Rising interest rates: Weighing risk for TDF retirees

Vanguard Research

January 2016

Matthew C. Brancato, CFA, CPA; Scott J. Donaldson CFA, CFP®; David C. Pakula

- How might a rising interest rate environment affect target-date fund (TDF) investors who rely on their portfolio and other sources of income in retirement?
- To illustrate the different levers that drive bond prices, we first examine a simplified portfolio entirely comprising fixed income securities. We then examine a retirement portfolio of a hypothetical investor in the Vanguard Target Retirement Funds to illustrate the potential impact of a sustained rise in interest rates.
- Our findings suggest that Vanguard TDF investors in or near retirement who begin to draw down their portfolios have a reasonable probability of funding their spending needs over both the short and long term.
- However, investors in retirement do face three key risks, regardless of the movement of interest rates: the risk of not saving enough; the risk that a large spending need will materialize and compromise their portfolios' viability; and the risk that an unexpected inflationary environment could seriously damage their portfolios.

The timing of the U.S. Federal Reserve's interest rate "liftoff" has long been a focal point of global economic and market news. How should investors respond to liftoff? Should they rethink their asset allocations? What will be the likely impacts on their total portfolio as rates rise? Are recent retirees or those nearing retirement at risk? And can this risk be quantified? This paper examines the portfolio of a hypothetical investor in the Vanguard Target Retirement Funds to provide an analytical framework for addressing each of these issues and assessing the potential impact of rising rates on retirees' portfolios.

The role of bonds in a portfolio

Since the Federal Reserve recently increased short-term rates, we should see more of a rise at the short end of the interest rate curve than at the long end—if the current "forward interest rate curve" is any indication (Davis, 2014). Of course, with this move, bonds issued at lower interest rates than the ones available at the time of the rate rise will be worth comparatively less. More specifically, their prices will fall, so that the bonds' total returns, on a forward-looking basis, equal the total return on new issues with higher interest rates.

A bond portfolio that constantly buys new issues and experiences the maturation of older issues confronts two contrasting forces. On the one hand, the prices of existing bonds in the portfolio fall, as just described. On the other hand, the bond portfolio buys newer issues with higher yields. On a net basis, our findings suggest that a TDF investor with a time horizon longer than the portfolio's duration may actually benefit from a rising interest rate environment.

Today, many investors seem to place a greater weight on the uncertainty associated with *when* interest rates will begin a sustained rise than on the value of a portfolio's bonds themselves or their broader role in a portfolio. In fact, the diversification benefit, due to the mechanics of more certain bond coupon payments

Important note: 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 may 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. For more information, see the Appendix.

Notes on risk: All investing is subject to risk, including the possible loss of the money you invest. Past performance is no guarantee of future results. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index. Diversification does not ensure a profit or protect against a loss. 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. Investments in stocks or bonds issued by non-U.S. companies are subject to risks including country/regional risk and currency risk. Prices of mid- and small-cap stocks often fluctuate more than those of large-company stocks.

Investments in target-date funds are subject to the risks of their underlying funds. The year in the fund name refers to the approximate year (the target date) when an investor in the fund would retire and leave the workforce. The fund will gradually shift its emphasis from more aggressive investments to more conservative ones based on its target date. An investment in a target-date fund is not guaranteed at any time, including on or after the target date. Investors should periodically monitor the portfolio to ensure it is in line with their current situation.

leading to lower volatility, is exactly why bonds are owned in a portfolio. A bond's nominal total return through maturity in the absence of default is known in advance.

In contrast, no one can predict with certainty what the equity returns (including dividend payments) in a rising rate environment will be. Stock volatility can increase as a result of changes in both company fundamentals and investors' perception of factors that may affect those fundamentals. Of course, the trade-off is that stock fund holdings can potentially generate more upside return than can bond funds. A portfolio similar to that of an investment such as Vanguard Target Retirement Income Fund, containing about 30% stocks and 70% bonds, can deliver a well-balanced, diversified solution (Vanguard, 2013).

Impact of rising interest rates

Levers that drive returns for a simplified fixed income portfolio

Many variables can affect the success of a retirement portfolio. Spending from the portfolio and movements of interest rates are two major factors. To analyze these variables, we looked, first, at a simplified scenario (illustrated in **Figure 1**), involving a hypothetical 100% fixed income portfolio whose bonds had a 7-year average maturity and an initial yield of 2.3%. The portfolio's duration, a measure of the sensitivity of bond—and bond mutual fund—prices to interest rate movements, was 5.8 years (as we discuss later, duration can be used to measure the effect of bond-price volatility on a portfolio's total return).[1] Figure 1 looks at a hypothetical investor's ending portfolio value using the simplified model at age 95 as a multiple of his or her salary at retirement, given various drawdown and interest rate assumptions.

Figure 1. Hypothetical retiree's ending portfolio value at age 95 as a multiple of ending retirement salary with various drawdown and interest rate increase scenarios for a 100% fixed income investor

Portfolio drawdown

Percentage of balance from private sources	1.3%	1.6%	1.9%	2.1%	2.4%	2.7%	2.9%
Percentage of final-year salary from private sources	20%	24%	28%	32%	36%	40%	44%
Interest rate increase 0.0%	19x	17x	15x	12x	10x	8x	5x
0.5%	32x	29x	26x	23x	20x	17x	14x
1.0%	53x	49x	44x	40x	36x	31x	27x
1.5%	84x	78x	72x	66x	60x	54x	48x
2.0%	131x	123x	115x	106x	98x	90x	81x
				Base case			

Notes: This hypothetical illustration is not based on the results of any specific portfolio. Table assumes a 100% fixed income portfolio whose bonds have a 7-year average maturity and an initial yield of 2.3%. For simplicity, the portfolio turns over each year and therefore reflects the current yield environment as rates rise. Final-year salary (at age 65) is inflation-adjusted to calculate spending. Drawdown figures are from private sources only. Consistent with research outlined in the paper *Vanguard's Approach to Target-Date Funds* (Donaldson et al., 2015), Social Security is assumed to bring the total percentage of final-year salary under the "base case" to 78%, which equals about 5% of the hypothetical investor's portfolio balance.

Source: Vanguard.

1 As of October 31, 2015, the Barclays U.S. Aggregate Bond Index had an average duration of 5.8 years, an average coupon rate of 3.16%, and a yield-to-date of 2.3%.

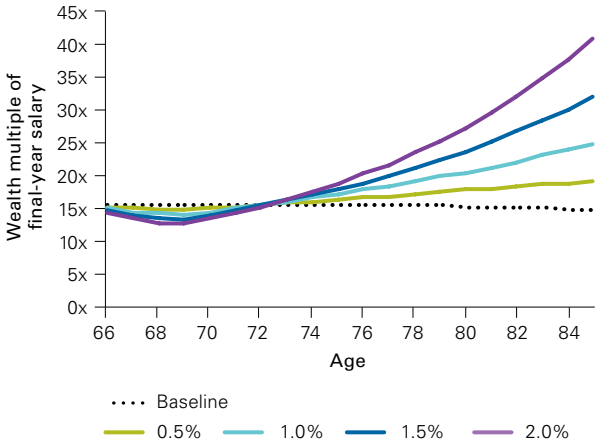
The interest rate sensitivity table in Figure 1 shows that an increase in interest rates benefits the long-term investor by providing an opportunity to incorporate bonds with higher interest rates over time. For example, the figure's base-case scenario shows that as interest rates continue to increase, the multiple of one's retirement salary remaining at age 95 increases. This effect overwhelms the short-term decrease in portfolio value caused by a rising rate environment.

Of course, timing matters, and not all investors can wait for the long term. To frame this concern, **Figure 2** illustrates the change in hypothetical portfolio values (as a multiple of final-year salary) over time for a retiree, given various increases in interest rates.

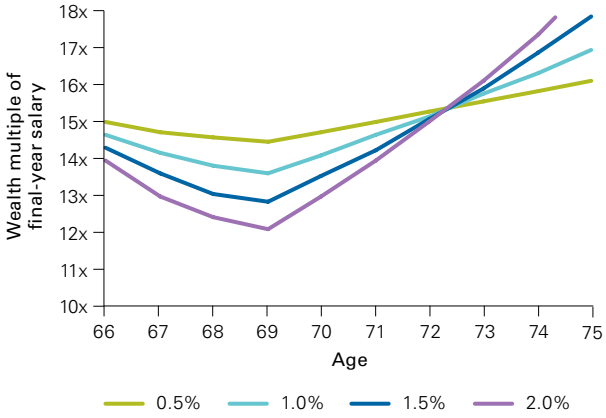
As Figure 2 shows, the portfolio value decreases as interest rates rise, and then the portfolio begins to recover. Part *b* of the figure, which highlights the first ten years of retirement, illustrates that the portfolio benefits from the higher-yielding bonds purchased within a six-year window and, assuming a continuation of the same drawdown strategy used at the beginning of the time horizon, recovers to the full portfolio value within six years.

Figure 2. Hypothetical retiree's portfolio values across time under various interest rate scenarios

a. Portfolio values across time, ages 66–85



b. Highlighted portfolio values over first ten years of retirement, ages 66–75



c. Rising interest rate scenarios

Interest rate rise for each of the next four years	Resulting interest rate in five years
0.5%	4.3%
1.0%	6.3%
1.5%	8.3%
2.0%	10.3%

Notes: This hypothetical illustration is not based on the results of any specific portfolio. Data include Social Security. Private sources are expected to make up 32 percentage points of a 78% replacement rate, on average.

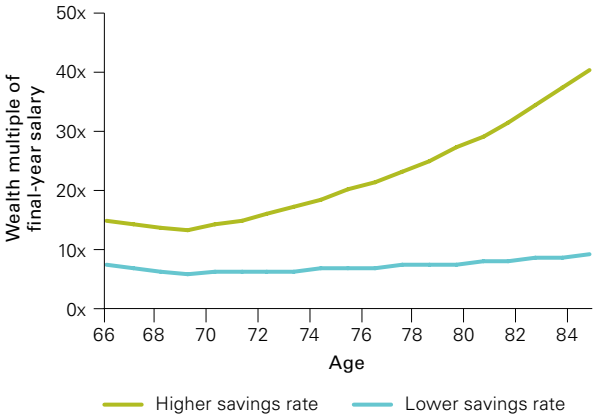
Source: Vanguard.

Nevertheless, a rising interest rate environment is not without risk. Savings risk, spending risk, and inflation risk are three key risks to consider:

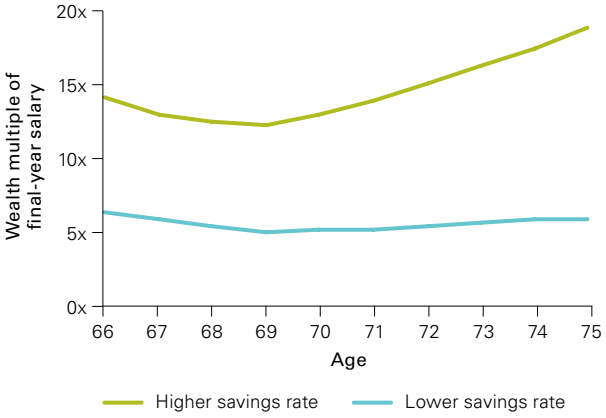
- **Savings risk** (or risk of outliving savings)**:** As is well documented, retirement outcomes are highly dependent on savings rates. Our baseline analysis in Figure 2 refers to an average investor who has saved 15.4x his or her ending salary.[2] **Figure 3** highlights the fact that lower savings rates translate into a lower balance throughout retirement, including during the largest of our four rising rate scenarios in Figure 2.
- **Spending risk:** All else equal, a rising interest rate environment decreases the short- to medium-term value of a fixed income portfolio; thus, if a large unexpected spending need occurs, the portfolio's longer-term ability to recover could be jeopardized.
- **Inflation risk:** The driver of an interest rate movement matters. If a rising rate environment coincides with inflationary pressure, the equity portion of a portfolio can also suffer, compromising the portfolio's ability to generate enough to meet spending needs. We explore this last point in the next section.

Figure 3. Hypothetical retiree's portfolio values across time under various interest rate and savings rate scenarios

a. Portfolio values across time, ages 66–85



b. Highlighted portfolio values over first ten years of retirement, ages 66–75



c. Savings rate impact over rising rate environments

Interest rate rise for each of the next four years	Starting savings rate	Ending savings rate
+2.0%	5%	10%
+2.0%	1%	6%

Notes: This hypothetical illustration is not based on the results of any specific portfolio. Data include Social Security. Private sources are expected to make up 32 percentage points of a 78% replacement rate, on average. In general, people increase their savings rate over the years. These tables' rates are consistent with findings in Vanguard's *How America Saves 2014*.

Source: Vanguard.

2 See Donaldson et al. (2015) for the rationale behind the wealth multiple, and also Vanguard's reports on *How America Saves 2014*, an annual survey of the 3 million participants served by Vanguard's recordkeeping business and integrated data from the Social Security Wage Index. The figures just cited in the text correspond to a savings rate that starts at 5% at age 25 and increases to approximately 10% at age 65. Our analysis included a company match of $0.50 per dollar up to 3% of salary. Ending salary was $60K and followed productivity patterns of U.S. workers.

Empirical analysis of inflation risk

Ultimately, the impact of interest rates on portfolio returns depends upon what caused the interest rate change in the first place. Interest rates are driven by several key macroeconomic factors: long-run inflation expectations, the real federal funds rate, the inflation risk premium, expected real gross domestic product (GDP) growth, and structural fiscal deficits. These factors can act alone or in combination to influence rates (Davis et al., 2010). Interest rate movements that coincide with economic growth generally can be expected to provide a positive long-term portfolio impact for a TDF investment, mainly because equities, which hold a prominent place in Vanguard's TDF portfolios, typically do well in such an environment. In contrast, interest rate movement associated with runaway inflation expectations can be detrimental to real portfolio returns, mainly because equities and nominal bonds do poorly in that type of environment. As an illustration, consider two different time periods: the 1970s and 1990s (see **Figure 4**). Although both decades saw periods of negative bond returns, equity returns diverged *significantly* over the two periods.

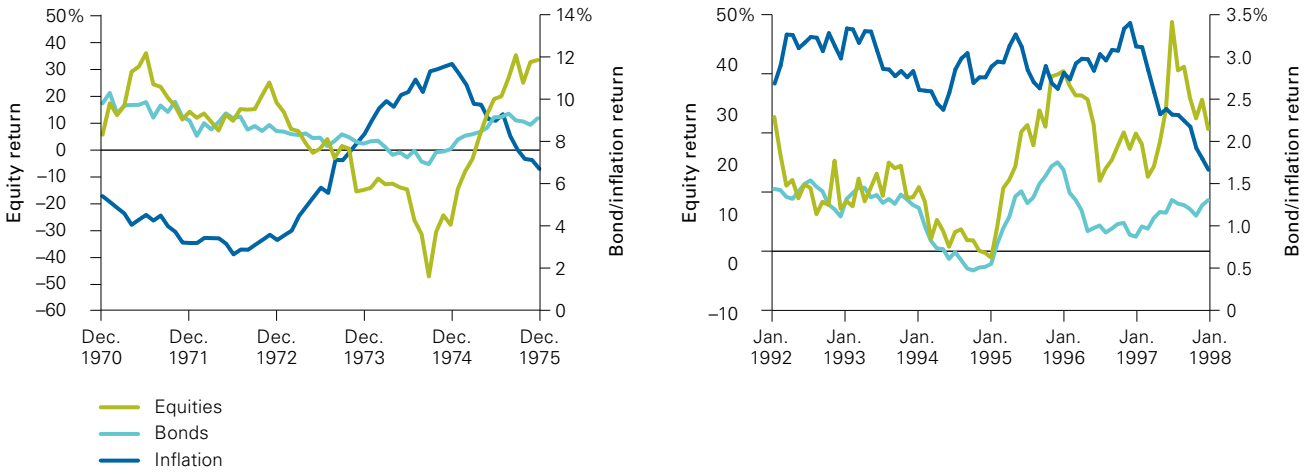
During the inflationary 1970s, we saw negative equity returns, whereas the economic expansion of the 1990s saw positive equity returns. Over both time frames, bonds provided a steadier stream of returns than equities.

Of course, many factors can affect future returns aside from the macroeconomic environment, and predicting the path of interest rates is notoriously difficult. How might bonds in a TDF react during a future rising rate environment? To analyze this, we examined the effects of a portfolio's interest rate sensitivity (that is, its duration) under various scenarios.

Duration and bond-price volatility

The Vanguard Target Retirement Funds offer a potentially enduring investment solution that can withstand many different market scenarios. As of October 31, 2015, the duration of the fixed income position of the funds was approximately 5.8 years, which is similar to that of the Barclays U.S. Aggregate Bond Index. As mentioned earlier, a portfolio's average duration is useful to know because it provides investors with a way to quantify the

Figure 4. Underlying TDF asset class and inflation returns during 1970s and 1990s



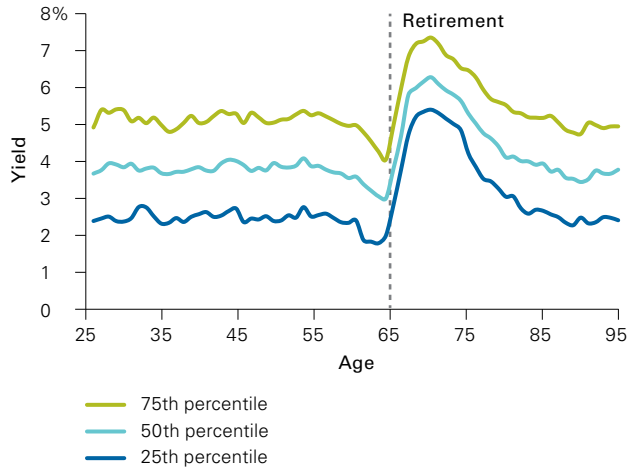
Sources: Vanguard analysis. Stocks represented by Standard & Poor's 500 Index from March 4, 1957, through 1974; Wilshire 5000 Index from 1975 through April 22, 2005; and MSCI US Broad Market Index thereafter through September 30, 2015. Bonds represented by Citigroup High Grade Index from 1969 through 1972; Lehman U.S. Long Credit Aa Index from 1973 through 1975; and Barclays U.S. Aggregate Bond Index thereafter through September 30, 2015.

impact of movements in interest rates (and therefore of bond-price volatility) on the portfolio's total return. Specifically, the expected change in interest rates can be multiplied by the portfolio's duration to determine the approximate percentage change, up or down, of the portfolio's total return. It's important to note that this calculation also assumes a parallel shift in the yield curve. So, for the Vanguard Target Retirement Funds, a 1% move (up or down) in U.S. interest rates creates a 5.8% change in the nominal U.S. bond portion of the portfolio.[3] Using the Target Retirement 2010 Fund as an example, as of October 31, 2015, nominal U.S. bonds made up 35.5% of the fund, so an investor in the fund would experience about a 2% decline (that is, 5.8% x 35.5%) in total return from a 1% rise in interest rates, all else equal. Although a simple duration analysis is helpful, it does not provide a straightforward way to examine the expected portfolio impact over a period of time or given a more realistic yield curve movement.

Vanguard Capital Markets Model analysis

For more robust analysis, we thus examined two hypothetical investors in the Vanguard Target Retirement Funds (both shown in **Figure 6**, below). The first investor experiences a "base-case" market environment, derived from the Vanguard Capital Markets Model, while the second investor sees a dramatic rise in interest rates over a ten-year period in retirement.[4] This second investor experiences three consecutive years of rising rates starting at age 66, followed by seven years of sustained high interest rates over the remainder of the ten-year analysis period (note that **Figure 5** furthermore illustrates probable paths about 20 years beyond the initial ten years analyzed). (Note that to illustrate the impact on yields in our rising interest rate scenario, we first provide, in Figure 5, Vanguard's forecast of the distribution of the 5-year U.S. Treasury yield across the hypothetical TDF investor's full life cycle: ages 26–95.)

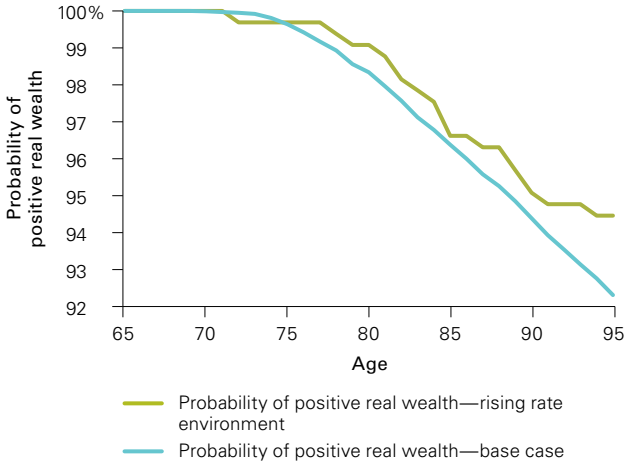
Figure 5. Distribution of 5-year U.S. Treasury yield in rising interest rate scenarios across hypothetical TDF Vanguard investor's full life cycle



Notes: This hypothetical illustration is not based on the results of any specific portfolio. It corresponds to the distribution of simulated 5-year U.S. Treasury yields, which have evolved concurrently with a scenario defined by three consecutive years of rising rates beginning at age 66, followed by seven consecutive years of sustained high interest rates. This scenario takes place during a hypothetical Vanguard TDF investor's retirement years. The scenario's criteria were satisfied by only 325 of the 10,000 possible paths (about 3% of paths).

Source: Vanguard.

Figure 6. Probabilistic outcomes under base-case and rising-rate scenarios



Notes: This hypothetical illustration is not based on the results of any specific portfolio. The scenarios outlined represent bottom-decile outcomes generated through the Vanguard Capital Markets Model. The analysis started with 10,000 outcomes and was filtered to identify paths that matched the criteria cited in the figure. This yielded 325 paths (about 3% of the 10,000 hypothetical paths), indicating that the outcomes analyzed are relatively low-probability, tail events.

Source: Vanguard.

3 Equity duration is assumed to be zero owing to the instability of duration for this asset class.

4 The Vanguard Capital Markets Model (VCMM), a proprietary Vanguard statistical model, simulates forward-looking asset-return distributions for a broad array of asset classes and risk factors. The model is based on initial market conditions, as well as risk-and-return assumptions, that are dynamic and forward-looking and include distributional tail events. The VCMM uses historical data of economic and financial drivers of asset returns to estimate and calibrate. For more information on the VCMM, see this paper's notes on page 2, the Appendix on page 9, and Davis, Aliaga-Díaz, Ahluwalia, et al. (2014).

Our analysis then examined the probability that this investor would retain a positive balance of retirement wealth at various age points in retirement. Figure 6 shows that our hypothetical "rising rate environment" Vanguard TDF investor increased the probability of retaining a positive retirement balance in retirement. This suggests that the short-term impact on existing bonds in a portfolio during a rising interest rate environment is offset by the opportunity to purchase higher-yielding bonds following this period. In other words, higher interest rates can positively affect medium- to long-term investors. These simulations took into account baseline drawdown assumptions that, along with Social Security, delivered a replacement ratio of 78% (Aon Consulting and Georgia State University, 2008).[5]

Conclusion

Many TDF investors seem to believe that the inability to predict when interest rates will begin a sustained rise is more of a concern than the value of a portfolio's bonds themselves or their broader role in a portfolio. Bonds are a unique and important diversifier in a balanced portfolio, precisely because their expected yield and future value are mathematically determined. As interest rates rise, the current value of a bond portfolio will be worth less because higher-yielding bonds can be purchased in the market than the ones owned in the portfolio. However, over time, as these newer, higher-yielding bonds are added to a bond portfolio, the investor can benefit.

The time horizon to realize this benefit is similar to that of the average duration of the portfolio's bonds. It's important to understand that a rising interest rate environment may not be the traumatic event to an investor's portfolio that many investors seem to believe. The cause of the rate rise is essential to understand, such as whether the rise was expected by the market, the timing of the rise, and the economic factors involved. Interest rate movements that coincide with economic growth generally can be expected to provide a positive long-term portfolio impact for an investment like a TDF, mainly because equities typically do well in such an environment. In contrast, interest rate movements associated with runaway inflation expectations can be detrimental to portfolio returns, primarily because equities and bonds tend to do poorly in that type of environment.

References

Aon Consulting and Georgia State University, 2008. *Replacement Ratio Study: A Measurement Tool for Retirement Planning*. Chicago: Aon Consulting.

Bruno, Maria, Scott J. Donaldson, Francis M. Kinniry Jr., Todd Schlanger, and David Walker, 2013. *Vanguard's Framework for Constructing Diversified Portfolios*. Valley Forge, Pa.: The Vanguard Group.

Davis, Joseph, 2014. *Global Macro Matters: Rate Liftoff—It's Not 'Easy' Being the Fed*. 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 A. Aliaga-Díaz, Andrew Patterson, and Harshdeep Ahluwalia, 2014; 2015. *Vanguard's Economic and Investment Outlook*. Valley Forge, Pa.: The Vanguard Group.

Davis, Joseph, Roger Aliaga-Díaz, Harshdeep Ahluwalia, Frank Polanco, and Christos Tasopoulos, 2014. *Vanguard Global Capital Markets Model*. Valley Forge, Pa.: The Vanguard Group.

Donaldson, Scott J., Francis M. Kinniry Jr., Vytautas Maciulis, Andrew J. Patterson, and Michael A. DiJoseph, 2015. *Vanguard's Approach to Target-Date Funds*. Valley Forge, Pa.: The Vanguard Group.

The Vanguard Group, 2014. *How America Saves 2014*. Valley Forge, Pa.: The Vanguard Group.

The Vanguard Group, 2013. *Vanguard's Principles for Investing Success*. Valley Forge, Pa.: The Vanguard Group.

5 According to Aon Consulting and Georgia State University (2008), 32% of income is expected to come from private sources and 46% from Social Security.

Appendix. About the Vanguard Capital Markets Model

Important note: 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 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 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 31, 2014.

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. Readers are directed to the research paper titled *Vanguard Global Capital Markets Model* (Davis et al., 2014), for further details.

Wage scale

Investor salary growth is modeled after the U.S. Social Security Administration's wage index. The SSA wage index is based on reported wages across workers' age spectrum of 25–65 for low-, medium-, and high-income earners. This wage scale allows us to trace the earnings progression of an average earner over a 40-year working career, accounting for factors such as career development. Therefore, as modeled, the average participant reaches a peak salary at age 55 (in real terms) and experiences a decline in real salary through the age of 65. In our life-cycle simulations, we also allow for 1.1% annual salary growth, on a real basis, in addition to the cross-sectional increase in the wage scale, which reflects the historical average productivity growth of the U.S. economy.

Contribution rates

Age-specific contribution rates are derived from *How America Saves 2014* (Vanguard, 2014), a report surveying the 3 million participants served by Vanguard's recordkeeping business. Contribution patterns account for the likelihood that investors will start with a lower savings rate in their early working years and increase their contributions as retirement approaches. Contributions start at approximately 5% at age 25 and increase to approximately 10% at age 65. In addition, the simulations include a company match of $0.50 per dollar up to 3% of salary, which is consistent with industry averages.

Replacement ratios and drawdown scenarios

We follow industry convention in assuming that retirees will spend a percentage of their age 65 salary every year in retirement from a combination of Social Security benefits and investment income from private sources. The replacement ratio assumption (as a percentage of age 65 salary) is consistent with retirees maintaining the same standard of living enjoyed during their final working years. Replacement ratios vary by income level, as Social Security makes up a smaller percentage at larger salaries. Vanguard draws on the work of Aon Consulting (with data from the U.S. Department of Labor's Bureau of Labor Statistics "Consumer Expenditure Survey") to assign appropriate replacement ratios based on retirees' age 65 income.

Asset returns

The asset-return distributions are based on 10,000 simulations from the VCMM. VCMM uses a statistical analysis of historical data to create forward-looking expectations for the U.S. and international capital markets.

The model uses index returns, without any fees or expenses, to represent asset classes. Taxes are not factored into the analysis. Inflation is modeled based on historical data from 1962 and simulated going forward with the median and volatility displayed in **Figure A-1**. U.S. stocks are represented by the Wilshire 5000 Composite Index; U.S. bonds are represented by the Barclays U.S. Aggregate Bond Index (a former Lehman Brothers index); international stocks are represented by the Morgan Stanley Capital International Europe, Australasia & Far East (MSCI EAFE) plus Emerging Markets Index; inflation is calculated from the Consumer Price Index; and intermediate TIPS and cash are derived from underlying U.S. Treasury yield data from the Federal Reserve Board.

Figure A-1. Annualized 75-year asset return distributions as of December 31, 2014

	Median return	Standard deviation
Domestic equity	9.3%	19.6%
U.S. nominal bonds	4.6	6.1
Inflation	2.1	3.0
International equity	9.8	20.5
International bonds	4.6	5.1
Short-term TIPS	3.5	4.4

Note: TIPS = Treasury Inflation-Protected Securities.
Source: Vanguard.

Vanguard®

Connect with Vanguard® > vanguard.com

Vanguard Research

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

For more information about Vanguard funds, visit vanguard.com or call 800-662-2739 to obtain a prospectus or, if available, a summary 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 registered trademark owned by CFA Institute.

ISGRIR 012016