

Risk of loss: Should the prospect of rising rates push investors from high-quality bonds?

Vanguard research

July 2013

Executive summary. Many investors, whether individual or institutional, hold a diversified bond portfolio primarily to mitigate the volatility inherent in stocks or other risky assets.¹ However, with yields near historic lows and higher-than-normal volatility in bonds, more investors view the bond market as abnormally risky. This view began to gain traction in early 2010 and has been bolstered in the first half of 2013 as the U.S. Federal Reserve's quantitative easing program has continued while economic data have modestly improved. Indeed, the preponderance of thought is that if and when interest rates rise, the fixed income portion of an investor's aggregate portfolio may face volatility and loss. The term "bond bubble" was coined to describe this fear and is now common in the financial media.

Given many investors' concerns, this update of our earlier paper on this topic (Philips, Kinniry, and Walker, 2010) offers insight on the risk of higher interest rates to a broadly diversified bond

Authors

Christopher B. Philips, CFA
Francis M. Kinniry Jr., CFA
Brian J. Scott, CFA
Michael A. DiJoseph, CFA
David J. Walker, CFA

¹ We recognize that investors may also hold bonds for the income they produce as part of a portfolio spending plan. However, for this discussion we elected to focus on the diversified total-return investor.

portfolio.² We begin by dissecting the math of nominal bond returns (that is, unadjusted for inflation) during and after a potential rise in yields and compare this risk to those inherent in the stock market. Next we explain how the existing low level of interest rates tells us nothing about how they will evolve in the future or when rates will increase. Although the low current level of interest rates significantly increases the possibility of realizing a loss in a bond portfolio and suggests that forward returns could be significantly lower than they have been historically, we continue to encourage investors to view bonds as a diversifier for the riskier assets in their portfolio. Ultimately, most bond investors should consider maintaining their strategic allocation to fixed income and avoid tactical changes that may increase the risk in their portfolios.

Important: The projections or 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. The asset-return distributions shown in this paper are drawn from 10,000 VCMM simulations based on market data and other information available as of December 30, 2012. 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. For more information on the VCMM, please see the Appendix.

Notes about risk and performance data: All investments, including a portfolio's current and future holdings, are subject to risk, including the possible loss of the money you invest. Past performance is no guarantee of future returns. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index. Bond funds are subject to the risk that an issuer will fail to make payments on time, and that bond prices will decline because of rising interest rates or negative perceptions of an issuer's ability to make payments. High-yield bonds generally have medium- and lower-range credit-quality ratings and are therefore subject to a higher level of credit risk than bonds with higher credit-quality ratings. While U.S. Treasury or government-agency securities provide substantial protection against credit risk, they do not protect investors against price changes due to changing interest rates. U.S. government backing of Treasury or agency securities applies only to the underlying securities and does not prevent share-price fluctuations. There are additional risks when investing outside the United States, including the possibility that returns will be hurt by a decline in the value of foreign currencies or by unfavorable developments in a particular country or region.

2 In this paper, when we refer to "bonds" we are concerned only with a broadly diversified, investment-grade bond portfolio. Investment-grade bonds are those that have a credit rating the equivalent of at least Baa3 or above by Moody's Investors Service. Portfolios focused on corporate bonds (including high-yield bonds) or laddered portfolios of individual bonds can face additional risks such as credit risk (widening spreads and/or default) for corporate bonds, or liquidity and concentration risk for smaller laddered portfolios. For a more detailed discussion on the role of individual bonds versus bond funds, refer to Bennyhoff (2009) and Donaldson (2009).

Today's low level of interest rates has fueled the belief that bonds are the main source of risk in a balanced portfolio. There is a strong probability that over the next ten years, the return of broadly diversified investment-grade bonds will underperform their average of the last ten years (+4.66% through May 31, 2013, based on the Barclays U.S. Aggregate Bond Index), and there is a higher-than-normal possibility of bonds realizing a negative return in the short term. That said, Vanguard believes it is worth reminding investors that a bear market in bonds is unlikely to be the same as a bear market in equities in terms of potential downside loss. Despite current conditions and the higher-than-normal chance of bond losses, we contend that bonds are likely to remain one of the best diversifiers of equity market risk and that they will likely provide downside protection to balanced investors over the long term.

Math drives bond returns

High-quality bonds are unique compared with other investments such as equities, by virtue of the bonds' well-defined return stream as a result of their highly certain income stream. Because of this dependence on income, bonds are uniquely affected by movements in interest rates. Rising rates lead to higher yields and lower prices (that is, capital losses) and vice versa. The sensitivity of a bond's price to changes in interest rates is measured by duration, a concept explored in Bennyhoff and Zilbering (2010).

Because duration is the common metric for evaluating risk between two comparable fixed income investments, a rule of thumb is often used to generalize the relationship between interest rate movements and performance: That is, if interest rates increase 1 percentage point (100 basis points), a bond's (or bond fund's) value will drop by approximately the bond's (or the fund's weighted average) duration. Of course, this formula presumes an instantaneous, parallel shift in the yield curve, a shift that, historically, has occurred only rarely

(Davis et al., 2010). This is because the factors driving increases in near-term rates (monetary policy set forth by the Federal Reserve) and long-term rates (inflation expectations) are quite different. However, for ease of presentation we presume a parallel shift in yields. In addition, we assume that all income received is reinvested.

As of May 31, 2013, the yield on the Barclays U.S. Aggregate Bond Index stood at 2.1%, with a weighted average duration of 5.5 years. To use a simplistic example, a 1 percentage point rise in yields during a 12-month period would lead to a new yield of 3.1% and a capital loss of -5.5%. All else being equal, the expected total return during that period would be the average of the starting and ending yields—2.6% plus the capital loss associated with the rising yields (-5.5%), or -2.9%. Following the 1-percentage-point rise in rates, the initial expected return for year two would be 3.1%, instead of 2.1%. Over a two-year holding period, an investor would roughly break even in this example.

But what happens if interest rates unexpectedly rise by a significant amount, say 3 percentage points, across the yield curve? Such a jump has happened only twice in the United States, once in 1980 and again in 1981, as the Federal Reserve drove interest rates higher in an effort to combat inflation. But in relative terms historically,³ if interest rates jumped from 2.1% to 5.1%, that rise would constitute a 143% change in rates. A change of this magnitude has never occurred in the United States, but it is not impossible, given current bond market conditions. **Figure 1**, on page 4, demonstrates the hypothetical impact of a 300-basis-point increase in interest rates on an investment linked to the broad U.S. bond market. As expected, in year one, the price decline would be significant, potentially leading to the second-worst 12-month return ever for U.S. bond investors (historically, the actual worst 12-month return for U.S. bond investors was -13.9% for the 12 months ended September 30, 1974).

3 In 1994 interest rates rose from 3% to 6%, a 100% increase. If we assume a 3% increase in rates from current levels (2.1% as of May 31, 2013, for the Barclays U.S. Aggregate Bond Index), that would constitute a 143% increase, which is relatively larger than the 100% increase in 1994.

Figure 1. Hypothetical example of impact of 3-percentage-point increase in interest rates

	Today	+1 year	+2 years	+3 years	+4 years	+5 years
Yield	2.1%	5.1%	5.1%	5.1%	5.1%	5.1%
Price change	0.0	-16.5	0.0	0.0	0.0	0.0
Total return	2.1	-12.9	5.1	5.1	5.1	5.1
Cumulative total return		-12.9	-8.5	-3.8	1.1	6.3
Annualized total return		-12.9	-4.3	-1.3	0.3	1.2

Notes: This hypothetical example does not represent the return on any particular investment. “Today’s” yields are as of May 31, 2013, based on Barclays U.S. Aggregate Bond Index. For simplicity, duration was assumed to remain at 5.5 years, but in practice, as yields change, duration also changes. Such a dramatic change in yields as this example assumes would likely constitute a rather significant adjustment to a fund’s weighted average duration. For purposes of illustration, we assumed no changes to yields in subsequent years.

Source: Vanguard.

For a total-return investor, the new yield level starting in year two (see Figure 1) would perhaps be of greater importance. Following the initial year of pain, that same investor who “stayed the course” would expect a 5.1% return going forward, all else being equal. Three years following the hypothetically second-worst bond market return ever, the diversified bond investor would be close to breaking even, simply by reinvesting interest distributions.⁴ It may be tempting to view this analysis as an endorsement for active fixed income investing in a rising interest rate environment. After all, why not use an active strategy in the hope that it will avoid the initial year of pain altogether by reducing the fund’s interest rate sensitivity before rates rise? Although such a strategy may seem conceptually appealing, in practice few active fixed income managers have consistently demonstrated foresight in timing interest rate movements. Vanguard research has shown that in a majority of rising-rate periods, active managers, on average, failed to outperform their relevant benchmarks.⁵

Current interest rates tell us nothing about where they’re headed

The three yield curves in **Figure 2** illustrate why concern grew in 2010 about the potential for a “bubble” and losses in bonds. The blue yield curve represents spot (actual point-in-time) U.S. bond

yields on May 28, 2010, while the red curve shows the three-year forward curve on May 28, 2010. This curve represents what the market expected the yield curve to look like three years hence, based on information available on May 28, 2010. Clearly, market expectations were that interest rates would rise across the entire curve, with the largest increases at the short and intermediate portions of the curve.⁶ The gold yield curve shown in Figure 2 represents the actual yield curve as of May 31, 2013.

Hindsight reveals, of course, that interest rates did not evolve as expected in 2010. In practice, interest rate movements rarely conform to expectations, because the factors that drive interest rate changes are notoriously difficult to accurately predict with consistency. An investor in 2010 who shortened the duration of his or her fixed income portfolio based on expectations of rising interest rates and the imminent bursting of the “bond bubble” lost significant income and capital gains as interest rates continued to fall into 2013.

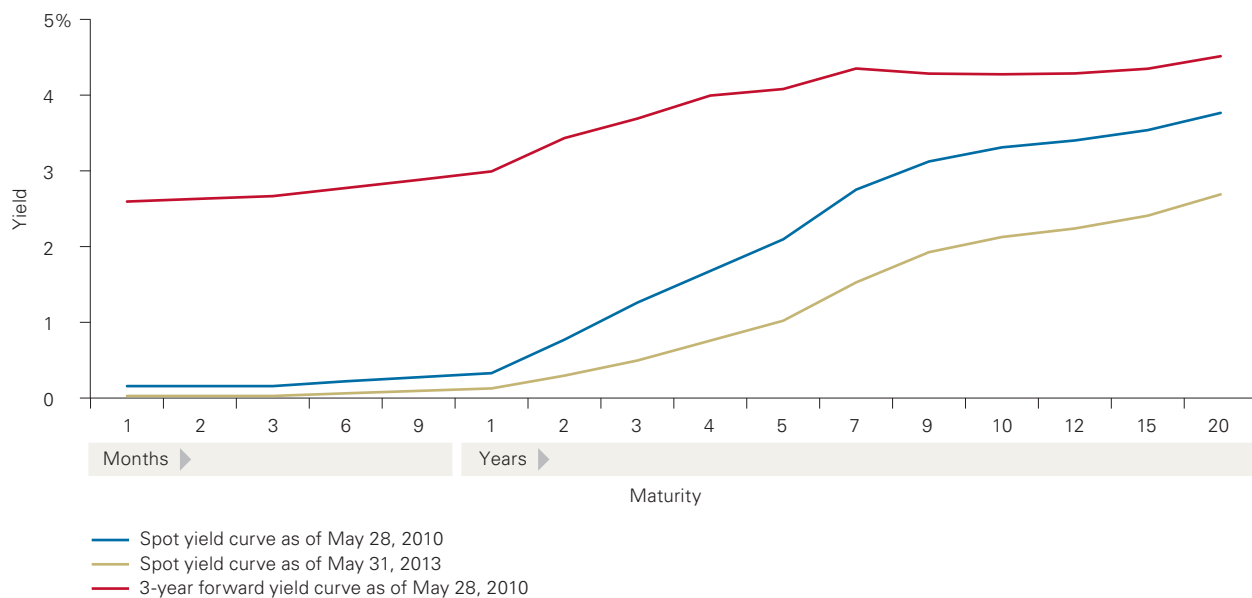
Figure 2 thus underscores that the current level of interest rates cannot be considered to presage future changes in rates: Just because interest rates are low doesn’t mean they can’t go lower or that they must go higher. On May 28, 2010, the yield of the 10-year Treasury note was 3.31%, near the

4 All illustrations and bond math examples in this paper are in nominal, not real, terms.

5 For more on the performance of active fixed income funds in rising rate environments, see Philips and Walker (2011).

6 For more on factors that drive the evolution of the yield curve, see Davis et al. (2010).

Figure 2. Interest rates rarely evolve as expected: U.S. bonds



Source: Vanguard.

lowest level that most of today's investors had ever seen in their lifetime (the last time the 10-year Treasury yield was this low was in August 1957). This fact likely contributed to the market's expectation that interest rates would increase. Given that predicting interest rate movements is so difficult and because the level of rates reveals nothing about their future direction, we encourage investors to avoid the temptation to stray from a broadly diversified fixed income exposure. Indeed, we would argue that periods of heightened economic uncertainty require greater, not less, fixed income diversification, similar to what an investor might achieve by shortening the duration of his or her portfolio to avoid losses in bonds if interest rates rise.

Putting a 'bond bear market' in context

When evaluating the potential risks in the bond market, it is critical to remember why bonds are an integral part of a well-thought-out asset allocation plan: *to diversify the risk inherent in the equity markets*. Simply put, although the fears of rising interest rates may be legitimate, as **Figure 3**, on page 6, shows, a potential bear market in bonds

can be dramatically different from a bear market in stocks (or other risky assets). In fact, unlike stocks, where the common definition of a bear market is a decline of at least 20% in prices, to most investors a bear market in bonds is simply thought of as a period of negative returns. And to date (as of May 31, 2013), the broad U.S. bond market has never experienced a -20% return. Indeed, it's the magnitude of returns that is the key differentiator between bad periods for bonds versus stocks. For example, the worst 12-month period for U.S. bonds since 1926 (the 12 months ended September 1974) saw a decline of -13.9%, while the worst 12-month period for U.S. stocks (the 12 months ended June 1932) returned -67.6%. In another example, the worst calendar year for the broad bond market since the inception of the Barclays U.S. Aggregate Bond Index was 1994, in which, owing to an unexpected upward shift in interest rates, the bond market dropped -2.9% (in 1995, following the decline, the bond market surged +18.5%). Contrast this to the experience of stock investors in 2008, in which the Standard & Poor's 500 Index lost more than -2.9% over the course of 27 individual trading days.

Figure 3. Stocks contain more risk than bonds (selected periods, January 1927–May 2013)

	Using rolling 12-month data		Using calendar-year data	
	U.S. stocks	U.S. bonds	U.S. stocks	U.S. bonds
Annualized 12-month return	10.2%	5.6%	10.0%	5.5%
Percentage of negative 12-month returns	26.4	15.1	28.7	14.9
Percentage of 12-month return that was less than –10%	13.8	0.2	13.8	0.0
Percentage of 12-month return that was less than –20%	6.3	0.0	6.9	0.0
Worst one-year return	–67.6	–13.9	–43.1	–8.1

Notes: When determining which index to use and for what period, we selected the index that, in our view, best represented the characteristics of the referenced market, given the information then available. Thus, U.S. stock market represented by Standard & Poor's 90 from 2/1926 through 3/3/1957; S&P 500 Index from 3/4/1957 through 1974; Wilshire 5000 Index from 1975 through April 22, 2005; and MSCI US Broad Market Index thereafter. U.S. bond market represented by S&P High Grade Corporate Bond Index from 1926 through 1968; Citigroup High Grade Index from 1969 through 1972; Lehman Brothers U.S. Long Credit AA Index from 1973 through 1975; Barclays U.S. Aggregate Bond Index from 1976 through 2009; and Spliced Barclays U.S. Aggregate Float Adjusted Bond Index thereafter. Data assume portfolio was rebalanced monthly. Data through May 2013.

Source: Vanguard.

Mitigating bond risk by moving to cash

We recognize that bond investors facing the prospect of rising rates might naturally be inclined to either shorten duration or move into cash. Such a strategy, however, comes with several potential concerns. Davis et al. (2010) noted the inherent risks to this approach in the event the yield curve experiences a “bear flattening,” meaning short-term rates rise whereas longer-term rates remain anchored. In addition, investors selling bonds for cash will experience an opportunity cost in the form of lower yield while they wait for the anticipated rise in rates. The longer the wait, the greater the sacrifice in yield. Finally, because cash has historically offered a meager real return, those investors employing such a strategy would then need to correctly time their exit. This is because, historically, cash investments have tended to underperform both stocks and bonds following a given rise in interest rates in both nominal and real returns.

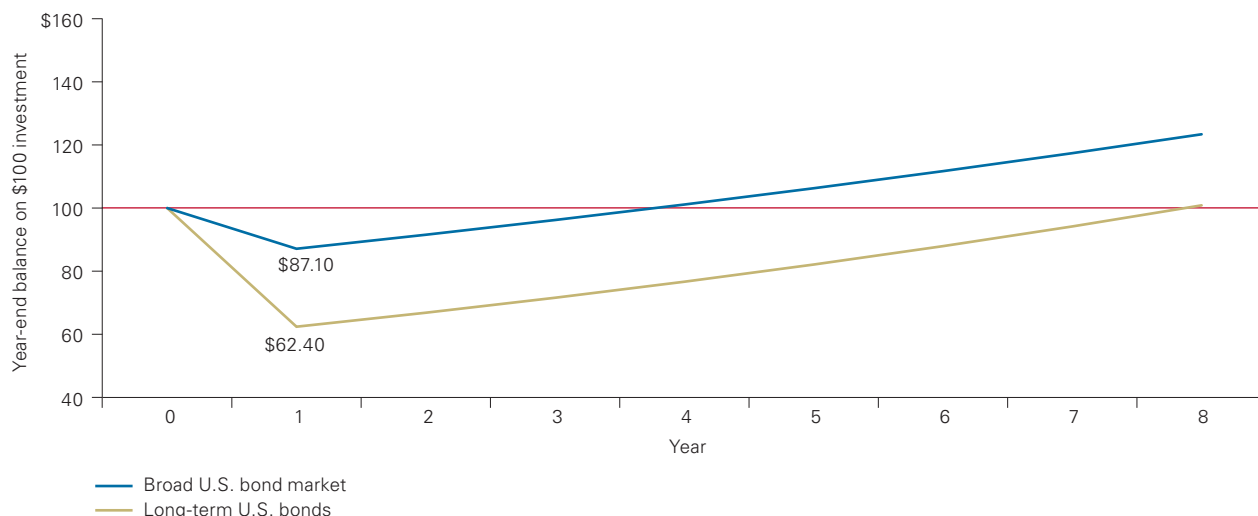
In addition to the “magnitude differences,” an additional challenge for stock investors is that, unlike bonds, in which a decline in prices leads to higher (nominal) yield—as shown in Figure 1—there is not so direct a relationship for stocks. This is because the yields and price/earnings (P/E) valuations in the stock market are driven by earnings as well as prices. In other words, two metrics are at work instead of one. In short, price declines do not automatically imply that earnings won't decline as well, leading to valuations during or after a bear market that may not improve, as witnessed during the previous two bear markets.⁷ (See also the box on this page on “Mitigating bond risk.”)

Despite today's lower outlook for bonds, not all bonds are alike

Although the current low level of interest rates cannot predict their future course, it does tell us that the possibility of realizing a loss in higher-quality bonds in the short term has rarely been higher. Today's low yields mean that even a small increase in interest rates may result in price declines that exceed the income that bonds generate. That said, it is important for investors to recognize that not all

⁷ For example, the bear market from March 2000 through September 2002 saw the S&P 500 Index's P/E ratio actually increase at the end of 2001, before finally falling to the levels that preceded the market peak. And more recently, over the course of the October 2007 through February 2009 bear market, earnings and prices each declined a similar amount, resulting in P/E valuations that remained stable throughout much of the bear market.

Figure 4. Hypothetical impact of one-time 3-percentage-point increase in interest rates on \$100 investment in two bond portfolios



Notes: This hypothetical example does not illustrate any particular investment. Broad U.S. bond market represented by Barclays U.S. Aggregate Bond Index and long-term U.S. bonds represented by Barclays U.S. Long Government/Credit Bond Index. For simplicity, durations were assumed to remain at 5.5 years for the broad U.S. bond market and 14.4 years for long-term bonds, per the durations for each benchmark as of May 31, 2013. In practice, as yields change, duration also changes. Such a dramatic change in yields as this example assumes would likely constitute a rather significant adjustment to a fund's weighted average duration. For purposes of illustration, we assumed no changes to yields in subsequent years.

Source: Vanguard.

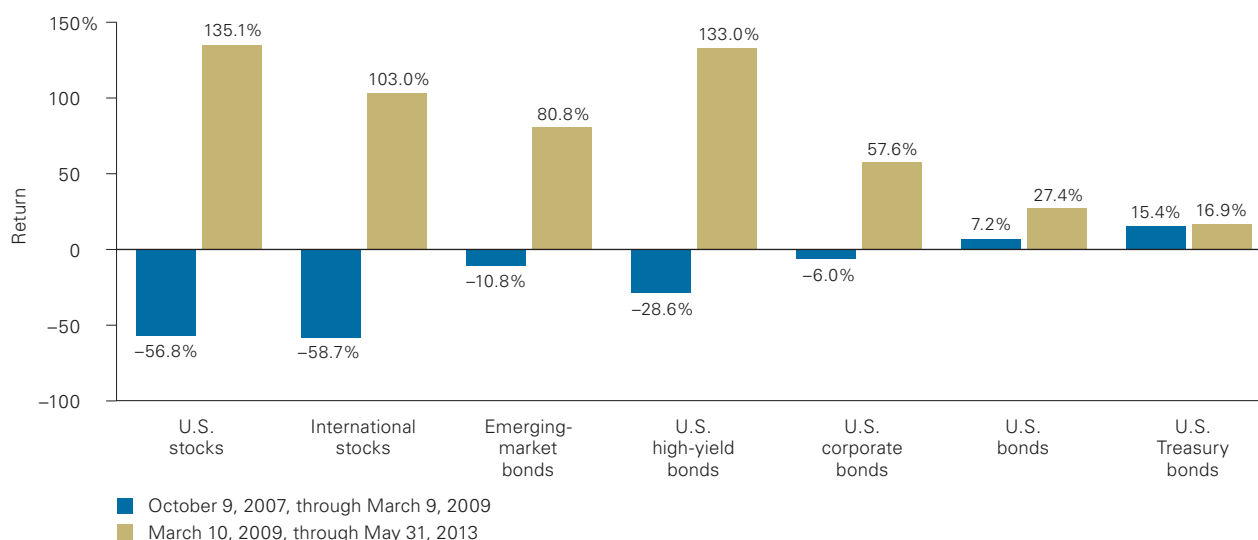
bonds are alike in terms of their sensitivity to interest rate changes. Some of the more dire pronouncements regarding losses in bonds reflect the experience an investor might realize in more interest-rate-sensitive bonds with very long durations.

Figure 4 illustrates this point by extending Figure 1's analysis to include the hypothetical impact of a one-time 3-percentage-point increase in interest rates on a \$100 investment in a long-term bond portfolio versus a broadly diversified total U.S. bond portfolio. In both cases, the one-time increase in interest rates results in a loss in year one, with the largest losses realized in the long-term bond portfolio (which is more highly sensitive to changes in interest rates). The losses in the long-term bond portfolio in year one are sizable, conform to the common definition of a bear market in equities, and would require eight years to recover. Meanwhile the broadly diversified bond portfolio, which is more similar to the bond

exposure of the "average" investor, realizes a –12.9% loss in year one and recovers all losses by the end of year four. This analysis is not meant to dismiss a loss of this magnitude as insignificant or to rule out the possibility of an even larger loss. Indeed, a –12.9% loss would exceed that of any 12-month decline that a diversified U.S. bond investor has realized since September 1974. This example is designed, rather, to illustrate how over time, a diversified long-term investor can recover losses realized during a sharp spike in interest rates, and that the losses realized during this period are likely to be smaller in magnitude than that of a typical bear market in equities.

The current low level of interest rates has focused investors' attention almost exclusively on interest rate risk. A more complete view of risk recognizes that bond prices are influenced by more than just unexpected changes in interest rates, and can also

Figure 5. Comparing performance of U.S. bonds versus U.S. stocks before and after the recent global financial crisis



Notes: Returns for U.S. stocks and international stocks represent price returns; returns for bonds represent total returns. U.S. stocks represented by MSCI US Broad Market Index; international stocks represented by MSCI World Index ex USA; emerging-market bonds represented by JPMorgan Global Emerging Markets Index; high-yield bonds represented by Barclays U.S. High Yield Bond Index; corporate bonds represented by Barclays U.S. Corporate Investment Grade Bond Index; U.S. bonds represented by Barclays U.S. Aggregate Bond Index; and Treasury bonds represented by Barclays U.S. Treasury Bond Index.

Source: Vanguard.

be affected by unexpected changes in inflation expectations, credit fundamentals, market liquidity, sovereign risk developments, and other factors. Portfolio construction that is driven solely by an interest rate forecast may expose investors to unintended outcomes and higher levels of volatility.

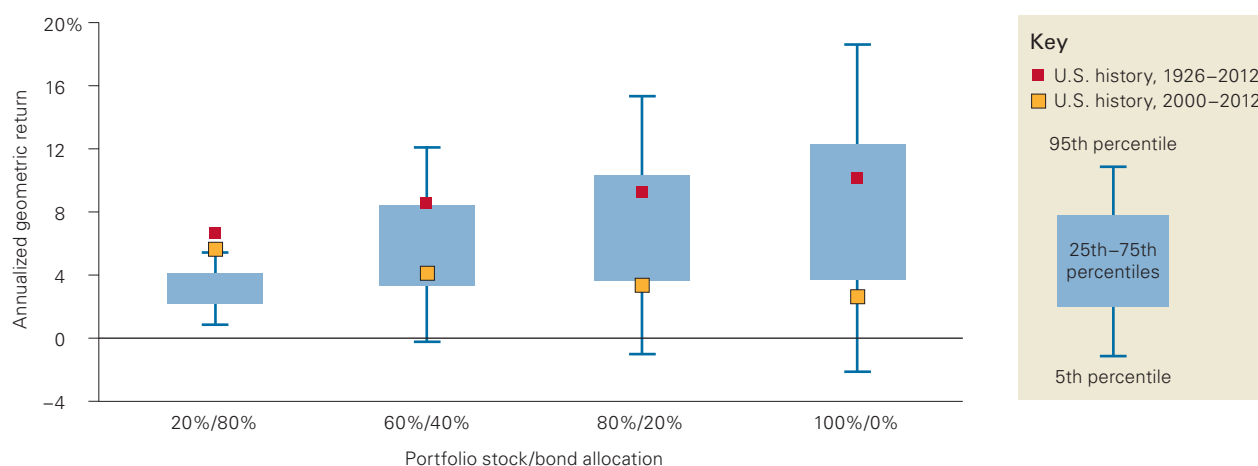
Figure 5 compares the performance of a variety of bonds with that of equities during the 2007–2009 global financial crisis (blue bars) and the subsequent equity market recovery (gold). Some of the more popular substitutes for U.S. Treasuries, like emerging-market debt, high-yield bonds, and even corporate bonds periodically exhibit return patterns that are far more similar to those of equities than bonds.⁸ Although long-term U.S. Treasuries have much higher volatility and price sensitivity to changes in interest rates, they have historically helped to mitigate equity market volatility in a flight to quality.

Your total portfolio matters most, not just the bonds within it

Although, going forward, the risk of loss in bonds in the short term has rarely been higher, what should matter most to investors who are diversified in stocks and bonds is the return of their total portfolio, not just the return of the bonds within it. For a diversified investor, the main source of risk and return over the long term is equities, while the role of bonds is to narrow the dispersion of potential returns. This point is demonstrated in **Figure 6**, which presents simulated nominal return distributions for March 2013–March 2022 for four hypothetical portfolios ranging from more conservative to more aggressive.

⁸ For more on the dynamic nature of correlations, see Philips, Walker, and Kinniry (2012).

Figure 6. Bonds tend to reduce, not increase, downside risk over the long term:
Nominal return outlook for various stock/bond portfolios over the next ten years



Underlying data for this figure

Portfolio stock/bond allocation	20%/80%	60%/40%	80%/20%	100%/0%
Bottom 5th percentile	1.0%	−0.2%	−1.1%	−2.2%
25th percentile	2.3	3.3	3.6	3.7
75th percentile	4.1	8.4	10.4	12.3
Top 95th percentile	5.5	12.1	15.4	18.6
■ U.S. history, 1926–2012	6.7	8.6	9.3	10.2
■ U.S. history, 2000–2012	5.7	4.3	3.4	2.6

Notes: This hypothetical example does not represent the return on any particular investment. Percentile distributions were determined based on results from the Vanguard Capital Markets Model (described in the Appendix). For each portfolio allocation, 10,000 simulation paths for U.S. equities and bonds were combined, and the 5th, 25th, 75th, and 95th percentiles of return results are shown in the “box and whisker” diagrams. The small red and yellow boxes indicating U.S. historical returns for 1926–2012 and 2000–2012 represent equity and bond market annualized returns over these periods. Returns are based on the broad-market indexes listed in the notes to Figure 3.

Sources: Vanguard, including VCMM simulations, and Thomson Reuters Datastream. For further details, see Davis, Aliaga-Díaz, and Patterson (2013).

Despite a muted return outlook and a greater risk of loss from bonds, these simulations illustrate that over a ten-year holding period the expected risk of loss in a balanced portfolio actually *decreases* as the allocation to high-quality bonds *increases*. The first portfolio shown in Figure 6, with an allocation of 20% stocks/80% bonds, would likely avoid a negative return over the ten years and would have a relatively narrow distribution of expected returns, though it is also likely to realize modest nominal returns. Comparing this potential outcome with those of the other portfolios in the figure with larger allocations to equities makes clear that equities, not bonds, increase both the probability of realizing a loss and the dispersion of returns.⁹

Conclusion

The implications of this paper’s analysis are clear: (1) For a majority of diversified, long-term investors, a potential bond bear market should not be viewed with the same level of apprehension as a potential equity bear market. Indeed, even the worst 12-month period for the U.S. bond market historically saw a little more than just one-fifth the losses of the worst 12-month period for the U.S. equity market; (2) If a bond bear market were to occur, investors would be able to somewhat offset price declines with higher nominal yields and potentially higher subsequent nominal returns; (3) Accurately predicting how interest rates will change is very difficult, and greater economic uncertainty argues for more fixed income diversification, not less; (4) Diversified fixed income

⁹ For more on Vanguard’s outlook on balanced portfolio returns, see Davis, Aliaga-Díaz, and Patterson (2013).

exposure remains a prudent complement to equities. Such a strategy may help to protect against losses similar either to the historical declines of longer-duration bond portfolios when interest rates have risen, or to the level of decreases similar to those experienced by lower-quality bond portfolios when equity markets have declined; and (5) Although the potential for negative returns in the short term for high-quality bonds has never been higher, over long-term holding periods we expect bonds to continue to reduce the risk of loss for balanced investors. Even when interest rates rise, what ultimately matters most for loss-averse investors is the return of their *total* portfolio, not just the returns of the bond *portion* of their portfolio.

References

Bennyhoff, Donald G., 2009. *Municipal Bond Funds and Individual Bonds*. Valley Forge, Pa.: The Vanguard Group.

Bennyhoff, Donald G., and Yan Zilbering, 2010. *Distinguishing Duration From Convexity*. Valley Forge, Pa.: The Vanguard Group.

Davis, Joseph H., Roger Aliaga-Díaz, Donald G. Bennyhoff, Andrew J. Patterson, and Yan Zilbering, 2010. *Deficits, the Fed, and Rising Interest Rates: Implications and Considerations for Bond Investors*. Valley Forge, Pa.: The Vanguard Group.

Davis, Joseph, Roger Aliaga-Díaz, and Andrew J. Patterson, 2013. *Vanguard's Economic and Investment Outlook*. Valley Forge, Pa.: The Vanguard Group.

Donaldson, Scott J., 2009. *Taxable Bond Investing: Bond Funds or Individual Bonds?* Valley Forge, Pa.: The Vanguard Group.

Philips, Christopher B., Francis M. Kinniry Jr., and David J. Walker, 2010. *Risk of Loss: Should Investors Shift From Bonds Because of the Prospect of Rising Rates?* Valley Forge, Pa.: The Vanguard Group.

Philips, Christopher B., and David J. Walker, 2011. *Rising Rates: A Case for Active Bond Investing?* Valley Forge, Pa.: The Vanguard Group.

Philips, Christopher B., David J. Walker, and Francis M. Kinniry Jr., 2012. *Dynamic Correlations: The Implications for Portfolio Construction*. Valley Forge, Pa.: The Vanguard Group.

Appendix. About the Vanguard Capital Markets Model

The Vanguard Capital Markets Model (VCMM) is a proprietary financial simulation tool developed and maintained by Vanguard's Investment Strategy Group. The VCMM uses a statistical analysis of historical data for interest rates, inflation, and other risk factors for global equities, fixed income, and commodity markets to generate forward-looking distributions of expected long-term returns.

The VCMM is grounded in the empirical view that the returns of various asset classes reflect the compensation investors receive for bearing different types of systematic risk (or beta). Using a long span of historical monthly data, the VCMM estimates a dynamic statistical relationship among global risk factors and asset returns. Based on these calculations, the model uses regression-based Monte Carlo simulation methods to project relationships in the future. By explicitly accounting for important initial market conditions when generating its return distributions, the VCMM framework departs fundamentally from more basic Monte Carlo simulation techniques found in certain financial software.

The primary value of the VCMM is in its application to analyzing potential client portfolios. VCMM asset-class forecasts—comprising distributions of expected returns, volatilities, and correlations—are key to the evaluation of potential downside risks, various risk–return trade-offs, and diversification benefits of various asset classes. Although central tendencies are generated in any return distribution, Vanguard stresses that focusing on the full range of potential outcomes for the assets considered, such as the data presented in this paper, is the most effective way to use VCMM output.

The VCMM seeks to represent the uncertainty in the forecast by generating a wide range of potential outcomes. It is important to recognize that the VCMM does *not* impose “normality” on the return distributions but, rather, is influenced by the so-called fat tails and skewness in the empirical distribution of modeled asset-class returns. Within the range of outcomes, individual experiences can be quite different, underscoring the varied nature of potential future paths.



P.O. Box 2600
Valley Forge, PA 19482-2600

Connect with Vanguard® > vanguard.com

Vanguard research >

Vanguard Center for Retirement Research
Vanguard Investment Strategy Group

E-mail > research@vanguard.com

For more information about Vanguard funds, visit vanguard.com or call 800-662-2739 to obtain a prospectus. Investment objectives, risks, charges, expenses, and other important information about a fund are contained in the prospectus; read and consider it carefully before investing.

CFA® is a trademark owned by CFA Institute.