios so security-level details are required to understand the estimated scenario impacts, and enable them to slice and dice results.

By integrating assets and liabilities within a single framework, we eliminate the inconsistencies that can arise when managing assets against insurance liabilities using separate models. The capabilities of Western Asset's solution are extensive and include the ability to run actuarial-defined scenarios for liabilities on our clients' managed portfolios. Additionally, our model incorporates loss given default and adjusts cash flows to account for the likelihood of defaults from credit exposures over time. The model also estimates individual security analytics in each future year over an investment horizon, allowing for an assessment of the impact of liability scenarios on future values of securities in a portfolio. Furthermore, the model incorporates the liquidity profile of existing assets and their future cash flows, providing insights into the potential impacts on portfolios in the event of unexpected liability payments occurring at a future time.

Building a Consistent ALM Framework

Insurers' scenarios are unique in that they are often designed from an actuarial standpoint, spanning long time horizons into the future, and are highly customized to meet each insurer's specific circumstances. Our framework addresses the challenges described in the following section.

Portfolio Cash Flows Are Complex as Liabilities but in Different Ways

The actuarial scenarios for analyzing insurance liabilities are typically specified in terms of generic interest rates and credit spreads, such as the US Treasury (UST) curve, and the US corporate credit curve. Even though most of the focus behind ALM has been on interest-rate fluctuations and their impacts on both sides of insurers' balance sheets, some actuaries might find that policy behavior is also sensitive to general market risk conditions, and the credit spread environment might represent those conditions as a proxy[2]. However, portfolios are exposed to risk factors specific to their respective asset classes, tenors, and sectors. For instance, a short high-yield bond and a

longer US investment-grade bond are both exposed to interest rates, but to different sectors of the yield curve and to different types of credit spreads due to varying credit risk levels and sector affiliations.

Portfolios need a bit more granularity to express their sensitivities to different market conditions than general assessments on interest rates and credit spreads. It is then necessary to translate these general macro assumptions behind actuarial scenarios to specific risk factor shocks that accurately describe the potential scenario impacts on different securities. To achieve this, we use Maximum Likelihood Estimation (MLE) procedures over the time horizon to propagate general interest rate and credit spread changes to specific risk factors that a portfolio is exposed to.

Liability Scenarios Encompass Multi-Decade Horizons, but Portfolios Need to Be Constructed Today

Insurers' scenarios are forward-looking and can span long time horizons of 30 years or more. Asset portfolios also evolve over time, even in run-down mode as bonds approach maturity, leading to changes in exposures to different tenors of interest rates and spread curves. Estimated asset impacts on changes in interest rates and credit spreads tend to be less pronounced as portfolios approach run-down, assuming everything else constant. A thorough analysis of how these assets react to interest rate and credit spread changes over time in different scenarios requires forecasting future asset sensitivities to these changes. Different securities in a portfolio respond differently to shocks, so the analysis must be done at the individual security level. Thus, a method for forecasting analytics for different bond types over the scenario horizon must be available for a comprehensive scenario analysis.

Liquidity Is Important

Insurance portfolios, given their long-term nature, often contain assets with different liquidity profiles, as portfolio managers aim to capture illiquidity risk premia for a portion of the assets. The burden associated with selling assets may vary according to different liabilities scenarios. Under unfavorable market conditions, immediately available cash flows may not be enough to cover claims. Therefore, categorizing assets based on their liquidity differences and examining asset composition as portfolios evolve over time can provide valuable information and help reduce future transaction costs.

Flexibility and Scalability Are Needed

Scenarios for each insurer may vary based on unique circumstances that change over time. Business, regulatory, and market conditions are constantly changing, which can alter the perspective for liabilities and asset returns, and trigger the need to consider new scenarios. Portfolio strategies must quickly adapt to new pathways for liabilities and market conditions. Scalability and flexibility are critical elements of a good ALM framework.

"Insurance portfolios, given their long-term nature, often contain assets with different liquidity profiles, as portfolio managers aim to capture illiquidity risk premia for a portion of the assets."

The Model

Starting With an Example: Three Scenarios of Policyholder Behavior

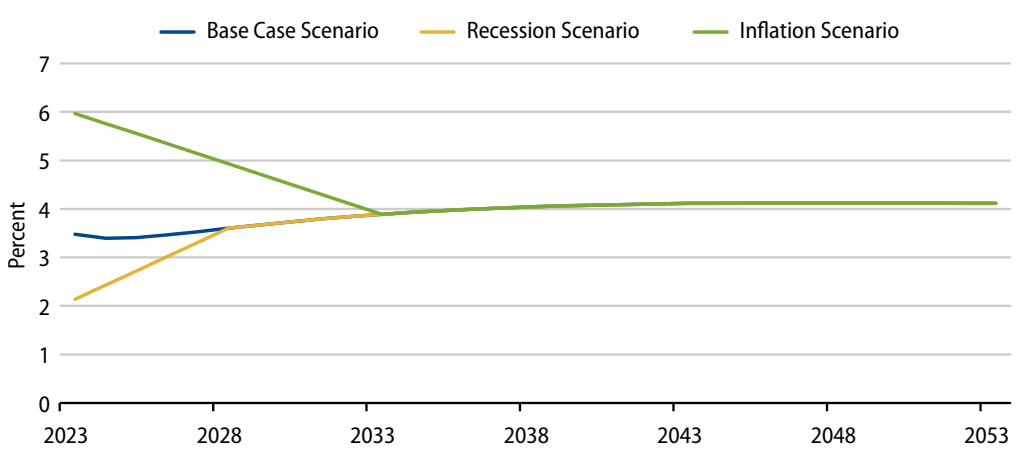
Our solution starts with actuarial scenarios[3], typically developed to assess liability behavior under different economic and market conditions, such as the aforementioned. These scenarios often assume future paths of "market" interest rates and "market" riskiness expressed in terms of changes in credit spreads. As an example of actuarial scenarios for a life insurer, the following charts illustrate the assumed future pathways for the 10-year UST rate[4] and the US corporate spreads under three different scenarios: a Base Case, a Recession Scenario, and an Inflation Scenario. Each scenario includes annual assumptions for each of these two market variables over a 30-year period.

In the Base Case Scenario, the interest rate and credit spreads are assumed to be generally flat over the scenario horizon, 30 years. In the Recession Scenario, the 10-year UST rate is assumed to be lower in the first few years compared to the Base Case, while the 10-year US corporate spreads are assumed to be wider. Both variables are assumed to revert to their assumed long-term average levels over time, which are the same as those in the Base

Case. Conversely, in the Inflation Scenario, the 10-year interest rate is assumed to be higher, and the US corporate spreads are assumed to be substantially wider compared to the Base Case. As in the Recession Scenario, both variables converge to their long-term averages over time. Exhibits 1 and 2 display the behavior of both market variables over the horizon in each scenario. Scenario shocks come in the form of the changes in the assumed scenarios relative to the current UST and corporate credit curves.

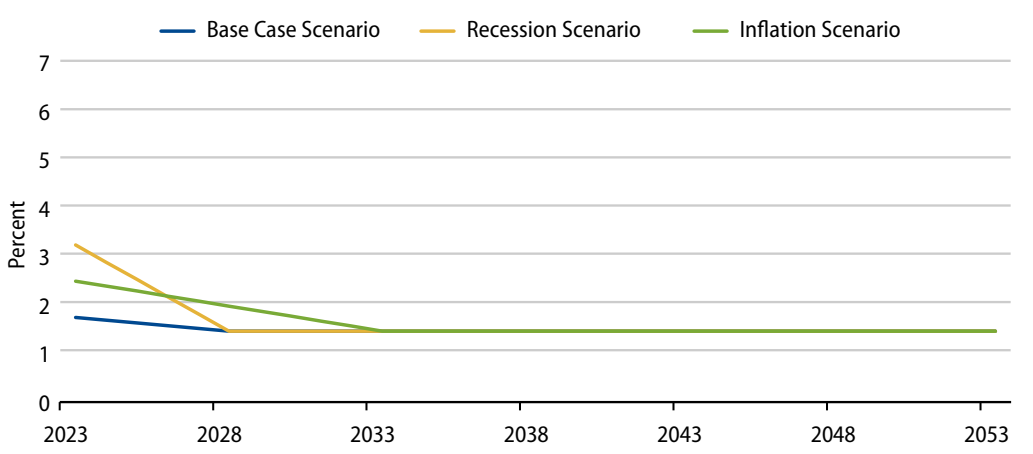
These scenario specifications describe future market conditions. However, what about the portfolio positioning over the horizon? To simplify the example, we assume that the portfolio holdings are constant throughout the scenario horizon. Proceeds from coupons and principals are assumed to be paid out when they are received to meet liability payments, and the portfolio is in run-down mode—that is, there are no new cash flows into the portfolio during the horizon. These assumptions are flexible, so rebalancing rules can be incorporated into the model as it evolves during the horizon.

Exhibit 1: 10-Year US Treasury Rate Scenarios



Source: Western Asset. As of 31 Mar 2023.

Exhibit 2: 10-Year US Investment-Grade Corporate Spread Scenarios



Source: Western Asset. As of 31 Mar 2023.

"While policyholder behavior might respond to more generic interest rate and credit spread specifications, a more granular, precise description of the risk factors that portfolios are exposed to is required."

From Liabilities to Portfolios: Striving For Consistency of the Scenarios

While policyholder behavior might respond to more generic interest rate and credit spread specifications, a more granular, precise description of the risk factors that portfolios are exposed to is required to evaluate the overall risk that assets backing liabilities are exposed to. For example, while actuarial stress tests might be based on shocks in, say, 10-year UST rates, as above, the portfolio may have exposures to shorter-term bonds, where the 2-year UST rate might characterize an important portfolio exposure. The same holds for generic credit spread specifications and the specific credit spreads that portfolios are exposed to. An important feature of our model is that it translates more generic actuarial scenarios into risk factor scenarios that aim for consistency between the actuarial and portfolio management approaches[5].

Our approach involves translating actuarial rates and spreads scenario shocks into asset risk factor shocks through a Maximum Likelihood Estimator (MLE)-based approach that uses ex-ante estimates of near-future market conditions from our proprietary risk system, WISER[6]. We perform this propagation[7] for every future year encompassed in each actuarial scenario using the estimated variance-covariance matrix in the MLE propagation process[8].

Each asset in the portfolio is exposed to a unique set of risk factors, which depends on its characteristics, including tenor, sector, credit rating, currency of issue and domicile. To estimate the impact of the liability scenario shocks on the assets in the portfolio in a consistent framework, we propagate the generic shocks to portfolio risk factor shocks. For instance, a typical fixed-income portfolio for an insurer might be exposed to subsector credit spreads, such as financial, industrial, utility, collateralized loan obligation (CLO) spreads, municipal bond spreads, and emerging market (EM) spreads. Exhibit 3 shows the time 0 (beginning of scenario horizon) estimated impacts to asset risk factors from the shocks implicit in each scenario for liabilities.

Exhibit 3: Risk Factor Scenarios

	Scenario Levels as of 31 Mar 2023 (%)		
Risk Factor	Base Case Scenario	Recession Scenario	Inflation Scenario
Shocked Risk Factors			
USD Rates 2Y	4.17	2.22	8.35
USD Rates 10Y	3.64	2.27	6.29
USD Rates 30Y	3.79	2.25	5.99
USD IG Corp Spread 10Y	1.68	3.18	2.43
Propagated Risk Factors			
USD IG Corp Financials Intermediate Spread	1.53	3.19	2.63
USD IG Corp Industrials Intermediate Spread	1.11	2.54	1.81
USD IG Corp Utilities Intermediate Spread	1.17	2.25	1.72
CLO AA Spread	2.81	3.46	3.95
CLO A Spread	3.70	4.71	4.54
Taxable Muni Spread	1.23	1.84	1.29
EMBI Spread	3.97	6.52	5.28

Source: Western Asset. As of 31 Mar 2023.

Model Results

Forecasting Portfolio Cash Flows

We forecast future cash flows from the portfolios under our management to facilitate a comparison with liability forecasts conducted by actuaries. When cash flow and liability forecasts are based on the same assumptions, the comparison can be made consistently. However, if there are implicit differences in the rates and spreads assumed for portfolio cash flow forecasts and liability forecasts at a given time, the comparison between cash flows and liabilities may be subject to significant noise stemming from model discrepancies.

Are actuarial models and asset risk models always interconnected? Our model is purposefully designed to account for shocks in the pertinent factors that impact both liabilities (such as generic rates and spreads influencing policyholder behavior) and portfolio behavior (the risk factors associated with the portfolio) at each point in the scenario horizon. The shocked variables are derived by subtracting the current market quotes for those variables from the projected levels assumed in each scenario over time. Consequently, the shocks evolve over time[9].

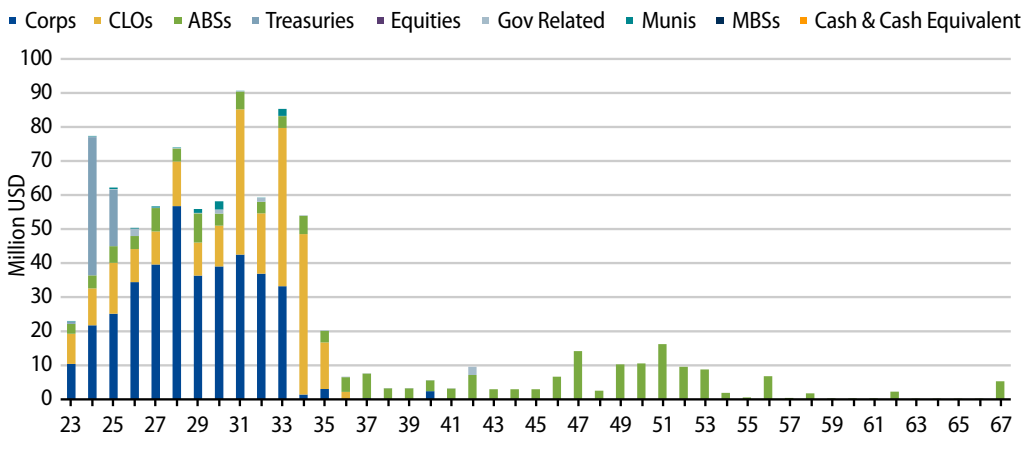
Given the often meaningful credit risk exposure in insurers' portfolios, we incorporate adjustments for potential asset defaults over the scenario horizon when forecasting cash flows. This approach leads to forecasted portfolio cash flows that account for the probabilistic occurrence of credit events over time. To accomplish this, we rely on our proprietary Credit Default Model (CDM), which is integrated into WISER, that produces estimates for probabilities of default (PD) for securities in the portfolio. We calibrated the CDM to consider differences in estimated PDs as spreads change over time in a particular scenario. In the examples in this paper, we adopt the following assumptions, which can be tailored to meet the specific requirements of our clients:

- For floating-rate securities, cash flows are projected to fluctuate in line with short-term interest rates in the scenario.
- For securitized products, cash flows are assumed to remain unaffected by defaults of the underlying assets.

We aggregate default adjusted cash flows at the security level to portfolio level by market value weights, and produce default-adjusted cash flows at each time point in each scenario.

Exhibit 4 illustrates the projected cash flows of the current portfolio in run down mode of the Base Case scenario, providing a breakdown of their asset class sources at each future year.

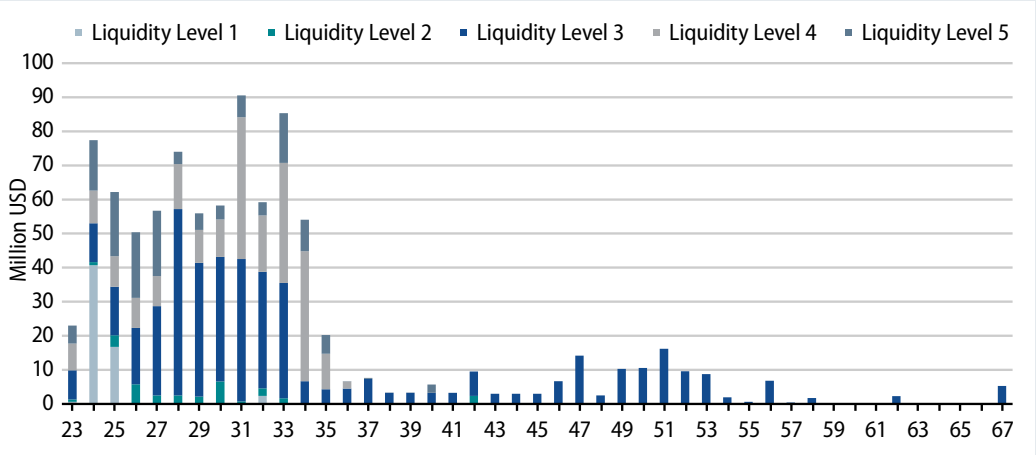
Exhibit 4: Life Casualty Portfolio Base Case Scenario—Projected Cash Flows by Asset Class



Source: Western Asset. As of 31 Mar 2023.

In addition, we can incorporate a liquidity profile of assets into the projected portfolio cash flows, as in Exhibit 5. This allows portfolio managers to assess the availability of liquid assets in the event of a market stress, as unexpected liabilities may arise. For this analysis, we utilize our proprietary liquidity tiering methodology for assets.

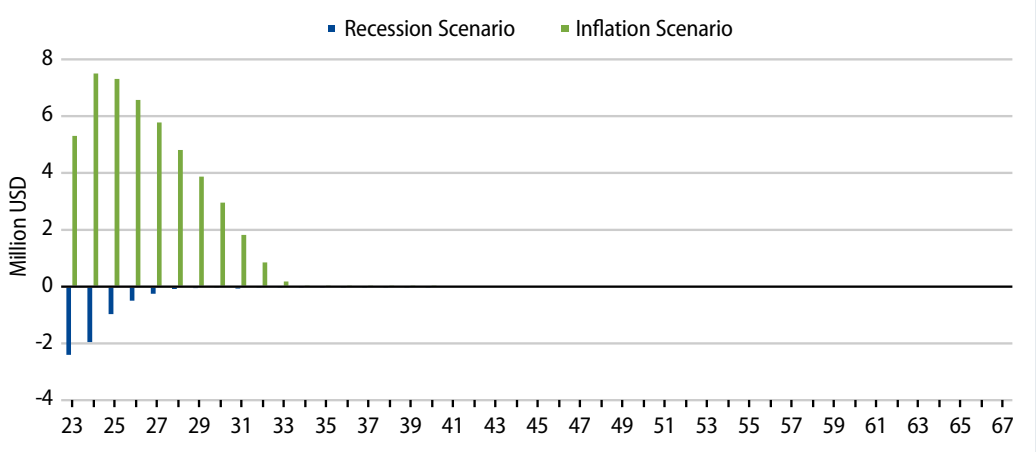
Exhibit 5: Life Casualty Portfolio Base Case Scenario—Projected Cash Flows by Liquidity Category



Source: Western Asset. As of 31 Mar 2023.

Exhibit 6 provides a comparison of projected asset portfolio cash flows for the Recession and Inflation scenarios in relation to the Base Case. In the Recession Scenario, cash flows from floating-rate securities are anticipated to decrease due to the lower interest rates in the early years. Similarly, cash flows from corporate bonds are expected to decrease due to the higher estimated probabilities of default caused by wider spreads assumed in the early years. Conversely, in the Inflation Scenario, cash flows from floating rate securities are projected to increase as a result of higher interest rates over the early years. Additionally, cash flows from corporate bonds are also estimated to increase due to the lower probability of default resulting from tighter spreads, once again, in the early years of the scenario. Notably, we observe that the positive impact from higher interest rates outweighs the higher estimated defaults.

Exhibit 6: Life Casualty Portfolio Projected Cash Flow Differences From Base Case Scenario



Source: Western Asset. As of 31 Mar 2023.

"In order to forecast how a portfolio responds to variables that influence liabilities behavior in a consistent manner, we developed a methodology for predicting the analytics of each security in the portfolio at each future point in time."

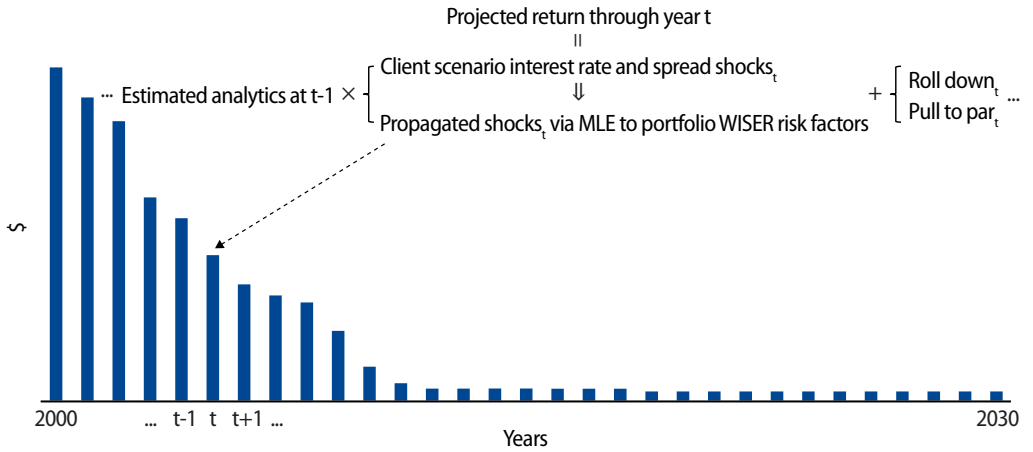
Forecasting Portfolio Values Over the Horizon

Asset portfolios comprise various types of securities that react differently to distinct interest rate and credit market conditions over time, particularly in response to risk shocks in the relevant risk factors under each scenario. The projection of default-adjusted cash flows in our model relies solely on the current portfolio positioning, assuming its constancy and run-down mode throughout the analysis horizon. However, to forecast future market values of portfolios, we must comprehend how forthcoming risk factor shocks affect portfolio values in the future. As securities' tenors shorten over the horizon, durations and spread durations of securities change.

In order to forecast how a portfolio responds to variables that influence liabilities behavior in a consistent manner, we developed a methodology for predicting the analytics of each security in the portfolio at each future point in the horizon, and we couple it with the successive MLE propagation of shocks from liabilities scenarios to portfolio risk factor scenarios. Forecasted securities analytics for a certain year are used as exposures over the next year.

Exhibit 7 illustrates the iterative process employed to forecast analytics and propagate liabilities shocks to portfolio risk factor shocks for a hypothetical security in each year of the horizon[10]. The analytics forecasts for individual securities are aggregated based on their market weights to generate portfolio analytics forecasts. The portfolio is then subjected to shocks based on its exposures to the propagated liabilities scenario shocks in their respective risk factors. Analytics forecasted in one year are used as exposures to risk factors in the next year in the horizon in each scenario. The portfolio contains different types of securities, and different analytics forecast methods are used for each type of security.

Exhibit 7: Framework of Market Value Projection



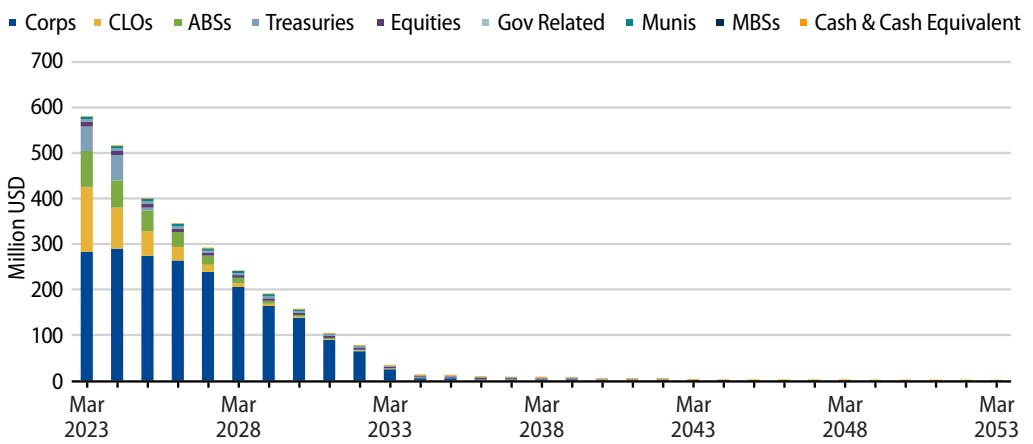
Source: Western Asset. As of 31 Mar 2023.

Exhibits 8 and 9 present the estimated market values of the sample Life Casualty Portfolio for the upcoming 30 years. The assets are categorized according to asset classes and Western Asset's internal liquidity tiering approach, with Liquidity Level 1 denoting the highest level of liquidity.

Providing a clear depiction of the asset allocation and liquidity characteristics of the portfolio over the horizon, as of the present moment, allows actuaries to gain a deeper understanding of how asset portfolios can effectively immunize risks arising from the mismatch between assets and liabilities. This objective is precisely what our model aims to achieve.

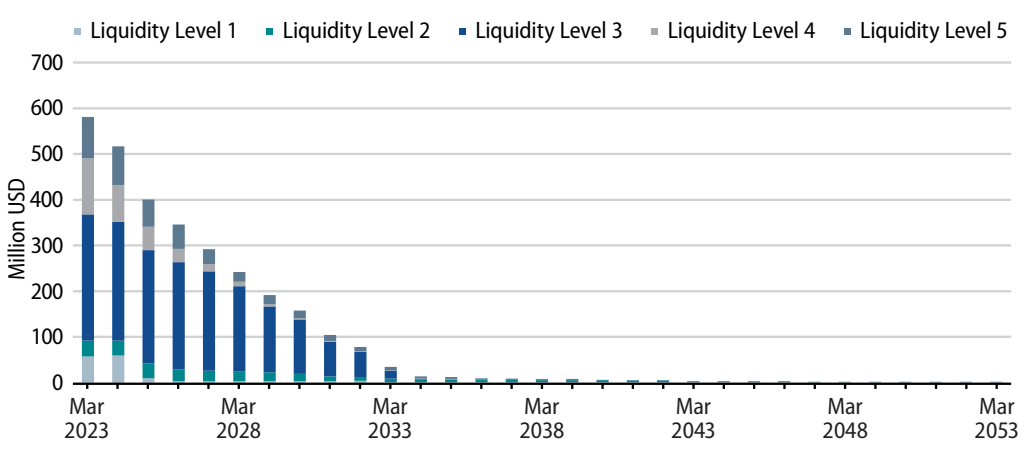
When comparing the projected market values between the Base Case Scenario and the Recession Scenario, it is observed that in the initial years, the negative effects resulting from wider credit spreads are projected to out-

Exhibit 8: Life Casualty Portfolio Base Case Scenario—Projected Market Values by Asset Class



Source: Western Asset. As of 31 Mar 2023.

Exhibit 9: Life Casualty Portfolio Base Case Scenario—Projected Market Values by Liquidity Category



Source: Western Asset. As of 31 Mar 2023.

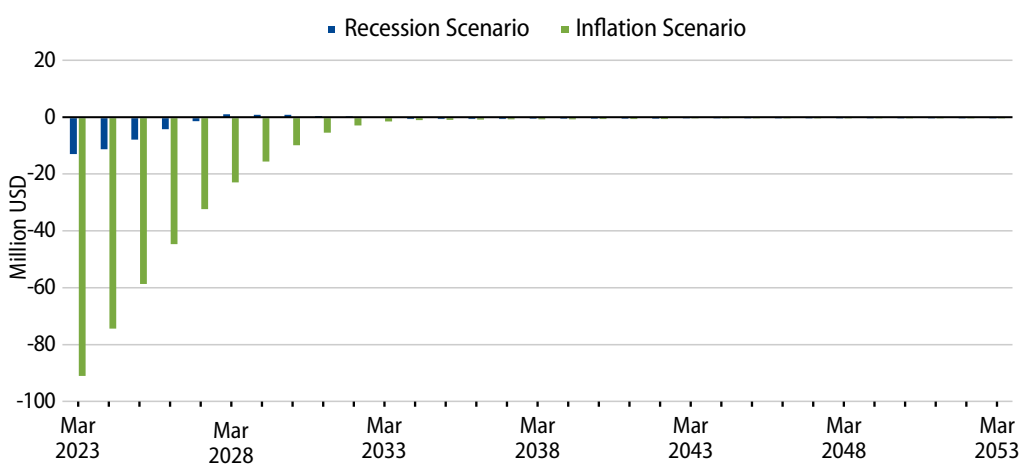
"The central concept behind our efforts with our insurance clients is to foster a partnership between actuaries and portfolio managers."

weigh the positive effects arising from lower interest rates. Consequently, the overall impact on projected cash flows from adopting the Recession Scenario is expected to be negative. In the Inflation Scenario, the combined influence of higher interest rates and wider credit spreads contributes to the estimated negative impacts on projected cash flows. Exhibit 10 illustrates the comparison of projected market value differences between the two alternative scenarios and the actuaries' Base Case for liabilities.

Conclusion

The primary focus of this paper is to present an approach that provides our clients with potential portfolio implications from their liabilities scenarios. By aiming for consistency between actuarial assumptions and portfolio risk, actuaries can collaborate with portfolio managers to establish guidelines for portfolio management that effectively mitigate risks arising from asset-liability potential mismatches. A discussion about future scenarios should form an integral part of the partnership between actuaries and portfolio managers. The central concept behind our efforts with our insurance clients is to foster a partnership between actuaries and portfolio managers.

Exhibit 10: Life Casualty Portfolio—Projected Market Value Differences From Base Case Scenario



Source: Western Asset. As of 31 Mar 2023.

Our framework offers projections of default-adjusted cash flows and market values for insurance fixed-income portfolios within forward-looking scenarios spanning long time horizons. These scenarios can be tailored to accommodate the distinctive characteristics of insurers' policies. By establishing a consistent connection between the generic actuarial assumptions regarding interest rates and credit spreads commonly employed by actuaries and the asset-specific risk factors that drive portfolio behavior, our model enables portfolio managers to construct portfolios within an asset-liability mismatch risk-aware mindset. The granular results provided by our framework offer enhanced visibility into the model, empowering insurers to develop well-informed action plans in response to various liability scenarios.

ENDNOTES

1. We thank our colleagues at Converge RE II for the inspiration behind this project, and for the partnership and invaluable feedback during the development of the model.
2. Other possibilities can be also contemplated, such as the inclusion of several macro-factors like oil and other commodities prices, or other market indicators. These can also be contemplated by our framework, which relies on ex-ante covariance estimates to propagate those macro indicators to specific risk factors that portfolios are exposed to.
3. Corporate pension funds are not in scope of this article, but their liabilities tend to be less sensitive to market variables, so scenarios might come from the asset side, for example, set by an investment committee. Our approach allows for translating asset shocks to liabilities shocks through their estimated impacts to discount rates of liabilities.
4. For simplicity, we only display the assumptions for the 10-year US Treasury rate, but the scenarios for liabilities are more complete and include assumptions for 2- and 30-year Treasury rates over the 30 year horizon as well.
5. While the scope of this paper does not encompass corporate pension fund ALM, it is worth noting that our model has found applications in the realm of pension fund ALM. Pension liabilities often exhibit less sensitivity to interest rates and spreads compared to insurance liabilities. As a result, scenarios for pension funds typically involve market shocks to their asset portfolios, typically specified by an investment committee. Our model is capable of translating asset shocks into corresponding shocks in liabilities, consistently impacting their discount rates in alignment with the shocks observed in the asset portfolio. It is important to acknowledge that there may be instances where propagation occurs simultaneously from both liabilities to assets and vice versa. Additionally, we have also observed potential applications of this framework in the analysis of future commitments for sovereign wealth funds.
6. Western Information System for Estimating Risk
7. This propagation methodology is better suited for central types of scenarios. For more extreme scenarios, where ruptures in market conditions are assumed, the MLE framework is likely not very useful, since it relies on the estimated variance-covariance matrix that usually does not hold under ruptures.
8. We utilize our current ex-ante estimates of near-term market conditions, which are expressed through WISER's variance-covariance matrix that undergoes a GARCH process to incorporate volatility clustering possibilities. We acknowledge that our ex-ante estimates for future market conditions are only for the near term since market conditions frequently change, and our estimates for risk factor volatilities and correlations may also change. We do not predict longer-term variance-covariance matrices for the horizon of the liabilities scenarios, and we understand that the analysis's outcome is reliant on current market conditions.
9. We should point that our model, despite allowing for time changing characteristics, is static in nature. It considers portfolio decisions as of now. A true dynamic model considers future portfolio decisions in its current decision framework. Given that our model dos not possess a closed form solution, in a true dynamic framework it would necessitate solving through dynamic programming techniques, which entails recursive calculations and a substantial computational capacity.
10. Considering a hypothetical portfolio comprising 500 securities, and a 30-year liabilities scenario, a total of 15,000 analytics forecast calculations are required. Since there are three scenarios in the example in this paper, the total number of calculations amount to 45,000. The MLE propagation from liabilities relevant factor shocks to portfolio risk factors shocks needs to be iterated once for each year of the horizon and for each scenario. Thus, in this specific case, there are 90 MLE propagations.