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Credit risk premia: Considerations for multiasset portfolios

- There has been a considerable gap between U.S. credit bond yield spreads over U.S. Treasury bonds and credit bond total returns in excess to returns from comparable-maturity Treasury indexes. Credit spreads therefore should not be confused with expectations for credit premia.
- Credit exposure has been a good diversifier to Treasuries, and credit premia also exhibit strong time diversification. In a historical analysis, we show that although credit returns are highly correlated with equity returns, credit risk has been compensated in a multiasset portfolio.
- Average excess returns and risk properties differ across sectors, so they should be considered thoughtfully in a portfolio construction framework. In steady state analysis, we show that credit tilt portfolios have positive certainty fee equivalents (CFE) compared with the base portfolios and thus can be considered beneficial to some investors seeking additional expected return in their portfolios.[1]

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1 As with any investment, investors should consider implementation costs and investment objectives when adding new assets to their portfolios.

In constructing bond portfolios, accepting credit risk in fixed income markets has long been a common way for investors to add yield and diversification to their portfolios, but some have questioned whether credit risk premium can add value in a multiasset portfolio.[2] In analyzing historical risk, return, and diversification properties of credit risk premium across credit sectors, we answer this question and offer considerations for implementing long-term static credit tilts in a multiasset portfolio. These portfolios, powered by Vanguard's portfolio construction framework and its proprietary models, are characterized as model-based strategic asset allocation methodologies that combine broad market beta exposure with sub-asset class tilts (Aliaga-Díaz et al., 2022). They aim to harvest credit risk premium for investors while ensuring risk–return efficiency in a multiasset portfolio.

It is traditionally understood that credit bonds are issued at a positive yield spread over comparable-maturity U.S. Treasury bonds to compensate investors for the risk of default. Default risk is defined as the possibility that a bond's issuer will be unable to pay its obligations in a timely manner, if at all. If the issuer defaults, investors can lose all or part of their original investment and any interest that was owed. Elton et al. (2001) further show that corporate bonds require a risk premium, because spreads and returns vary systematically with the same factors that affect common stock returns. Research has found that credit risk premia are magnified by the countercyclicality of default timing risk and proportional losses in the event of default and are also increased by market illiquidity (Berndt et al., 2018). Liquidity risk refers to the investor's ability to sell a bond quickly and at an efficient price, as reflected in the bid-ask spread—the difference between the prices at which dealers are willing to buy and sell the securities.

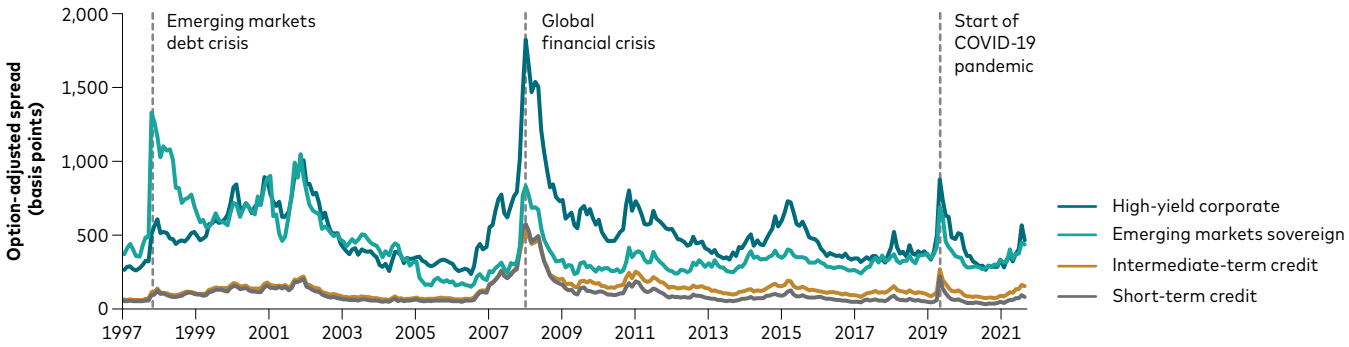
2 Prominent among those was David Swensen, the longtime Yale University chief investment officer and one of the inventors of the Endowment Model theory. He believed that investors in bonds should invest only in "full faith and credit" securities.

Our research evaluates the probability distributions of this risk premia across maturities (short-term to long-term) in the U.S. investment-grade universe, high-yield (low-quality corporates), and emerging markets (USD hard currency) sectors. Elton et al. (2001) define credit spreads as the yield difference between a coupon-paying corporate bond or an index of coupon-paying corporate bonds and a coupon-paying government bond or an index of government bonds of the same maturity. The option-adjusted spread (OAS), depicted across the credit categories in **Figure 1**, is one of the potential spread measures used to place a valuation on credit risk premium. OAS moves opposite the business cycle: When companies' earnings are expected to grow at a faster pace (as the economy is accelerating), OAS decreases, because increased profits would reduce the risk of default. And if earnings growth is expected to decelerate, which could increase default risk, OAS increases. We've seen the latter during recessions and at times of increased financial stress such as the emerging markets debt crisis, the global financial crisis, and most recently the start of the COVID-19 pandemic. High-yield and emerging markets sectors exhibit more credit risk resulting from the borrower's lower credit quality, and thus they are awarded higher average credit spreads and exhibit more OAS volatility than investment-grade credit sectors.

FIGURE 1

Credit spreads are countercyclical to the business cycle

Option-adjusted spreads for various credit categories



Notes: Short-term credit OAS is represented by the Bloomberg U.S. 1–5 Year Corporate Index from November 1997 through December 2003 and the Bloomberg U.S. 1–5 Year Credit Index from January 2004 through July 2022. Intermediate-term credit OAS is represented by the Bloomberg U.S. 5–10 Year Corporate Index from November 1997 through December 2003 and the Bloomberg U.S. 5–10 Year Credit Index from January 2004 through July 2022. High-yield corporate OAS is represented by the Bloomberg U.S. Corporate High Yield Index from November 1997 through July 2022. Emerging markets sovereign OAS is represented by the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index from November 1997 through July 2022. A basis point is one-hundredth of a percentage point.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

We caution investors evaluating credit risk premium that although credit spreads can be used in valuation frameworks, they should not necessarily be considered an expectation for the realized premium. Our research shows there can be considerable gaps between credit spreads promised to investors and long-term average credit bond index total returns in excess to returns from comparable-maturity Treasury indexes. This "slippage" in credit spreads is due to multiple factors, such as changes in spreads, index turnover based on downgrades and maturity rules, and to a small degree defaults, to name a few (Asvanunt and Richardson, 2017). The results of our calculations as summarized in **Figure 2** indicate that unrealized OAS can range from 25% to 65%, depending on credit sector. Historically, we find the best efficiency in capturing OAS to be in the short-term investment-grade credit and emerging markets sovereign USD indexes, and the least efficient in long-term investment-grade credit. Thus, when evaluating the historical risk and return properties of credit risk premium and considering a long-term tilt to these asset categories, we suggest that investors focus directly on excess return distributions.

FIGURE 2

Credit spreads are not fully realized in returns

Credit sector OAS and annualized excess returns

	Short-term credit	Intermediate-term credit	Long-term credit	High-yield corporate	Emerging markets sovereign
Average excess return	0.74%	0.74%	0.56%	2.32%	3.23%
Average OAS	0.98%	1.29%	1.59%	4.96%	4.20%
Average unrealized OAS	25%	43%	65%	53%	23%

Notes: Annualized excess return and average OAS for short-term credit, intermediate-term credit, long-term credit, and high-yield corporate are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Long Credit Index, and the Bloomberg U.S. Corporate High Yield Index from November 1994 through July 2022. Annualized excess return and average OAS for emerging markets sovereign are represented by the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index from November 1997 through July 2022.

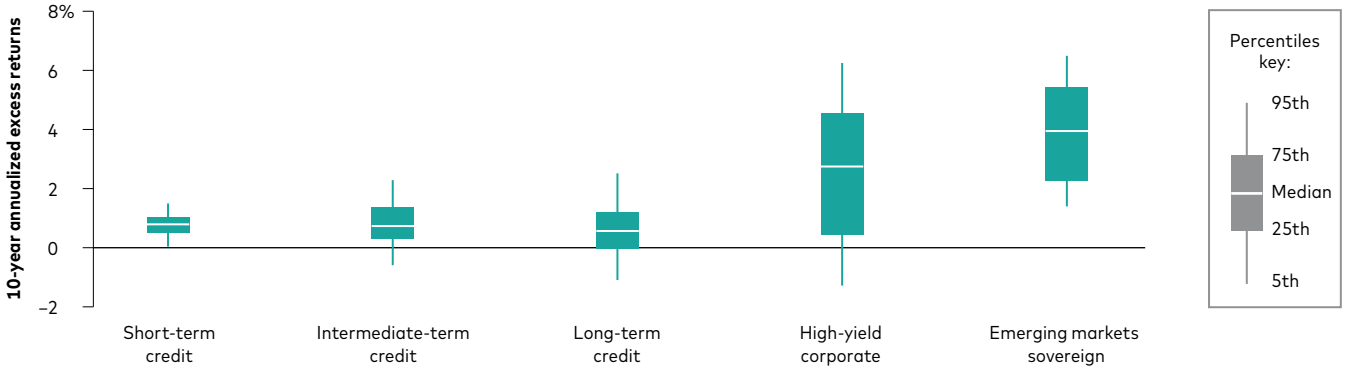
Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

In evaluating all possible 10-year holding periods, **Figure 3** summarizes the range of realized credit index excess returns. We find that more risky credit categories such as high-yield corporate and emerging markets sovereign in USD have higher historical median excess returns than the investment-grade credit indexes, but their historical returns also have a wider range and, in the case of high-yield corporates, lower tail. Based on this assessment, we can conclude that among the investment-grade sectors individually, short-term credit has generated the best risk-adjusted returns. Long-term credit index excess returns have not been nearly as reliable, exhibiting a lower average and wider range than those of short- or intermediate-term credit indexes. In the lower-quality categories of high yield and emerging markets, we find both to have high median excess returns (near 3%), but the range of outcomes for high yield has been wider.

FIGURE 3

In investment-grade credit, short-term has produced the best risk-adjusted excess returns

Historical 10-year excess return distribution for credit categories



Notes: 10-year annualized returns for short-term credit, intermediate-term credit, long-term credit, and high-yield corporate are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Long Credit Index, and the Bloomberg U.S. Corporate High Yield Index from January 1994 through July 2022. For emerging markets sovereign, they are represented from November 1997 through July 2022 by the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

Beyond evaluating long-term average excess returns and uncertainty or risk within their return distributions, a complete portfolio construction framework requires an assessment of diversification properties. To evaluate the diversification effect, we first look at the long-term cross-correlations with other asset categories as well as evaluate their time diversification. As **Figure 4** shows, although excess returns are highly correlated across credit categories, suggesting modest diversification benefits, returns from credit risk and returns from interest rate risk have been negatively correlated on average. These "diversifying risk premia" are a critical consideration in both the bond and the multiasset portfolios.

FIGURE 4

Credit and Treasury bonds contain diversifying risk premia

Correlation among credit excess returns and Treasury total return

	Short-term credit	Intermediate-term credit	High-yield corporate	Emerging markets sovereign USD	Total Treasuries
Short-term credit	**1.00**				
Intermediate-term credit	0.96	**1.00**			
High-yield corporate	0.79	0.83	**1.00**		
Emerging markets sovereign USD	0.63	0.67	0.75	**1.00**	
Total Treasuries	–0.22	–0.30	–0.45	–0.34	**1.00**

Notes: Monthly excess return correlations are from January 1994 through July 2022 between short-term credit, intermediate-term credit, high-yield corporate, and Treasuries; those categories are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg U.S. Treasury Index. Correlations with emerging markets sovereign, as represented by the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index, are from November 1997 through July 2022.

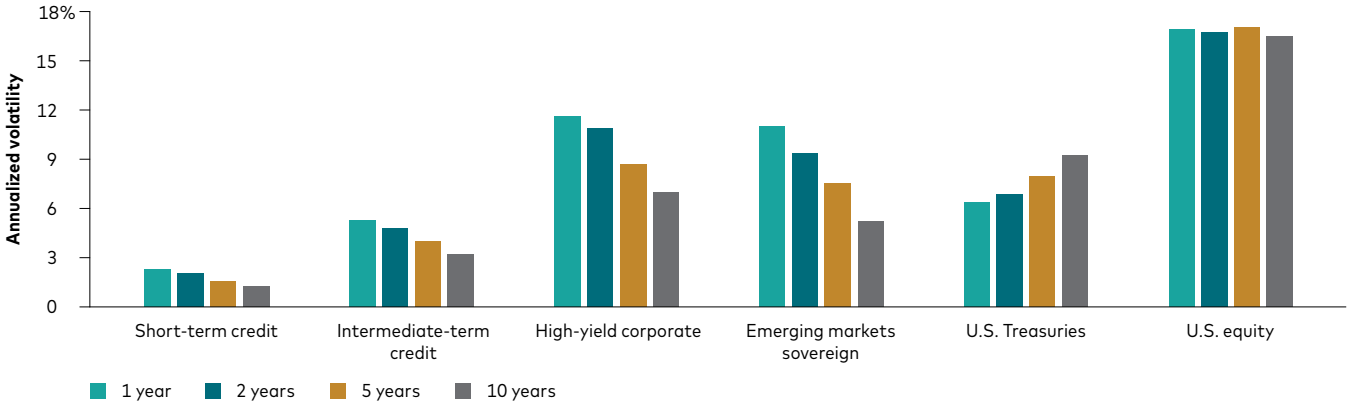
Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

Cross-correlation is a measure of "traditional" diversification in which investors can reduce portfolio volatility by holding assets that are not perfectly correlated. A less appreciated element of diversification—but one of consequence that should be considered for long-term investors—is that of time or holding-period diversification. Ultimately, time diversification is a result of the mean-reverting nature of the key risk factors that drive asset returns. One can gain insight into this behavior through an analysis of the annualized return volatilities of asset categories across various holding periods. In analyzing credit excess return volatility from holding periods of one to 10 years, we find that volatility decreases as time horizon increases. The reverse is true with Treasuries: As their holding period increases, so does their volatility. This suggests that credit risk premium offers better time diversification, resulting from the mean-reverting nature of credit spreads, and becomes more reliable over longer periods. Conversely, increasing risk over longer holding periods is indicative of more persistence in the level of Treasury bond yields when compared with credit spreads. Lastly, annualized volatility in U.S. equities is stable over 10-year horizons because equity valuation multiples have mean-reverted only over very long holding periods. Based on the results shown in **Figure 5**, this suggests that portfolio construction frameworks assessing both risk and return will increasingly allocate to credit categories over longer time horizons.

FIGURE 5

Credit bonds offer improved time diversification

Credit excess return volatility in different holding periods



Note: Annualized volatility is calculated by multiplying the standard deviation of annualized returns by the square root of the holding period.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live through July 2022. Data start December 1976 for short-term credit, October 1993 for intermediate-term credit, June 1984 for high-yield corporate, October 1998 for emerging markets sovereign, and December 1973 for both U.S. Treasuries and U.S. equity.

Historical portfolio statistics

We have established that credit risk has historically been compensated in the bond portfolio based on the positive long-term average excess returns of credit bonds over Treasuries. We next evaluate whether credit tilts have added value in the multiasset portfolio. Because of declining long-term bond yields since the early 1980s, any duration differences between bond portfolios will result in the longer-duration asset outperforming. Therefore, a fair historical analysis of credit risk premium in the multiasset portfolio requires the credit tilt portfolio to be duration-matched to the bond market portfolio.

After making this adjustment, we compare annualized nominal returns, volatilities, and Sharpe ratios for duration-matched traditional 60% stock/40% bond portfolio and various credit tilt portfolios. In **Figure 6**, we show the results for the 50% investment-grade and 25% high-yield and emerging markets credit tilt portfolios to highlight financially meaningful differences in annualized returns compared with the base portfolios. We can see that, when duration-matched, credit tilts of this magnitude have historically improved average nominal returns and generated similar Sharpe ratios as the base 60/40 portfolio. This provides evidence to support the conclusion that credit has been a compensated risk in multiasset portfolios.

FIGURE 6

Duration-matched credit portfolio tilts have been a compensated risk

Statistics for historical portfolios

	Short-term credit		Intermediate-term credit		High-yield corporate		Emerging markets sovereign	
	Base	50% overweight	Base	50% overweight	Base	25% overweight	Base	25% overweight
Annualized return	7.79%	7.92%	8.33%	8.44%	8.07%	8.29%	7.04%	7.35%
Volatility	8.99%	9.20%	9.07%	9.53%	9.00%	9.59%	9.07%	9.78%
Sharpe ratio	0.61	0.61	0.67	0.65	0.64	0.63	0.56	0.55

Notes: Data cover January 1994 through July 2022 for short-term credit, intermediate-term credit, and high-yield corporate; data cover November 1997 through July 2022 for emerging markets sovereign. The credit categories are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index. Annualized risk-free return (cash) used in the Sharpe ratio calculation is 2.28% since 1994 for short-term credit, intermediate-term credit, and high-yield corporate and 1.95% since 1997 for emerging markets sovereign.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

Portfolio construction considerations

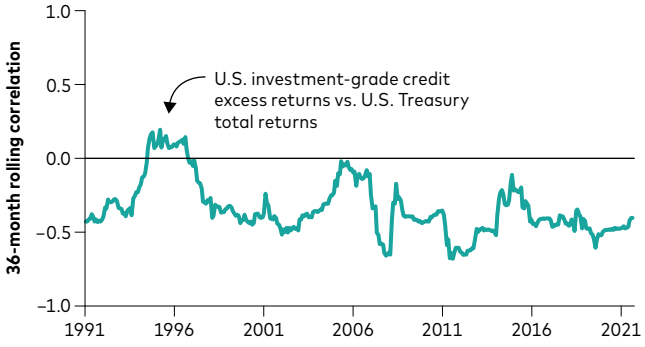
We established in Figure 4 that, on average, U.S. investment-grade credit has diversifying risk premia properties in the bond markets. **Figure 7** shows that the rolling 3-year correlation between U.S. credit and broad U.S. Treasury total returns has varied through time but remains negative except for a slightly positive correlation for 1995–1997.

On the other hand, as **Figure 8** shows, credit risk has a highly positive but not perfect rolling correlation with equities. We also observe that bond returns from interest rates since the late 1990s have had a negative correlation with equity. So as we construct the credit tilt portfolio, these correlation dynamics will be a critical portfolio construction consideration.

FIGURE 7

Correlations vary, but credit and Treasury bond diversification has been persistent through time

Rolling correlations of U.S. investment-grade credit factor and U.S. interest rate factor



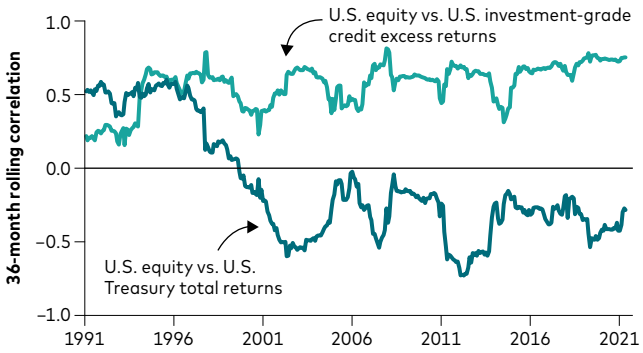
Note: Figure shows rolling 36-month correlation for broad U.S. investment-grade credit (as measured by the Bloomberg U.S. Credit Index) and U.S. Treasury (as measured by the Bloomberg U.S. Treasury Index) total monthly returns from July 1991 through March 2022.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

FIGURE 8

Interest rate exposure is the primary source of diversification in the stock and bond portfolio

Rolling correlations of U.S. equity total returns with U.S. investment-grade credit factor and U.S. interest rate factor



Note: Figure shows rolling 36-month correlation of MSCI USA Index total returns with U.S. interest rate factor returns (as measured by the Bloomberg U.S. Treasury Index) and with U.S. investment-grade credit factor returns (as measured by Bloomberg U.S. Credit Index total returns minus Bloomberg U.S. Treasury Index total returns) from December 1991 through March 2022.

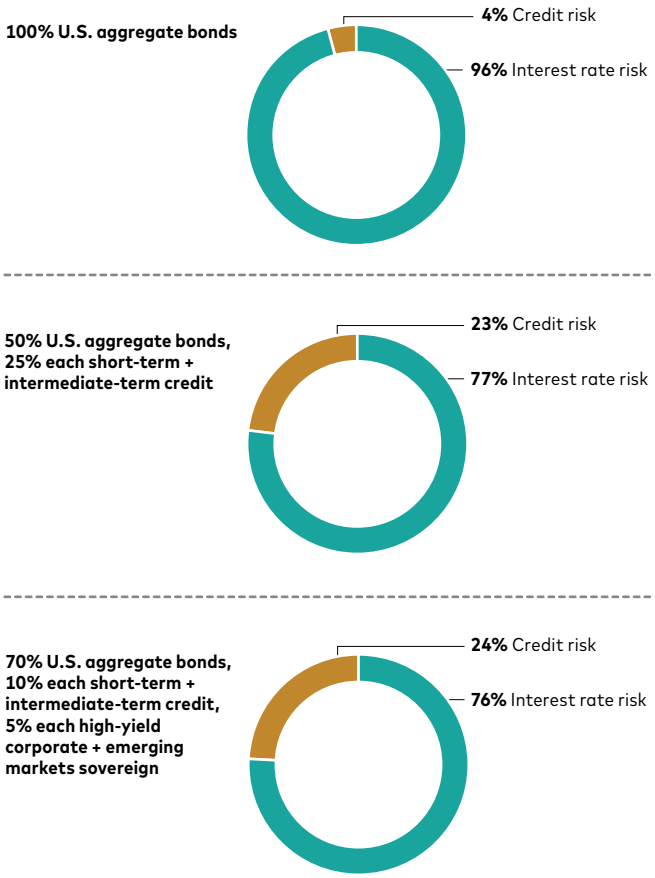
Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live.

Using risk contribution analysis, we decompose total bond portfolio volatility into its interest rate risk component that comes from the Treasury market's rate changes, and its credit risk component that arises from credit-specific risks, as measured by credit excess returns. Because return volatility from investment-grade credit is mostly driven by interest rate risk, whereas high-yield and emerging markets risk are dominated by credit risk, monitoring these risk contributions is an important consideration in determining limits on the credit tilt. Ensuring that most of the bond volatility comes from interest rate risk is an important way to preserve diversification in the multiasset portfolio and can be used to determine allocations among credit sectors that may contribute more or less credit risk. As shown in **Figure 9**, when lower-quality credit exposure is added to the portfolio, the total credit allocation must be lower to create the same amount of credit risk.

FIGURE 9

Monitoring risk contributions from credit can help preserve proper diversification

Interest rate as primary source of risk



Notes: Risk contributions are calculated as the partial derivatives of total return volatility with respect to excess return volatility and interest rate duration return volatility. U.S. aggregate bonds, short-term credit, intermediate-term credit, high-yield corporate, and emerging markets sovereign are represented by, respectively, the Bloomberg U.S. Aggregate Bond Index, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index.

Sources: Vanguard calculations, based on data from Refinitiv Datastream and Barclays Live from November 1997 through July 2022.

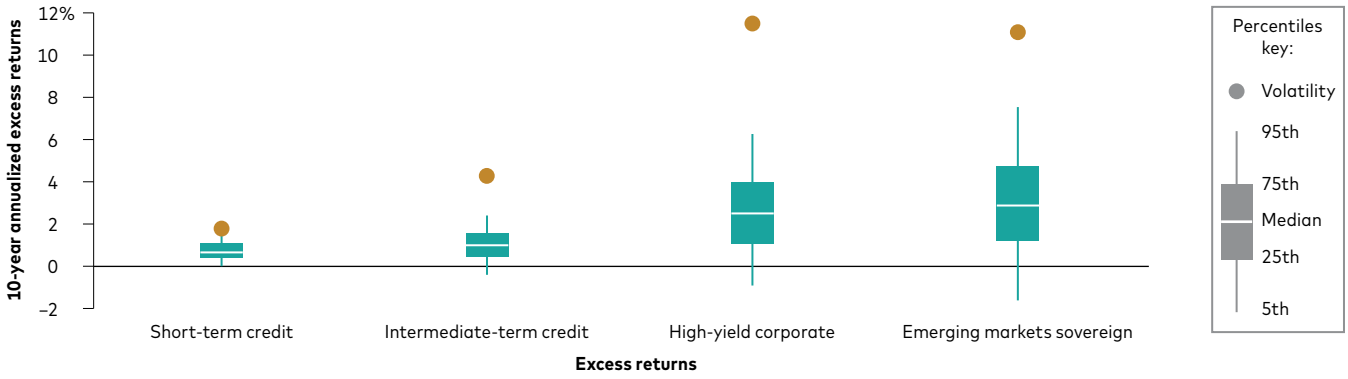
Asset return modeling

The historical existence of credit risk premia provides the foundation for our long-term forward-looking views on compensated risk premia. Our proprietary Vanguard Capital Markets Model (Davis et al., 2014) models and projects these excess return distributions over the long term. The steady state of VCMM—which represents an equilibrium view not dependent on market conditions today—is informed by historical research and guided by forward-looking qualitative viewpoints. **Figure 10** summarizes the VCMM's 10-year steady state excess return projections.

FIGURE 10

VCMM steady state properly captures risk and return considerations

10-year excess return distribution



Note: Short-term credit, intermediate-term credit, high-yield corporate, and emerging markets sovereign are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index.

Source: Vanguard Capital Markets Model.

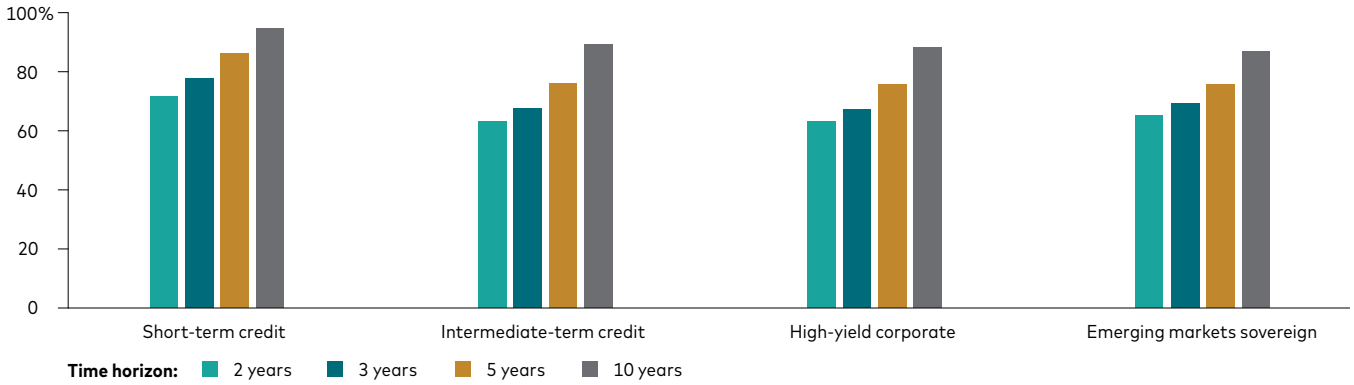
IMPORTANT: The projections and other information generated by the Vanguard Capital Markets Model (VCMM) regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Distribution of return outcomes from VCMM, derived from 10,000 simulations for each asset class and macroeconomic variable modeled. Simulations are as of December 31, 2022. Results from the model may vary with each use and over time. For more information, please see the Appendix on page 18.

Next, to substantiate the time diversification of credit premia in VCMM that we observe historically, we compared excess returns with duration-matched Treasury expected returns over different time horizons and calculated the probabilities of outperformance. We found that as the time horizon increases, the probability of credit outperforming Treasuries increases (**Figure 11**). This validates that time diversification observed historically is properly modeled in VCMM.

FIGURE 11

Time diversification inherent in increased probability of credit outperformance over time

Probability of credit return outperformance



Note: Short-term credit, intermediate-term credit, high-yield corporate, and emerging markets sovereign are represented by, respectively, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index.

Source: VCMM projections.

Vanguard Asset Allocation Model optimization

We use the Vanguard Asset Allocation Model (Aliaga-Díaz et al., 2019) as the foundation for developing our optimized portfolios. VAAM is a utility-based model that evaluates the risk and return trade-offs of selected asset classes to reach optimal solutions relative to a level of risk aversion (i.e., risk tolerance) based on VCMM asset return projections. The model can incorporate multidimensional variables such as risk and return of passive market exposures, correlations, and volatilities. The model can even optimize among factors and active combinations, though that is beyond the scope of this analysis. The VAAM optimization process evaluates thousands of unique portfolio combinations and proposes the portfolio with the highest expected utility score based on the portfolio's distribution of terminal wealth.

Portfolios are selected from the frontier based on a fixed risk-aversion level, and portfolio rankings are based on certainty fee equivalents. CFE is a measure developed to rank portfolios based on the expected risk and return dimensions for each option. It is calculated as the difference between each portfolio and the VAAM-derived "optimal" portfolio based on the latest inputs and capital market assumptions for a given scenario. It can be understood as the additional fee, in basis points, that an investor is willing to pay to access the optimal portfolio compared with staying in the two other options. The CFE calculation is derived from the utility value attached to a certain portfolio risk-return trade-off, as expressed through the coefficient of risk aversion in utility functions (Aliaga-Díaz et al., 2019).

Using VAAM for our forward-looking portfolio analysis, we analyze the benefit of static credit tilts in the multiasset portfolio. VCMM simulations used for this assessment are considered "steady state" and represent long-term average risk and return not dependent on current market conditions. For this analysis, we are including credit asset return simulations with the four broad market stock and aggregate bond market categories. The resulting portfolio optimizations will determine whether static portfolio tilts to credit asset categories are preferred in the VAAM expected utility maximization framework. Next, we compare risk and return metrics to the traditional stock/bond portfolio. We test multiple stock/bond mixes that target the established Vanguard home-bias portfolio, in which U.S. equity equals 60% of total equity and U.S. aggregate bonds equal 70% of total bond allocation across the portfolios. Critically, as informed by the historical risk decomposition analysis, credit exposure is constrained not to exceed a 25% contribution to the bond portfolio volatility, which ensures proper diversification in the multiasset portfolio. **Figure 12** compares asset allocation weights and portfolio expected risk and return metrics across 20%, 40%, and 60% equity portfolios and VAAM optimized portfolios after adding credit sectors.

FIGURE 12

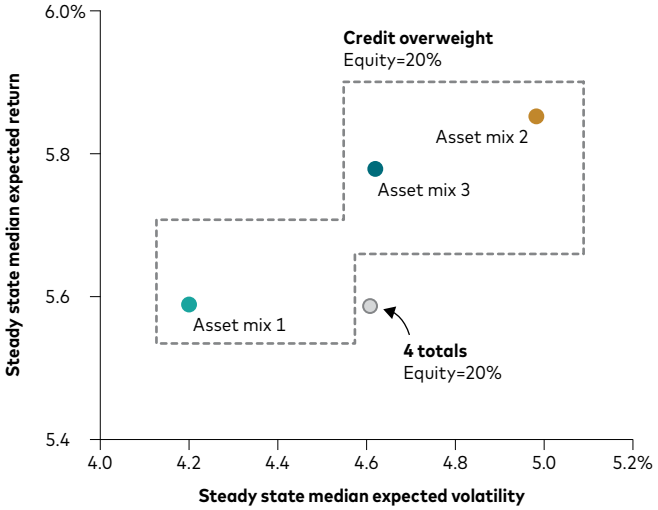
Credit tilt portfolios can be beneficial to investors across all risk profiles

VAAM optimized portfolio statistics

a. Conservative portfolio (20% equity)

Key

- **4 totals**
- **Asset mix 1:** Short-term + intermediate-term
- **Asset mix 2:** Short-term + intermediate-term + high-yield + emerging markets
- **Asset mix 3:** Short-term + intermediate-term + high-yield



	Base	Asset mix 1	Asset mix 2	Asset mix 3
U.S. investment-grade bonds	56%	16%	32%	33%
International bonds (hedged)	24%	24%	24%	24%
U.S. short-term credit bonds	0%	33%	4%	12%
U.S. intermediate-term credit bonds	0%	7%	12%	4%
U.S. high-yield corporate bonds	0%	0%	1%	8%
Emerging markets sovereign bonds (USD)	0%	0%	7%	0%
Total fixed income allocation	**80%**	**80%**	**80%**	**80%**
Median return	5.59%	5.58%	5.85%	5.77%
Median volatility	4.61%	4.20%	4.97%	4.62%
Median Sharpe ratio	0.51	0.56	0.52	0.54
Median maximum drawdown	–1.4%	–0.7%	–1.6%	–1.2%
Probability of outperformance relative to base (over 10 years)	—	50.3%	88.0%	99.0%
CFE to base	—	0.24%	0.25%	0.24%

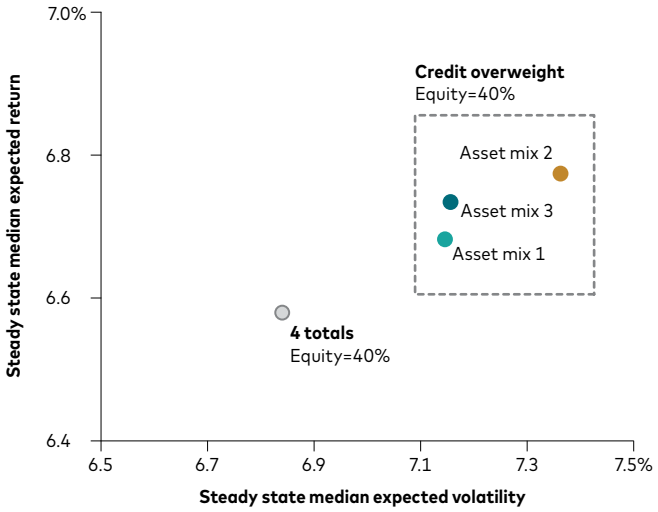
Notes: Returns of U.S. investment-grade bonds, international bonds (hedged), short-term credit bonds, intermediate-term credit bonds, high-yield corporate bonds, and emerging markets sovereign bonds in USD are represented by, respectively, the Bloomberg U.S. Aggregate Bond Index, the Bloomberg Global Aggregate ex USD Index – USD Hedged, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index. "4 totals" is a global diversified portfolio constructed using U.S. stocks, international stocks (unhedged), U.S. investment-grade bonds, and international bonds (hedged). For example, for a 60/40 4-totals portfolio, we used these proxies: for U.S. stocks, a 36% weighting in the MSCI US Broad Market Index; for non-U.S. stocks, a 24% weighting in the MSCI All Country World ex USA Index; for U.S. bonds, a 28% weighting in the Bloomberg U.S. Aggregate Bond Index; and for non-U.S. bonds, a 12% weighting in the Bloomberg Global Aggregate ex-USD Index – USD Hedged. The sum of asset category allocations may not equal the total fixed income allocation due to rounding.

Source: Vanguard Asset Allocation Model forecasts as of December 31, 2022.

b. Moderate portfolio (40% equity)

Key

- **4 totals**
- **Asset mix 1:** Short-term + intermediate-term
- **Asset mix 2:** Short-term + intermediate-term + high-yield + emerging markets
- **Asset mix 3:** Short-term + intermediate-term + high-yield



	Base	Asset mix 1	Asset mix 2	Asset mix 3
U.S. investment-grade bonds	42%	12%	24%	24%
International bonds (hedged)	18%	18%	18%	18%
U.S. short-term credit bonds	0%	0%	0%	2%
U.S. intermediate-term credit bonds	0%	30%	12%	10%
U.S. high-yield corporate bonds	0%	0%	0%	6%
Emerging markets sovereign bonds (USD)	0%	0%	6%	0%
Total fixed income allocation	**60%**	**60%**	**60%**	**60%**
Median return	6.58%	6.68%	6.77%	6.74%
Median volatility	6.84%	7.14%	7.36%	7.15%
Median Sharpe ratio	0.47	0.49	0.48	0.49
Median maximum drawdown	–3.6%	–3.9%	–4.2%	–3.9%
Probability of outperformance relative to base (over 10 years)	—	72.7%	87.4%	82.0%
CFE to base	—	0.09%	0.15%	0.14%

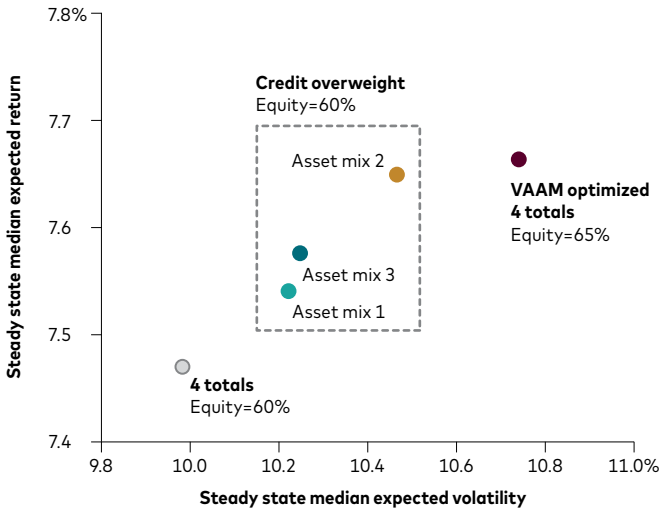
Notes: Returns of U.S. investment-grade bonds, international bonds (hedged), short-term credit bonds, intermediate-term credit bonds, high-yield corporate bonds, and emerging markets sovereign bonds in USD are represented by, respectively, the Bloomberg U.S. Aggregate Bond Index, the Bloomberg Global Aggregate ex USD Index – USD Hedged, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index. "4 totals" is a global diversified portfolio constructed using U.S. stocks, international stocks (unhedged), U.S. investment-grade bonds, and international bonds (hedged). For example, for a 60/40 4-totals portfolio, we used these proxies: for U.S. stocks, a 36% weighting in the MSCI US Broad Market Index; for non-U.S. stocks, a 24% weighting in the MSCI All Country World ex USA Index; for U.S. bonds, a 28% weighting in the Bloomberg U.S. Aggregate Bond Index; and for non-U.S. bonds, a 12% weighting in the Bloomberg Global Aggregate ex-USD Index – USD Hedged.

Source: Vanguard Asset Allocation Model forecasts as of December 31, 2022.

c. Moderately aggressive portfolio (60% equity)

Key

- **4 totals**
- **VAAM optimized 4 totals**
- **Asset mix 1:** Short-term + intermediate-term
- **Asset mix 2:** Short-term + intermediate-term + high-yield + emerging markets
- **Asset mix 3:** Short-term + intermediate-term + high-yield



	Base	Benchmark 65% 4 totals	Asset mix 1	Asset mix 2	Asset mix 3
U.S. investment-grade bonds	28%	25%	8%	16%	16%
International bonds (hedged)	12%	10%	12%	12%	12%
U.S. short-term credit bonds	0%	—	0%	0%	1%
U.S. intermediate credit bonds	0%	—	20%	8%	7%
U.S. high-yield corporate bonds	0%	—	0%	2%	4%
Emerging markets sovereign bonds (USD)	0%	—	0%	3%	0%
Total fixed income allocation	**40%**	**35%**	**40%**	**40%**	**40%**
Median return	7.47%	7.66%	7.54%	7.65%	7.57%
Median volatility	9.98%	10.74%	10.22%	10.47%	10.24%
Median Sharpe ratio	0.412	0.410	0.419	0.420	0.421
Median maximum drawdown	–7.4%	–8.4%	–7.7%	–8.0%	–7.7%
Probability of outperformance relative to base (over 10 years)	—	—	69.5%	87.3%	80.3%
CFE to base	—	—	0.05%	0.10%	0.09%
CFE to benchmark 65%	—	—	0.04%	0.08%	0.08%

Notes: Returns of U.S. investment-grade bonds, international bonds (hedged), short-term credit bonds, intermediate-term credit bonds, high-yield corporate bonds, and emerging markets sovereign bonds in USD are represented by, respectively, the Bloomberg U.S. Aggregate Bond Index, the Bloomberg Global Aggregate ex USD Index – USD Hedged, the Bloomberg U.S. 1–5 Year Credit Index, the Bloomberg U.S. 5–10 Year Credit Index, the Bloomberg U.S. Corporate High Yield Index, and the Bloomberg Emerging Markets USD Sovereign – 10% Country Capped Index. "4 totals" is a global diversified portfolio constructed using U.S. stocks, international stocks (unhedged), U.S. investment-grade bonds, and international bonds (hedged). For example, for a 60/40 4-totals portfolio, we used these proxies: for U.S. stocks, a 36% weighting in the MSCI US Broad Market Index; for non-U.S. stocks, a 24% weighting in the MSCI All Country World ex USA Index; for U.S. bonds, a 28% weighting in the Bloomberg U.S. Aggregate Bond Index; and for non-U.S. bonds, a 12% weighting in the Bloomberg Global Aggregate ex-USD Index – USD Hedged. Benchmark 65% "4 totals" is a VAAM optimized global diversified portfolio constructed using U.S. stocks, international stocks (unhedged), U.S. investment-grade bonds, and international bonds (hedged). It is anchored on the same risk aversion as the investment-grade/high-yield 60/40 credit tilt portfolio while locking in the sub-asset allocation. The sum of asset category allocations may not equal the total fixed income allocation due to rounding.

Source: Vanguard Asset Allocation Model forecasts as of December 31, 2022.

From the positive CFE calculations, we can observe that credit tilt portfolios are preferred to the base portfolio in all three cases. Interestingly, we also observe that the highest-ranking portfolios combine both investment-grade and high-yield/emerging markets credit categories and that portfolios with higher bond allocations benefit the most from these credit tilts. Although we show that the credit tilt portfolios are preferred in our utility framework, accepting credit risk in the multiasset portfolios does involve a risk-and-return trade-off. As Figure 12 shows, the credit tilt portfolios with both investment-grade and high-yield/emerging markets categories increase expected returns, but with higher volatility. This results in slightly lower Sharpe ratios and moderately larger expected maximum drawdowns across the portfolios. Notably, investment-grade-only credit tilts in conservative portfolios result in a risk-reduction benefit—lower expected volatility and portfolio drawdowns—as diversifying interest rate and credit premia are prominent in the lower-equity portfolio.

Although we have demonstrated that credit risk premium is compensated in a multiasset portfolio relative to a constant equity allocation, some may still argue that one can achieve a similar result by adding more equity risk to the portfolio. To test this premise, we use the VAAM utility function to extract the optimized equity allocation for the same risk aversion as the investment-grade/high-yield 60/40 credit tilt portfolio. When anchoring on this risk aversion, the optimal equity weight in the 4-totals market index portfolio is 65%. As Figure 12 shows, this credit tilt portfolio achieves a positive CFE compared with the equity tilt portfolio, further supporting the conclusion that a long-term credit tilt can add value to the multiasset portfolio.

Conclusion

In our research, we validate the existence of the historical credit risk premia and prove that multiasset investors have historically been compensated for taking that risk within the multiasset portfolio. Our research also indicates that credit exposure is a good diversifier to Treasuries, that the reliability of credit premia improves through time as seen from decreasing holding-period volatility, and that credit risk contributions should be monitored to preserve diversification in a stock/bond portfolio. However, credit sectors are not equal. Average excess returns and risk properties differ across sectors, so they should be considered individually when added to the portfolio. In steady state analysis, we show that credit tilt portfolios have positive CFEs compared with the base portfolios and thus can be considered beneficial to some investors seeking additional expected return in their portfolios.

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Appendix

About the Vanguard Capital Markets Model

IMPORTANT: The projections and other information generated by the Vanguard Capital Markets Model regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. VCMM results will vary with each use and over time.

The VCMM projections are based on a statistical analysis of historical data. Future returns may behave differently from the historical patterns captured in the VCMM. More important, the VCMM may be underestimating extreme negative scenarios unobserved in the historical period on which the model estimation is based.

The Vanguard Capital Markets Model® is a proprietary financial simulation tool developed and maintained by Vanguard's primary investment research and advice teams. The model forecasts distributions of future returns for a wide array of broad asset classes. Those asset classes include U.S. and international equity markets, several maturities of the U.S. Treasury and corporate fixed income markets, international fixed income markets, U.S. money markets, commodities, and certain alternative investment strategies. The theoretical and empirical foundation for the Vanguard Capital Markets Model is that the returns of various asset classes reflect the compensation investors require for bearing different types of systematic risk (beta). At the core of the model are estimates of the dynamic statistical relationship between risk factors and asset returns, obtained from statistical analysis based on available monthly financial and economic data from as early as 1960. Using a system of estimated equations, the model then applies a Monte Carlo simulation method to project the estimated interrelationships among risk factors and asset classes as well as uncertainty and randomness over time. The model generates a large set of simulated outcomes for each asset class over several time horizons. Forecasts are obtained by computing measures of central tendency in these simulations. Results produced by the tool will vary with each use and over time.

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