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The Importance of Granular Risk-Integrated Analysis: Two Case Studies

Abstract

The Risk-Integrated Credit Solution (RICS) brings together Moody's granular credit risk modeling – covering both stochastic credit migration/default and valuation/spread, leveraging Moody's granular credit correlation model (GCorr™) – with Moody's Scenario Generator (SG) models for other market risks, including interest rates, inflation, equity returns, exchange rates, and others. In this paper we demonstrate the importance of a granular portfolio risk-integrated modeling framework through two case studies, showing that a high-level representation of the portfolio and/or siloed modeling of different risks in separate systems can result in meaningful misrepresentation of portfolio risk. The first case study focuses on the importance of granular modeling of the portfolio, and the second on the importance of a risk-integrated modeling framework that accounts for joint effects by multiple risks on the portfolio.

1. Introduction

The various "shocks" that have hit the globe recently – due to pandemic, war, high inflation and subsequent sharp rises in interest rates, etc. – have reiterated the complexity and interconnectedness of financial markets and market variables. Understanding the impact of these variables on portfolio risk is a challenge that is made only more difficult if one wants to account for simultaneous changes in market variables.

To aid insurers in better understanding the risk in their portfolio, Moody's Analytics has created a solution known as the Risk Integrated Credit Solution (RICS). RICS combines two cornerstones of Moody's Analytics: granular credit modeling using Moody's rich credit correlation model, GCorr [1] and other credit models, alongside the Scenario Generator (SG) modeling crucial market drivers such as interest rates, inflation, equity and exchange rates [2]. Bringing these credit and market risks into one modeling framework allows us to directly capture their joint effects on an investment portfolio, which is key for addressing a host of problems, for which conventional solutions are limited. Readers interested in understanding more about RICS can consult [3], [4], and [5] for details.

This paper aims to highlight why granular and risk-integrated modeling is necessary for insurers to get a handle on the risk inherent in their portfolios. We demonstrate this with two simple examples that illustrate the challenges facing insurers and other portfolio managers today and common techniques to solve them:

1. **Estimating credit portfolio risk**: Portfolio risk depends on the interrelationships between modeled assets that determine the shape of the value distribution at future times. To simplify modeling of a typical portfolio, insurers will often use a high-level representation for the portfolio by bucketing assets into categories. We show that two portfolios that appear identical under bucketing approaches can exhibit significantly different portfolio risk. Granular modeling is able to discern such differences and thus provide an appropriate measurement of the risk for each portfolio.

2. **Combining credit and market risks**: The value of a portfolio is usually affected by several factors and market variables simultaneously. Modeling these in one consistent framework is the challenge RICS is built to address, but without this capability insurers often rely on copulas to combine different sources of risk. This exercise demonstrates the limitations with the copula approach and how these are overcome with a fully risk-integrated solution.

The main takeaway from both these case studies is that the true risk of a portfolio can be severely over- or under-estimated using conventional techniques. A granular risk-integrated modeling framework, however, avoids these issues and can provide a significantly better understanding of the overall portfolio risk and what contributes to it. This improved understanding of portfolio risk helps identify concentration areas in the portfolio and investment opportunities *relative to the existing portfolio*, leading to significant improvements to portfolio risk measurement and risk management.

2. Importance of Granular Portfolio Modeling

When insurers model their portfolios, which can contain several hundred or even thousands of credit risky instruments, a common approach to simplify the analysis is to "bucket" instruments into a few different categories. For corporate bonds, these categories are typically based on the currency, rating and duration of the bond. The idea here is that all bonds in a given bucket behave in a similar way, and thus we have reduced the problem of modeling, say, 1,000+ instruments to modeling 10-20 buckets. On the face of it, this appears to be a good approach to cut the computational burden and still maintain a realistic handle on the risk in the portfolio, but it requires general assumptions about the correlation between instruments, both in the same bucket and across different buckets. Finding the right bucket correlations is extremely challenging, and moreover, such bucket correlations depend on the specifics of each portfolio. For example, a portfolio with multiple bonds in the same sector or from the same issuer would require higher intra-bucket correlations and higher inter-bucket correlations across duration buckets. A better diversified portfolio would require lower correlation assumptions.

To illustrate the importance of granular portfolio modeling without such simplifying assumptions, we consider the following case study, where we show that two portfolios that appear the same under the bucketing approach have materially different credit risk. This shows that portfolio bucketing can misrepresent the actual portfolio risk in a meaningful way.

We consider two portfolios that we refer to as "diversified" and "non-diversified." The non-diversified portfolio is made up of 250 bonds from 200 issuers and concentrated in the same country and sector. The diversified portfolio is made up of 250 bonds from

250 issuers, but split across countries and sectors. To remove exchange-rate effects we assume all bonds are issued in USD. The bond characteristics are otherwise identical in the portfolios; specifically, bonds in both portfolios range in maturity from 3-11 years, averaging 7 years and the issuers are split among ratings as (AA 12%, A 32%, BBB 44%, BB 8%, B 4%). Given the similar makeup of both portfolios, the expected return of the portfolios is approximately the same, but the distribution is quite different.

To understand the differences we examine the variance of the portfolio value. (To allow for sufficient migration/defaults we consider this after 5 years.) As well as outputting the total risk, RICS also decomposes the variance into the various risk types, as shown on the left in Figure 1. As expected, the diversified portfolio has a lower overall risk, with the reduction coming from credit related risks. A large part of the overall risk is attributed to interest rates, a common feature of asset-only analysis; however, in reality, asset cash flows are typically used to support liabilities.

If we repeat the analysis with liabilities drawing down the cash produced by the asset portfolio, we obtain results as shown on the right in Figure 1. The inclusion of liabilities attenuates a large part of the interest rate risk but has little to no effect on credit risk. This more realistic version of the analysis further highlights the large reduction in the overall risk between the diversified and non-diversified portfolios.

Figure 1: Risk decomposition of diversified vs. non-diversified portfolio, assets-only (left) and with liability (right)
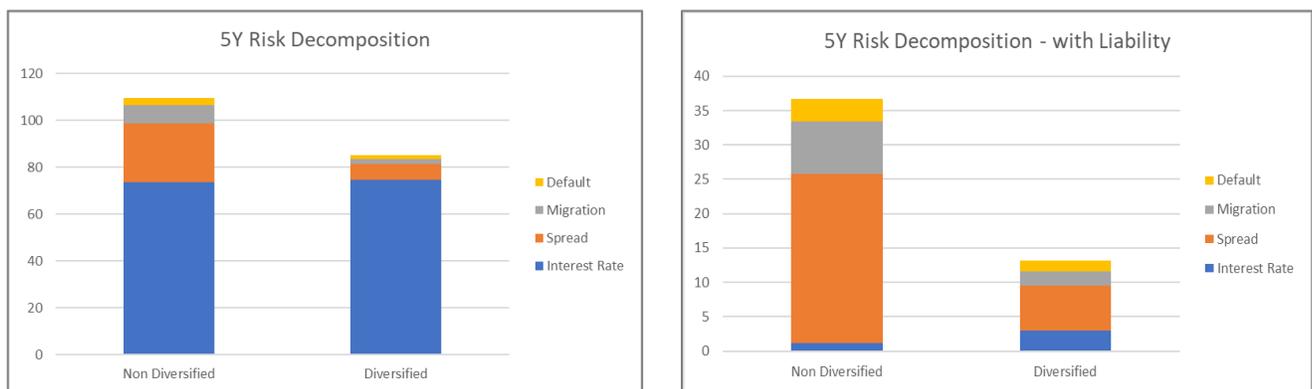
This example highlights the shortcomings of high-level portfolio representation and bucketing approaches. It is worth reiterating that under the coarse lens of rating/duration splits these portfolios look identical. Yet from our more granular modeling we see that they are not, and indeed the differences can be stark. Especially when insurers invest in several bonds that are from the same issuer or are concentrated in a particular sector, it is important that the risk is realistically reflected. Bucketing approaches are unlikely to reflect the true correlations across or within the buckets for any specific portfolio, which can misrepresent the overall portfolio risk and the decomposition into risk types. By contrast, a granular modeling framework with appropriate correlation assumptions directly captures portfolio risk from the bottom up, accounting for each specific portfolio's composition, overlapping names and diversification effects.

3.   Integrated Modeling to Combine Credit and Market Risk Effects

The purpose of the RICS framework is to combine credit risk with spread risk and other market risks – such as equity, inflation, interest rates, exchange rates, and others – in a single stochastic model that preserves sensible economic relationships between variables in all scenarios and all future times.

By contrast, if these risks are modeled separately in standalone systems, the results must somehow be aggregated. Simply adding results from these separate systems does not account for diversification effects and other structural joint effects, leading insurers and asset managers to rely on copulas. A standard approach, e.g. in the EIOPA solvency regime, is to combine credit and market value-at-risk (VaR) using a Gaussian copula with a prescribed set of correlation assumptions between risk variables. But recent developments in risk-integrated modeling frameworks have underscored meaningful limitations with copula approaches for aggregating credit and market risks.

To illustrate the benefits of an integrated risk model, we use an example of aggregating credit and equity risks. We consider a representative portfolio of bond assets and liabilities typical of a U.S. insurer, together with some investment in an equity index. We then compare the 99th-percentile VaR of the portfolio for different equity holdings, which we report as the diversification benefit[1] attained by holding each equity, as shown in Figure 2.

Here we have set the holding amounts in each equity index to be such that the standalone "equity VaR" is the same in all cases, so any copula assumptions treating equity as a monolithic category would necessarily produce the same aggregated answer, implying the same risk for the combined portfolio despite differences in equities.

However, using the RICS model to combine credit and equity scenario-by-scenario with credit/equity correlations that depend on the particular assets, we can see clear differences. The obtained diversification benefits span a wide range from approximately $250 million to over $330 million (corresponding to roughly 20 to 30% of the total portfolio VaR). The lowest diversification benefit is obtained when holding the U.S. large-midcap index (E_USD), since the credit-risky bond assets of the largely U.S.-dominated portfolio are most correlated with the firms making up this index. The less correlated overseas equities such as the Japan (E_JPY) and Australia (E_AUD) indices show a greater diversification benefit due to the credit portfolio being mostly concentrated in U.S. and European markets. Even within the U.S., there are additional differences in diversification between equity indices like the Nasdaq (NDX), Russell 2000 (RUT), and S&P MidCap (SP_MID), reflecting their correlations with the specific bond portfolio here, as captured by the industry and sector assumptions in the RICS granular credit model.

Figure 2: Diversification benefit obtained from different equity investments
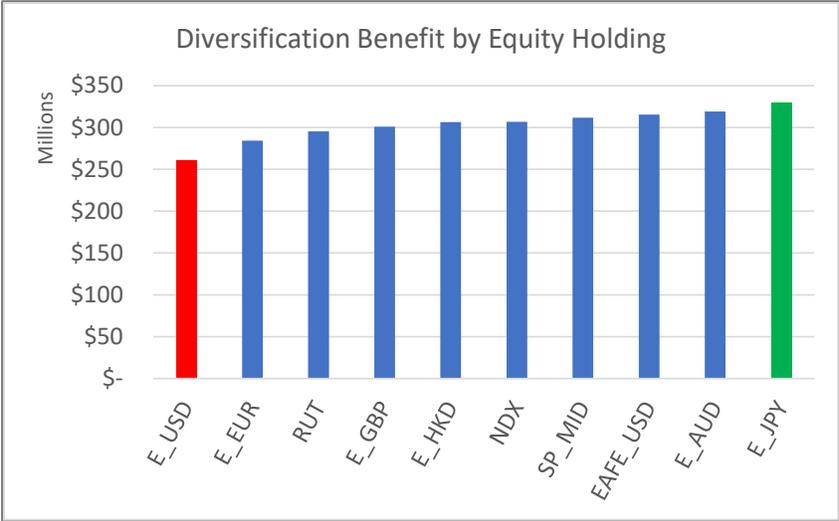
The overall impact to the insurer could be material. A copula framework can result in significantly overstated or understated risk measures like value-at-risk , economic capital, RBC, and so on, depending on the mismatch between copula aggregation assumptions and the actual portfolio dynamics. Furthermore, this mismatch might vary unpredictably with the tail percentile in question (95th vs. 99th vs. 99.5th, etc.), time horizon, valuation date, specific portfolio composition, asset liability management decisions, and many other factors. No single correlation assumption, even one tailored to an insurer's particular asset/liability portfolio, will adequately capture the joint dependency between risk factors for all purposes.

An integrated risk model as in RICS offers a superior and more reliable approach to combining credit and market risks, suitable for a diverse range of applications.

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[1] We define the diversification benefit to be the difference between the simple sum (credit VaR + equity VaR) and the VaR of the combined portfolio (credit + equity), which properly accounts for diversification effects.

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