

WHITEPAPER

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Cashflow Matching with Granular Credit Assets

A key function of insurance ALM is to choose assets to support long-dated liabilities. This paper uses the example of direct cashflow matching as a way to demonstrate the importance of granular credit modeling in determining the efficacy of these asset-selection strategies. We find the optimal rating choice to minimize the total cost of implementing a strategy, including the required cash reserve, and show that industry choice has a material impact on this cost.

We utilize a new algorithm that accounts for specific bond terms and conditions, as well as specific issuer properties, to build portfolios of assets to match a set of runoff liabilities. We then use our new Risk-Integrated Credit Solution (RICS) to model the future cashflows and calculate the cash reserve (extra cash required to ensure payment of the liabilities at a 99.5% confidence level). RICS brings together:

1. A market leading correlation modeling using a variant of the Moody's Analytics Global Correlation Model™ (Gcorr¹) designed to capture long term rating dynamics. The model differentiates between 61 countries, 49 industries and hundreds of commercial real estate and retail loan factors.
2. Moody's cutting-edge market risk modeling (MA Scenario Generator²).
3. New models to capture spread and rating migration in granular credit markets.

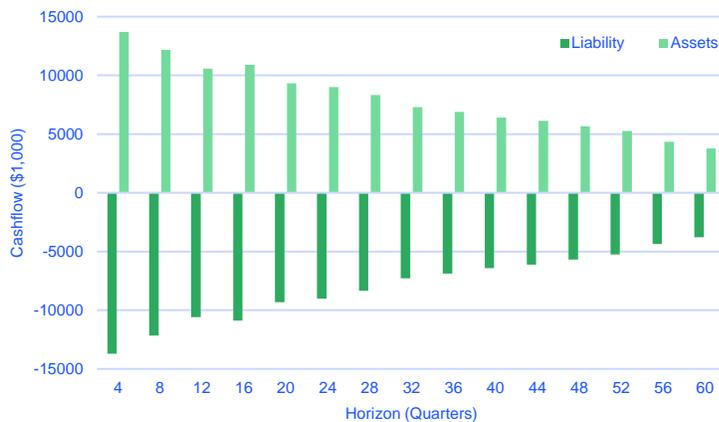
Using this granular credit model, we show the importance of industry- and issuer-concentration risk, and how this impacts the total cost of implementing the strategy. These are effects that would be missed when using higher-level asset representations. Specifically, we compare different ways to diversify a portfolio including industry/country/asset class composition and issuer characteristics. The fact that industry choice can have a material impact on the cost of implementing a cashflow matching strategy demonstrates that granular credit modeling can have important ramifications for insurance ALM and investment decisions.

1. For more information, see "Modeling Credit Correlations: An Overview of the Moody's Analytics GCorr Model" by Huang, Lanfrancioni, Patel, and Pospisil (2012).
2. For more information, see "Real World Best View Calibrations" by Hibbert, Jessop and Aldasani-Khyami (2018)

1. Cashflow Matching

The core problem addressed by life insurance ALM is managing a portfolio of assets against a set of very long-dated liabilities. One solution to this problem is to hold assets whose cashflows directly replicate the required liability cashflows. However, cashflow matching is only possible where liabilities are highly predictable and where assets exist at sufficiently long maturities. For example, holding a portfolio of bonds to match fixed annuity cashflows, as shown in Figure 1.

Figure 1 Run-Off Cashflow Matching.



Even in cases where liability cashflows are predictable, it is usually undesirable to rely strictly on risk-free assets with predictable cashflows. More generally, the choice of assets affects:

1. Repayment risk and balance sheet volatility
2. Cost of the strategy

These two considerations often compete. For example, using treasury bonds gives certainty over repayments and a stable balance sheet, but is very expensive to implement. On the other hand, higher-yield assets are cheaper to buy, but they result in more uncertainty of cashflows and are more sensitive to credit and market conditions.

Understanding these tradeoffs requires analysis of multiple scenarios (cashflow testing) and, ideally, a fully stochastic simulation accounting for dynamics on both sides of the balance sheet. Any uncertainty around cashflows introduces a risk of insolvency due to a potential mismatch between assets and liabilities along some future scenarios. This risk is usually mitigated using cash reserves, which we account for in the cost of the asset strategy in our examples.

Analyzing the risks associated with these strategies is often done using approximate asset representations, which ignore credit considerations such as the number of issuers, credit quality of specific issuers, concentration effects, and the difference in recovery between interest and principal payments. This paper explores the importance of these granular credit considerations for cashflow matching and cash reserve setting. We include a comparison of different approaches to diversification of the asset portfolio and their effect on cash reserves and overall strategy cost.

2. The Importance of Granular Credit

We begin with matching the expected cashflows using an algorithm that accounts for granular credit considerations and realistic bond features. We then use a stochastic simulation of credit and market risks (RICS) to account for the risk associated with the cashflow-matched portfolio. Finally, we calculate the cash reserve needed to guarantee payment of all liabilities with 99.5% confidence and compare how much cash is required across various asset choices.

Expected Cash Flows

Cashflow matching often uses high-level asset representations, e.g., zero-coupon bonds with given tenors and ratings, rather than using specific instruments available in the market. This simplification can lead to material errors in calculating expected cashflows. Our cashflow matching algorithm starts with a pool of specific instruments and chooses allocations to ensure that net expected cash is non-negative on every timestep, and zero when all liabilities have been paid.

This granular asset representation allows us to account for:

1. Specific instrument-level probability of default and expected recovery term structures.
2. Each instrument's terms and conditions, for example coupon payments or amortization schedules, as well as the appropriate recovery on each of these cashflows.

This approach results in a more realistic matching of expected cashflows. Moreover, using real bonds rather than stylized hypothetical instruments means that the resulting allocation is directly investable, and it does not require further mapping onto real instruments.

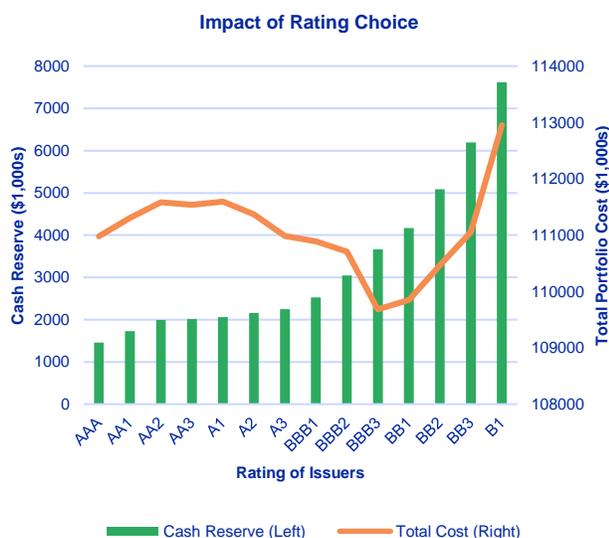
Cost of Strategy and Cashflow Mismatch Risk

This section considers how the choice of assets impacts portfolio risk, both through credit quality and correlations of assets, where granular modeling is critical to understanding concentration risk. To measure the risk of a particular asset choice, we use a Monte Carlo simulation to calculate the 99.5th percentile of the net cash balance at each time-step and set a cash reserve to ensure that that value remains positive throughout the simulation. In this exercise, we present the implications of credit asset choices to the required cash reserve and to the strategy cost (accounting for the cash reserve). Specifically, we explore the following credit asset dimensions:

1. Issuer initial rating
2. Issuer industry composition
3. Issuer size or amount of systematic risk (RSQ)

Our measure of systematic risk is the issuer R-squared, RSQ, the exposure of an issuer to its underlying systematic factor.

Figure 2 Impact of Rating Choice.



In our model, investors demand compensation for risk borne, and so riskier bonds must have higher coupons when priced at par. But, as in CAPM, investors are only compensated for taking systematic risk, not idiosyncratic risk. This means that investors require higher returns from issuers more exposed to systematic risk (i.e., those with higher RSQ), resulting in higher coupons when priced at par.

We hold the total number of issuers fixed across different exercises to ensure a comparable level of diversification of issuer-specific shocks.

Clearly, holding riskier assets requires a higher cash reserve, as the probability of experiencing credit loss and the volatility of cashflow payments are higher. However, risky assets also pay a higher coupon. As Figure 2 shows, there are levels of risk for

which the total cost of the strategy (analysis date cost of bonds and cash reserve) is increasing in credit quality, with the cheapest overall strategy being to invest in BBB3 bonds. The exact composition of the minimum cost portfolio depends on the specific liability cashflows and market conditions and the universe of available instruments, but it is important to note that such an optimum exists.

Holding a more diverse portfolio is also important. Next, we compare two approaches to reducing portfolio concentration: industry diversification and selecting issuers with less exposure to systematic risk (e.g., smaller issuers tend to be less correlated with other issuers in the same sector).

Figure 3 Impact of Industry Choice and Impact of Issuer Size.



We see in Figure 3 that not all diversification is the same. While both approaches to portfolio diversification result in lower cash reserves, only the industry diversification strategy also lowers the total cost. This result is due to the fact that investors demand higher return on more systemic issuers, increasing their coupon and reducing the notional required. Therefore, choosing less-systemic issuers is an expensive way to lower the cash reserve. In contrast, portfolio diversification across industries/countries/asset classes (corporate, CRE, retail) is more cost-effective, as it leads to a reduction in cash reserve with minimal effect on the cost of the bond portfolio.

The fact that industry choice can have a material impact on the cost of implementing a cashflow matching strategy demonstrates that granular credit modeling can have important ramifications for insurance ALM and investment decisions.

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