Getting More from Less: Three Levers for a Low-return World

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Abstract

As global interest rates hover near historic lows, defined benefit pension plan sponsors must grapple with the prospect of lower investment returns. This paper examines three levers that can enhance portfolio outcomes in a low-return world. The levers include: increased contributions; reduced investment costs; and increased portfolio risk. We use portfolio simulations based on a stochastic asset class forecasting model to evaluate each lever according to two criteria—its magnitude of impact and the certainty that this impact will be realized. Our analysis indicates that increased contributions have the greatest and most certain impact. Reduced costs have a more modest, but equally certain impact. Increased risk can deliver a significant impact, but with the least certainty.

Keywords: Low-return environment, defined benefit pension plans, active equity management, factors, private equity, hedge funds.

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As fixed income yields hover near historic lows, defined benefit (DB) pension plan sponsors must grapple with a rise in the present value of plan liabilities and a fall in prospective investment returns. Our asset class projections illustrate the dramatic change in the investment outlook. From 1926 through 2016, a portfolio with a 60 percent allocation to global equities and 40 percent allocation to global fixed income generated an annualized return of 8.5 percent. For the 10 years through 2026, we estimate that the median return for the same portfolio will be almost 3 percentage points lower, as illustrated in Table 1. *(Table 1 here.)*

The prospect of lower returns has reshaped plan sponsor expectations. In 2014, 42 percent of corporate DB plans surveyed by Stockton (2016) projected median long-term returns of more than 7 percent.[1] In 2015, only 31 percent expected returns of 7 percent or more.[2] Even as expected returns decline, most plans are underfunded. J.P. Morgan estimates that plans sponsored by companies in the Russell 3000 Index have an average funding ratio of 80.5 percent.[3] The present value of every dollar in pension obligations, in other words, is backed by about 80 cents in assets. The challenges for public sector plans are greater. Aggregate assets in the largest public plans, according to actuary and benefits consultant Milliman, equaled an estimated 69.8 percent of total plan liabilities as of June 30, 2016.

We examine three levers that plan sponsors can use to improve their funding levels in a lower-return future. Sponsors can:

(1) Increase contributions.

(2) Reduce costs.

(3) Increase risk.

A few caveats: We explore these levers in the context of a total return investment strategy. In our work with well-funded DB plans, however, we typically encourage a liability driven

investment (LDI) strategy for corporate pension plans. An LDI strategy can change the concept of risk dramatically, from a focus on return volatility to a focus on the stability and level of the funding ratio (Stockton, 2014).

Even so, total return is an important focus for many pension plans. A long-horizoned plan that can tolerate the strategy's attendant contribution volatility may be well served by a total return approach. Cash balance plans and hybrid pension plans, which combine final-pay and cash balance plans, often default to the total return way of thinking. Finally, the public pension plans generally embrace the total return logic as well.

We evaluate each lever according to two criteria—its magnitude and its certainty of impact. We define 'magnitude' as the median change in the expected value of a $100 million portfolio over a 10-year investment horizon. 'Certainty' is the median change in the projected dispersion of portfolio values. Figure 1 displays the combination of magnitude and certainty for each lever, including the various implementations of the risk lever. *(Figure 1 here.)*

We start with an overview of the motivations and investment rationales for each of the levers. We conclude with a hierarchical assessment of their potential impact on portfolio returns, risk, and expected values. We also detail the impact of risk-oriented investment decisions on a hypothetical DB plan's funding ratio.

Increase Contributions for a Significant and Certain Impact on Portfolio Value

An increase in contributions is the most reliable strategy to improve plan funding levels. Every additional dollar in contributions immunizes a dollar of future liabilities against the vagaries of capital market returns. The decision to increase contributions must compete with other uses of

corporate cash flow such as capital investment and returns to shareholders, but the benefits are clear.[4]

Consider a DB plan with $100 million in assets and liabilities of $121.5 million. Its funding ratio is 82 percent. The portfolio allocates 60 percent of its assets to global equities, 40 percent to global bonds. We model changes in the portfolio's value over a 10-year period to illustrate the impact of additional contributions. (Reality is more complicated than this hypothetical illustration. Contribution levels are a function of both regulation and plan sponsor goals. For a US corporate plan with a funding deficit, for example, the Pension Protection Act of 2006 mandates a minimum contribution equal to roughly one 1/7 of the shortfall.) Figure 2 presents the portfolio's future value assuming no additional contributions and annual contributions of $0.5 million or $1 million, a simplified illustration. *(Figure 2 here)*

Increased contributions have a certain impact, and if the contributions are large enough, the magnitude of impact can be high. Annual contributions of just $0.5 million raise the funding ratio to 99 percent at the end of the 10-year period, a 7 percentage point improvement in the funding ratio relative to no contributions. Contributions of $1 million per year produce a modest surplus, giving the sponsor ample flexibility to implement LDI strategies that neutralize the plan's vulnerability to changes in interest rates and asset and liability values. (See Sparling (2014) for an overview of derisking strategies triggered by changes in plan funding status.) While a powerful lever, we recognize that competing demands for cash can make higher contributions impossible or unattractive for some plan sponsors.

Reduce Costs for a More Modest but Certain Impact on Portfolio Value

When a pension plan retains the services of in-house or external portfolio managers, the only guarantee is that those services have a cost. The future performance delivered by those managers is uncertain. All else equal, reducing costs has a certain and positive impact on the future value of a portfolio. The short-term benefits are relatively modest. Over time, however, a modest reduction in costs can deliver significant long-term benefits as annual savings compound.

Tables 2a and 2b quantify the impact of costs on a portfolio with an initial value of $100 million. We assume a return of 7 percent per year before fees, a figure consistent with the plan sponsor expectations reported in Stockton's survey. Net of 100 basis points in annual fees, the portfolio's value would grow to about $178 million after 10 years. If fees had been 50 basis points, however, the portfolio would have accumulated an additional $9 million in assets. Over 30 years, annual savings of 50 basis points would translate into more than $90 million in additional assets. *(Table 2 here.)*

Though the concept of reducing costs is simple, the outcome can be surprisingly powerful. This is particularly true for plan sponsors with a long-term horizon, as the compounded annual savings steadily chip away at any funding shortfall. Over 30 years, for example, a 50-basis-point difference in annual costs compounds to more than 9,000 basis points (91 percentage points) in cumulative return.

Increase Risk for a Potentially Significant but Uncertain Impact

An increase in contributions and a reduction in costs address inflows and outflows to deliver certain growth in a portfolio's long-term value. An increase in portfolio risk is a different strategy. It seeks to accelerate the rate at which portfolio assets grow.

The impact can be significant—potentially more significant than increasing contributions and reducing costs—but the certainty of success is lower. We consider several widely used risk-oriented strategies.

- Higher allocations to traditional, risky assets (global equities) through the use of market capitalization weighted index portfolios.
- Style-factor tilts—an emphasis on equity and fixed income factors that have historically earned premiums over the broad stock and bond markets.
- Allocations to traditional active equity management.
- Allocations to alternatives.

We assume that an increase in a portfolio's strategic equity allocation would be achieved through passively managed index portfolios. The other options—style factor tilts, traditional active management, or alternatives—all represent forms of active management. These strategies introduce active risk, but produce no change to a portfolio's broad strategic allocation. We review the investment cases for each risk-oriented strategy.

Higher equity allocation. An increase in a plan's strategic equity allocation represents a move along the efficient frontier to a risker portfolio, with a higher expected return, as illustrated in Figure 3. A higher expected return can help a plan close any funding shortfall, but the higher volatility associated with this expected return diminishes the certainty that this benefit will be realized. *(Figure 3 here)*

Style factor tilts. A static allocation to style factors seeks to improve the risk and return characteristics expected from a portfolio's allocation to broad asset classes. Although researchers have identified a number of potential style factors, we focus on three—size, value, and credit. These factors are notable for both the extensive literature documenting each and the empirical research on their performance. Table 3 includes possible risk-based or behavioral explanations for the persistence of their excess returns (Banz 1981; Fama and French 1992, 1993; Pappas and Dickson, 2015). *(Table 3 here)*

Like any active strategy, the use of factor tilts demands both a conviction that the factors represent an enduring opportunity to earn a return premium and the patience to stick with this conviction through factors' inevitable periods of underperformance.[5]

Actively managed equity funds. Traditional active management is another option for plan sponsors. Stockton's survey finds that most DB plan sponsors invest a majority of their assets in actively managed portfolios, as is typical for institutional investors.[6] Survey respondents reported that, on average, 66 percent of equity and 72 percent of fixed income assets were actively managed.

Three elements need to be present for active management to be successful—talent, cost, and patience. Talent is paramount. On average, the odds that an active manager will outperform a relevant benchmark are low. In the 17 rolling, three-year periods for the 20 years ending 2016, only 15 percent of US equity funds, on average, outperformed their benchmarks. When those results are weighted by assets under management, rather than the number of funds, the odds improved to 38 percent. Talent is key to beating the odds against outperformance.

Low cost is another requirement, not simply because of the mathematical reality that lower costs equal higher net returns. In an analysis of various portfolio characteristics, Wallick et. al. (2015b) find that cost is the most powerful predictor of future outperformance.[7]

Even if an investor identifies talent, and secures it at a low cost, success requires patience. Active managers typically produce inconsistent patterns of returns, as illustrated in Figure 4. Of the 2,085 US-domiciled active equity funds in existence at the start of 2000, only 552 (26 percent) outperformed their prospectus benchmark over the subsequent 15 years. Among this 26 percent, almost all (98 percent) failed to outperform their benchmarks in at least four calendar years over the 15 year period. More than 50% of these top performers delivered seven or more years of underperformance. Only those investors patient enough to hang on through these periods of weakness managed to realize the superior long-term returns delivered by these exceptional managers. *(Insert figure 4)*

Alternative investments. Alternative investments are widely used in DB plans. These investments include non-traditional asset classes such as real estate and commodities and specialized investment vehicles such as private equity and hedge funds. On average, plan sponsors allocate 11 percent of portfolio assets to alternatives, according to the Stockton survey. Of the corporate plans that invest in alternatives, 89 percent expect to maintain or increase their allocation; the remaining 11 percent are considering a reduction in these allocations.

We consider two alternative strategies, hedge funds and private equity. Neither is a separate asset class. They represent, in effect, a repackaging of publicly or privately traded traditional asset classes. Both strategies represent a form of active management. As with traditional active management, talent is key because the spread between winners and losers is extreme (see Figure

5). In alternatives, however, the selection challenge is greater because of the limited access to many managers and the higher due diligence hurdles for complex and at times opaque strategies. *(Figure 5 here)*

Wallick et. al. (2015c) find that hedge funds have generally not delivered long-term outperformance relative to a portfolio balanced between global equities and global fixed income.[8] Their conclusions about private equity are similar. The researchers nevertheless note that vehicles such as venture capital and leveraged buyout (LBO) funds may deliver a "liquidity risk premium"—the reward investors expect for locking up their money over a specified period. Absent this expected premium, however, Wallick et. al. (2015) find that the median venture capital fund has trailed the returns of the public equity markets, while the median LBO has more or less matched them. Other researchers have reached similar conclusions. (Moskowitz and Vissing-Jorgensen, 2002; Kaplan and Schoar, 2005; Cochrane, 2005; Conroy and Harris, 2007; Phalippou and Gottschalg, 2009).

These analyses take place within a total return framework, but the LDI case for alternatives may be no more compelling. Bosse (2012) finds that alternatives allocations (REITs and commodities, in particular) funded from a portfolio's fixed income holdings produce a notable increase in funding ratio volatility. If funded from the equity allocation, the alternatives allocation must be significant (24% of portfolio assets in the analysis) to produce a modest decline in the volatility of portfolio assets relative to plan liabilities (-3%).

A Decision Hierarchy for Plan Sponsors

When we examine increased contributions, reduced costs, and increased risk in a quantitative framework, a decision-making hierarchy emerges. Tables 4a and 4b detail the magnitude and certainty of impact for the three levers. Increased contributions deliver the most powerful combination of certainty and impact. Reduced costs have a lower magnitude of impact, but high certainty that the impact will be realized. Cutting costs is a productive strategy in any investment environment. In ideal circumstances, increased risk has a significant and positive impact, but the likelihood of realizing this impact is uncertain.

We test each lever's impact on a $100 million portfolio with an initial allocation of 60 percent global equities and 40 percent global fixed income. For each lever, we generate 10,000 potential portfolio outcomes over a 10-year period, based on asset class projections from the Vanguard Capital Markets Model®. *(Table 4 here)*

Increased contributions. We model the impact of annual contributions equal to $0.5 million and $1 million. This lever is conceptually simple. (Finding the funds for higher contributions can be devilishly difficult in practice, of course.) Increased contributions produce no incremental change in the returns produced by portfolio assets or in the volatility of those returns.

But higher contributions have a significant impact on portfolio values. Relative to the original portfolio, annual contributions of $1 million produce a median expected increase in portfolio value of about $13 million at the end of the 10-year period. The magnitude and certainty of this lever's impact is the highest of the three levers available to plan sponsors.

Reduced costs. We illustrate the impact of cost, and thus cost reduction, by assessing fees of 25 and 50 basis points on the original cost-free portfolio. Lower costs (all else equal) lead to higher

returns, with no incremental increase in return volatility. The impact on portfolio value at the end of the 10-year period is more modest. Even so, it's larger than intuition might suggest because of the compounding of annual cost savings. The longer the time period, the greater the power of this compounding benefit.

Increased risk. The magnitude of impact for increased risk varies by strategy. Compared with increased contributions and reduced cost, the certainty that this impact will be realized is low.

These conclusions reflect our assumptions about the implementation approaches and return premiums associated with the risk-oriented strategies. For plan sponsors that use different assumptions, the results of the analysis may vary. (Table A1 includes additional analysis, with higher and lower variations on these assumptions.) But this framework is not intended to identify an optimal strategy. Rather, it outlines a process that plan sponsors can use to evaluate the various options.

To test each approach, we implement a 10 percent allocation to the risk-oriented strategy, funding it from the original portfolio's relevant asset class. Our assumed return premiums are consistent with averages found in empirical research (Wallick et. al. 2015c). We review the impact of each risk-oriented strategy, from greatest to least.

Increased equity allocation. A 10 percentage point increase in the portfolio's strategic allocation to global equities adds an incremental 0.52 percentage point to annualized expected returns and an additional $8.7 million to the portfolio's projected median value at the end of the 10-year period. This move along the efficient frontier also produces higher volatility. In the original portfolio, the difference between simulated terminal values at the 25th and 75th percentiles is about $85 million.

When the equity allocation increases by 10 percentage points, the interquartile range increases to about $104 million.

Private equity allocation. A 10 percentage point allocation to private equity, funded from the original portfolio's public equity allocation, has the next greatest impact, adding an annualized 0.33 percentage point to returns and $3.7 million to the median portfolio's terminal value. The dispersion of portfolio values increases modestly, an interquartile range of $87 million, compared with $85 million in the original portfolio. A caution is in order: these summary statistics mask the challenge of selecting private equity funds that can in fact deliver these benefits. There is no investable beta for private equity funds—no indexed vehicle that captures the risk and return characteristics of the category. Success depends on picking above-average performers from a category with a high dispersion of outcomes.

Style factor tilts. A 10 percentage point allocation to equity style factors and a 10 percentage point allocation to credit in the fixed income allocation increase expected annualized return and modestly reduce the dispersion of returns. (Our analysis is based on long-only implementations of factor tilts.) The benefits reflect the potential persistence of style factor premiums and the factors' less than perfect correlation with the broad equity and fixed income markets. The effect is modest, however, and it's important to note that factors' excess returns can be highly cyclical. Plan sponsors must have an ex-ante belief in the persistence of any factor premiums and the patience to pursue these premiums through good periods and bad.

Active equity allocation. A 10 percentage point allocation to traditional active equity strategies, funded from the original portfolio's indexed equity allocation, has limited impact on portfolio risk and return. Again, our simulation is based on assumptions about active management as a category. The performance and impact of a given manager can, and does, vary widely.

Hedge fund allocation. We model two widely used hedge fund strategies, market-neutral and multi-strategy. (Although some hedge fund strategies have less volatility than broad market equities, they introduce consequential new risks such as a high degree of manager risk.) A 5 percentage point allocation to each, funded from the original portfolio's equity allocation, reduces the portfolio's expected annualized return, while producing a sizable decline in the volatility of returns. The hedge fund allocation reduces the difference between 25th and 75th percentile portfolio values to about $69 million, compared with an interquartile range of $85 million in the original portfolio.

Some plan sponsors will no doubt use return premium assumptions and allocation strategies that differ from those used in our analysis. In general, however, we would expect most assumptions to yield similar relative impacts for the risk-oriented strategies. A decision to increase the portfolio's equity allocation is likely to be the most consequential. This conclusion is consistent with research by Brinson et. al. (1986), which finds that a broadly diversified portfolio's strategic asset allocation is the primary driver of its performance. Subsequent research by Ibbotson and Kaplan (2000) and Scott et al. (2017) reaches similar conclusions.

The other risk-oriented strategies represent portfolio implementation decisions that, on average, will have lesser impacts on performance. It's possible, of course, for an aggressive

allocation to an exceptional active manager or private equity fund to have an outsized impact on portfolio performance, but this alluring possibility would be an outlier. Our hierarchical framework can help plan sponsors set reasonable expectations for the potential magnitude and certainty of each risk-oriented strategy.

The Impact of Investment Decisions on DB Plan Funding Ratios

Our analysis examines investment returns in a traditional mean-variance portfolio construction framework. Many total-return-oriented plan sponsors also assess the impact of investment decisions on critical pension plan metrics such as the funding ratio.

Table 5 presents the incremental changes in the expected funding ratio and the dispersion of the funding ratio that result from risk-oriented strategies. Our conclusions are similar to those presented in the total return framework. An increased equity allocation produces the greatest impact, but with the least certainty. Private equity, factor tilts, and active management produce a more limited increase in the funding ratio and modest changes in the dispersion of the funding ratio. Hedge fund strategies reduce the expected funded ratio status, with a decrease in the dispersion of the funding ratio. *(Table 5 here.)*

Conclusion

At the start of 2017, global government bond yields hovered below 2 percent. These interest rates most likely herald an era of more modest returns than those produced by global equity and fixed income markets over the past few decades. Lower returns intensify pressure on institutional

investors to meet their goals. The challenges are especially stark for investors such as DB plans, which have relatively inflexible obligations.

We examine three levers that investors can use to enhance a portfolio's chances of meeting these goals. The first is increased contributions. Higher contributions have a significant and certain impact on a portfolio's ability to meet its obligations, though this lever isn't always available. A second lever is reduced costs—a smart strategy in any return environment. The short-term impact is modest, but cost savings can compound to deliver significant long-term benefits.

The third lever is increased risk. We simulate the outcomes for a number strategies that increase a portfolio's risk profile. Some strategies can produce a significant improvement in expected return—a higher equity allocation is a notable example—but success is uncertain. The dispersion of potential outcomes can be wide, and increased risk-taking may amplify a portfolio's funding shortfalls.

Many sponsors will need to use a combination of the three levers. Our analysis provides a framework and a reasonable set of parameters for assessing the magnitude and certainty of impact delivered by each.

Appendix A: 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 US and international equity markets, several maturities of the US Treasury and corporate fixed income markets, international fixed income markets, US 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.

Impact of Risk-Oriented Strategies with Different Premium Assumptions

Table A1 illustrates the impact of various risk-oriented strategies under a range of premium assumptions. (*Table A1 here*)

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Table 1. Future returns may not look like those from the past: Implications for a 60 percent equity/40 percent fixed income allocation. [a]

	Historical return (%)		Projected return, 2016-2026 (%)		
	1926 – 2016	2000 - 2016	25th Percentile	50th Percentile	75th Percentile
Nominal	8.5	4.9	3.1	5.6	8.1
Real	5.5	2.7	1.2	3.8	6.4

[a] The long-term returns for our hypothetical portfolios are based on data for the appropriate market indexes through September 2016. The portfolio in our projections has the following allocation: 60 percent global equity and 40 percent global fixed income. The subasset allocation for equities is 60 percent US equity and 40 percent global ex-US equity, unhedged in USD, rebalanced annually. The subasset allocation for fixed income is 70 percent US bonds and 30 percent global ex-US bonds, hedged in USD, rebalanced annually. Projected returns at each percentile are based on 10,000 simulations generated by the Vanguard Capital Markets Model.®

Table 2a. The black magic of compounding costs: Value of a $100 million portfolio assuming a gross return of 7 percent and different costs

	Portfolio values ($ million)		
Cost (basis points)	10 years	20 years	30 years
0	196.7	387.0	761.3
25	191.9	368.1	706.3
50	187.1	350.2	655.4
75	182.6	333.2	608.3
100	178.1	317.1	564.8

Table 2b. Declines in asset values and cumulative return for each 25 basis-point increase in cost.

Cost (basis points)	10 years ($ million)	20 years ($ million)	30 years ($ million)	30-year cumulative return (percentage points)
0				
25	-4.8	-18.9	-54.9	-55
50	-4.8	-17.9	-50.9	-51
75	-4.5	-17.0	-47.1	-47
100	-4.5	-16.1	-43.6	-44

Table 3. Possible return rationales for select equity and fixed income risk factors

Factor	Risk explanation	Behavioral explanation
Value (equity)	Cyclical risk of positive correlation between economic activity and security's returns.	Recency bias leads to investors shunning distressed firms and overpaying for recent growth.
Size (equity)	Cyclical risk of smaller firms being more exposed to changing, negative economic activity and default risk.	N/A
Credit (fixed income)	Default and downgrade risk; positive correlation to economic activity.	N/A

Table 4a. Simulated 10-year performance of a $100 million portfolio with an allocation of 60% global equities and 40% global fixed income, rebalanced annually.

Expected annualized return (%)	Projected portfolio values ($ million)		
	25th percentile	50th percentile	75th percentile
5.70	136.0	174.1	220.9

Table 4b. Each lever's incremental impact on portfolio performance.

	Change in median return (pp)	Change in portfolio values ($ million)		
		25th percentile	50th percentile	75th percentile
Increase contributions[a]				
+$.5 million	--	+5.9	+6.7	+7.7
+$1.0 million	--	+11.8	+13.3	+15.6
Reduce costs[b]				
-25 basis points	+0.25	+3.3	+4.1	+5.1
-50 basis points	+0.50	+6.5	+8.1	+10.0
Increase risk				
10 pp increase in equity allocation	+0.52	+1.3	+8.7	+19.9
10 pp private equity allocation[c]	+0.33	+3.7	+3.7	+5.8
Static factor tilts[d]	+0.12	+2.6	+1.9	+2.2
10 pp allocation to active equity[e]	+0.05	+0.9	+0.8	+1.2
10 pp hedge fund allocation[f]	-0.38	+1.1	-6.2	-15.0

[a] We assume that contributions are made into the portfolio annually at the end of each year over the horizon.

[b] We analyze each lever relative to a cost-free portfolio. To evaluate the impact of reducing costs, we model an increase in costs (+25 and +50 basis points) relative to the initial portfolio. An alternative approach would be to assume costs of, say, 75 bps for the original portfolio and then deduct costs of 25 and 50 basis points. The two approaches produce roughly the same results.

[c] We assume that private equity provides a 2 percentage point liquidity premium relative to public equity. Private equity is modeled by assuming a premium over Vanguard's broad US equity return forecast and by increasing volatility to be Sharpe Ratio-matched to US equity returns. We assume

that private equity returns have a correlation of approximately 0.9 with US equity returns, consistent with Vanguard research. See Table A1 for alternative premium assumptions.

[d] We replace 10 percentage points of the broad equity allocation with 5 percentage point allocations to the value and size factors. We replace 10 percentage points of the fixed income allocation with the credit factor. See Table A1 for premium assumptions.

[e] We replace 10 percentage points of the broad equity allocation with active equity. We assume excess returns of 0.5 percentage point. Active fund excess return distributions are simulated based on statistical estimations from historical manager excess return data and are added to VCMM broad market US equity returns to form an active manager return distribution. See Table A1 for alternative assumptions.

[f] We replace 10 percentage points of the broad equity allocation with 5 percentage point allocations to market neutral and multi-strategy hedge funds. Market neutral and multi-strategy liquid alternative funds are assumed to have very low correlation with broad market US equity returns. Market neutral return expectations are the Vanguard's return forecast for cash (3 month T-bill) plus 1%, with a volatility target of 8%. Multi-strategy fund return expectations are the cash (3 month T-bill) forecast plus 2.2%, with a volatility target of 7%.

Table 5a. Projected funded status for portfolio with an allocation of 60% global equities and 40% global fixed income, rebalanced annually, and an initial funding ratio of 82%.

Projected funded status (%)		
25th percentile	50th percentile	75th percentile
66.6	97.5	137.0

Table 5b. Each risk-oriented lever's incremental impact on a portfolio's funded status.

	Change in funded status (percentage points)		
	25th percentile	50th percentile	75th percentile
10 pp increase in equity allocation	+0.1	+6.2	+15.6
10 pp private equity allocation	+2.8	+3.8	+5.5
Static factor tilts	+1.0	+1.4	+0.8
10 pp allocation to active equity	+0.8	+0.9	+1.4
10 pp hedge fund allocation	+1.1	-4.2	-12.2

Table A1. Each risk lever's incremental impact on the performance of a $100 million portfolio under different premium assumptions.

10 pp private equity allocation	Change in portfolio values ($ million)		
	25th percentile	50th percentile	75th percentile
3% liquidity premium	+5.0	+5.5	+8.1
1% liquidity premium	+1.9	+1.4	+1.1

10 pp factor tilts	Change in portfolio values ($ million)		
	25th percentile	50th percentile	75th percentile
Credit	+0.7	+0.7	+0.9
Value	+1.7	+0.1	-0.4
Small Cap	+1.5	+2.0	+2.7

10 pp allocation to active equity	Change in portfolio values ($ million)		
	25th percentile	50th percentile	75th percentile
-0.5% Excess Returns	-0.4	-0.8	-0.9
1.0% Excess Returns	+1.5	+1.6	+2.2

10 pp hedge funds allocation	Change in portfolio values ($ million)		
	25th percentile	50th percentile	75th percentile
Market Neutral	1.2	-6.4	-15.8
Multi-strategy	1.0	-5.9	-13.9

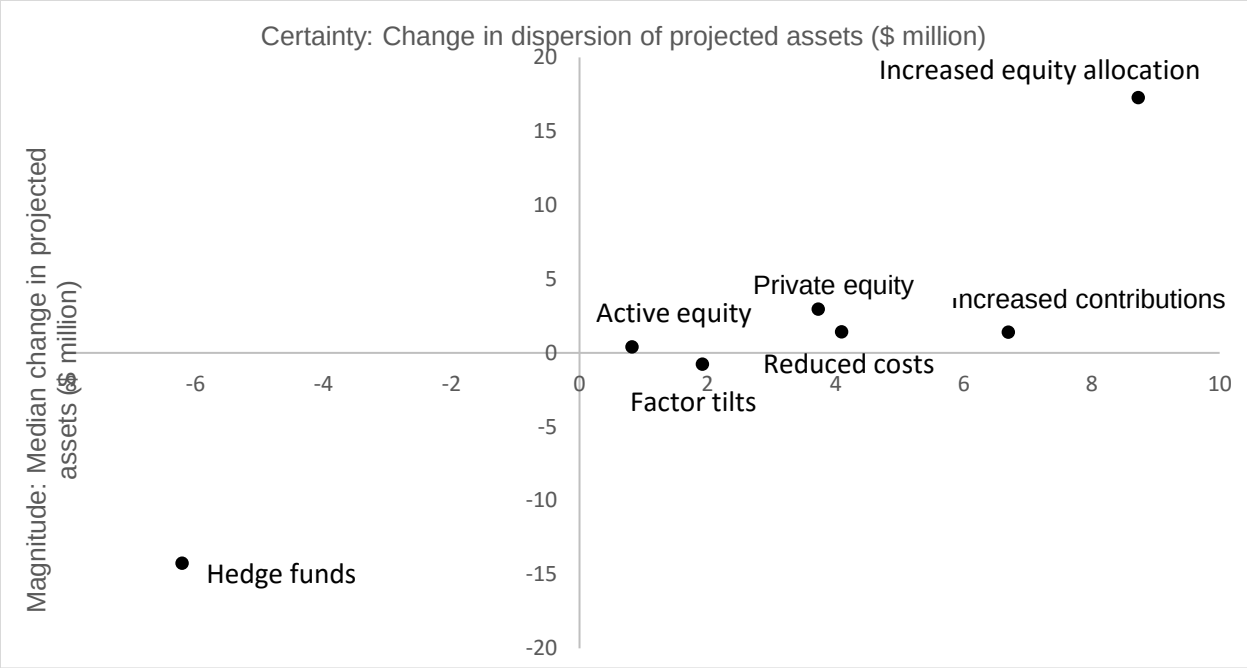

Figure 1. Each lever's magnitude and certainty of impact on a $100 million portfolio.

Note: Change in dispersion representes the differences between the one standard deviation range of asset outcomes in the base and modified portfolios. Each risk-oriented lever represented by a 10 percentage point allocation to the strategy. Increased contributions signify annual contributions of $500,000. Reduced costs signify a cost reduction of 25 basis points.

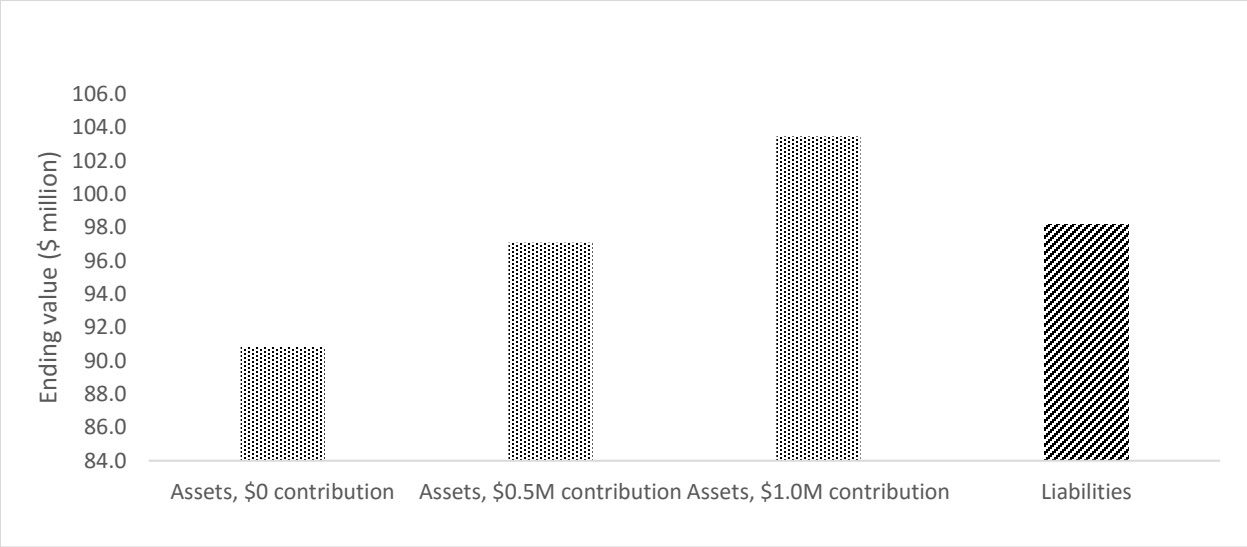

Figure 2. The impact of higher annual contributions on portfolio values at the end of 10 years.

Note: Contributions are made at the end of each year. Forecast displays the 50th percentile values for portfolio assets and liabilities based on VCMM simulations.

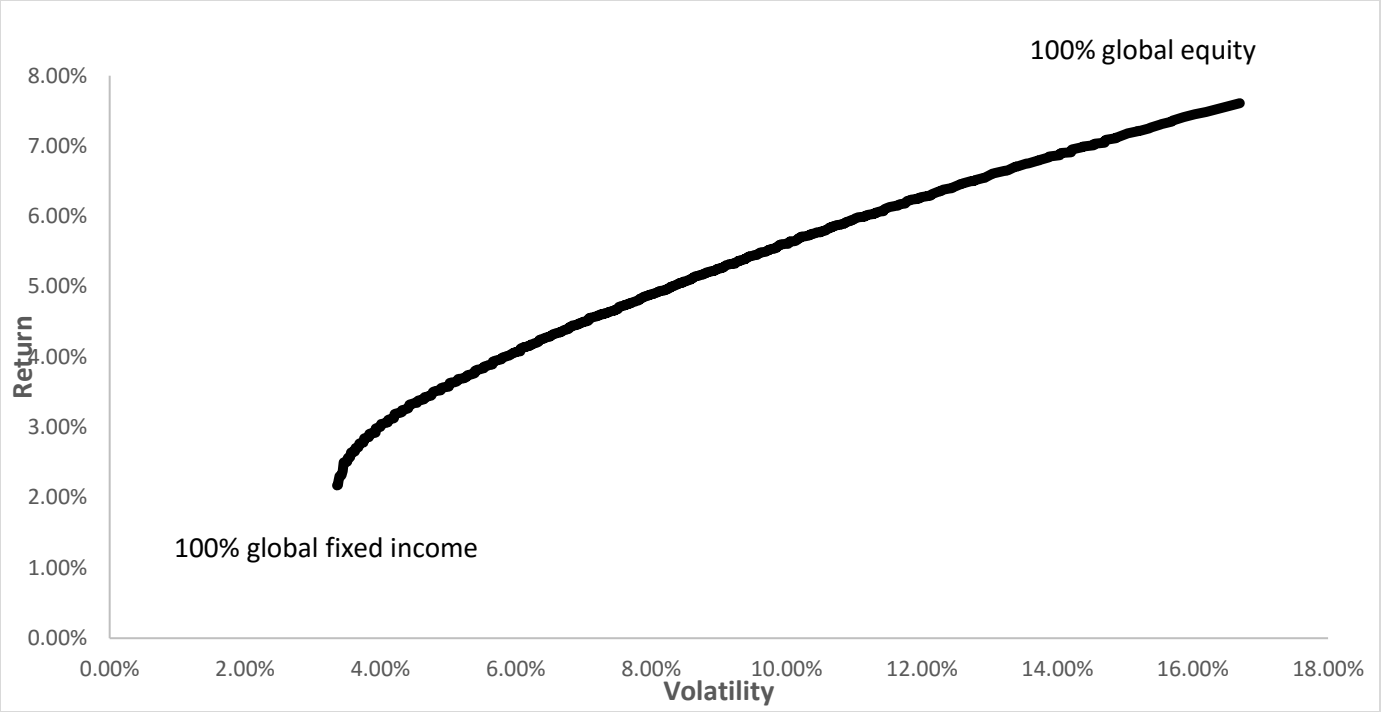

Figure 3. The efficient frontier for a portfolio of global equities and global fixed income.

Note: The equity portfolio consists of 60% US and 40% non-US stocks. The fixed income portfolio is 70% US and 30% non-US securities.

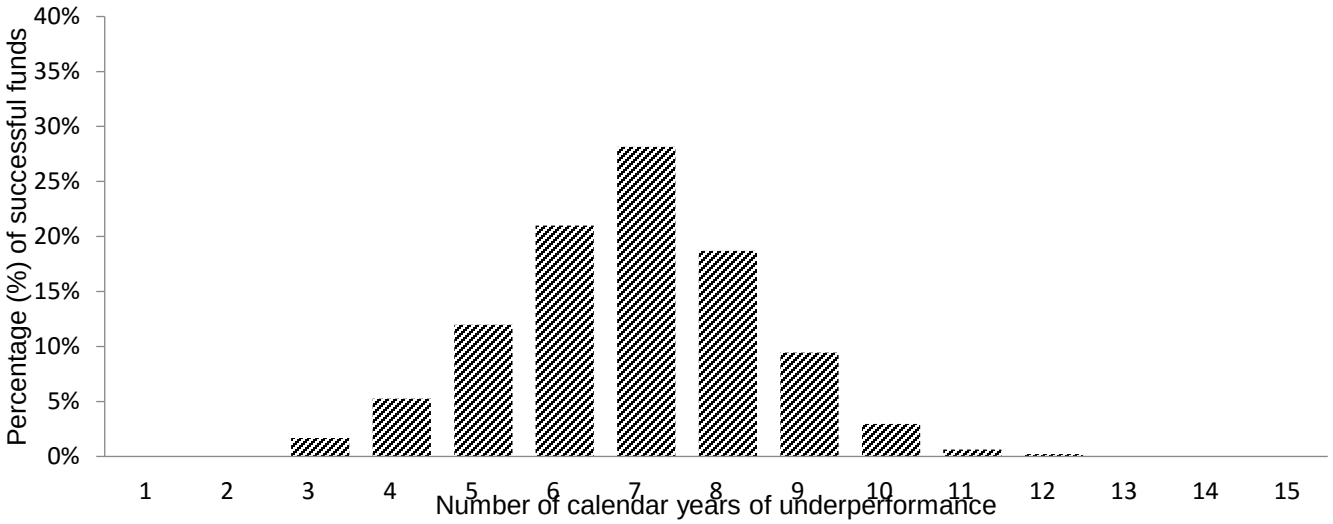

Figure 4. Even successful funds had multiple periods of underperformance: Distribution of 552 funds that outperformed their index, 2000-2014

Notes Data are as of December 31, 2015. Successful funds are those that survived for the 15 years and also outperformed their prospectus benchmarks. Our analysis was based on expenses and fund returns for active equity funds available to U.S. investors at the start of the period. The oldest and lowest-cost single share class was used to represent a fund when multiple share classes existed. Each fund's performance was compared with that of its prospectus benchmark. Funds that were merged or liquidated were considered underperformers for the purposes of this analysis. The following fund categories were included: small-cap value, small-cap growth, small-cap blend, mid-cap value, mid-cap growth, mid-cap blend, large-cap value, large-cap growth, and large-cap blend. Numbers do not add up to 100% because of rounding.

Sources: Vanguard calculations, using data from Morningstar, Inc.

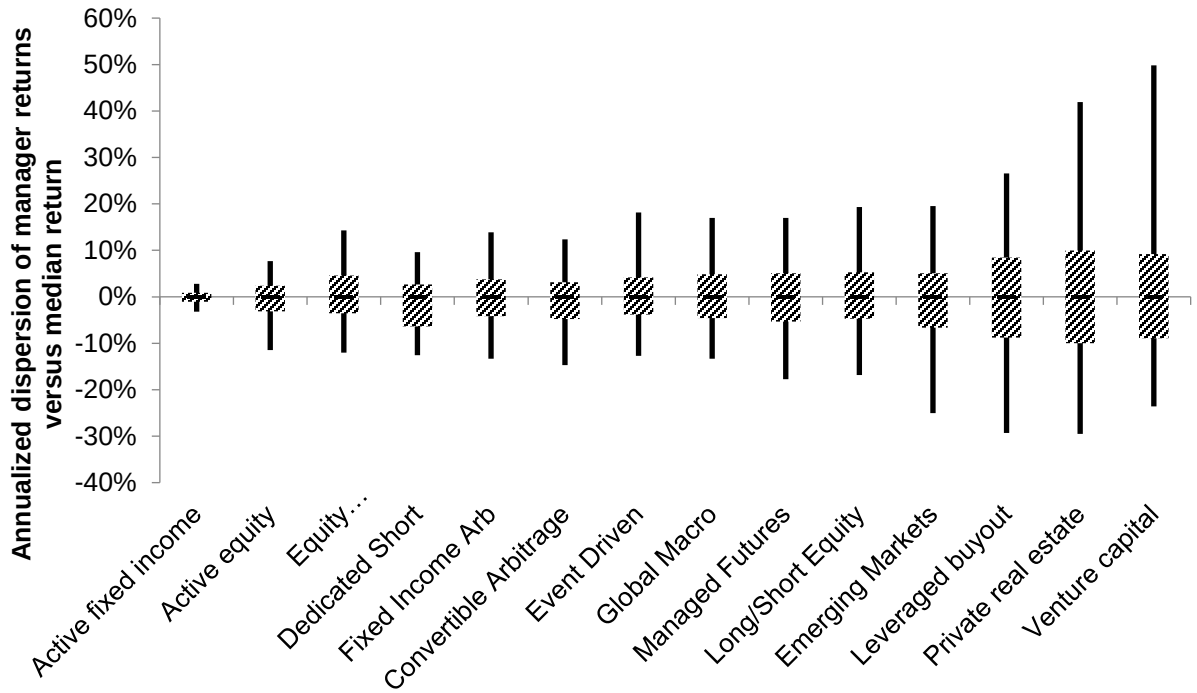

Figure 5. Manager dispersion with private alternative investments is significantly higher than with traditional asset classes

Note: Public U.S. active fixed income and active equity distributions were based on data provided by Morningstar, Inc., for mutual funds domiciled in the United States from January 1, 1994, through July 31, 2014. Equity-market neutral, dedicated short bias, fixed income arbitrage, convertible arbitrage, event-driven, global macro, managed futures, long/short equity, and emerging markets' distributions were based on data provided by Lipper TASS, for hedge funds in existence from January 1, 1994, through July 31, 2014. All funds are U.S.-dollar-denominated, adjusting for survivorship bias in each category. Leveraged buyout, real estate, and venture capital distributions based on data provided by Preqin. Each distribution was based on an IRR (internal rate of return) calculation from a series of annual cash flows from each fund. For private equity funds that had not yet distributed 100% of the fund's capital back to the limited partners, IRR calculations were based on an ending NAV value. Each distribution has been adjusted so that the median resides at point zero, to isolate the dispersion.

Source: Vanguard calculations, using data from Morningstar, Inc., Lipper TASS, and Preqin.

[1] The survey included responses from 178 corporate DB plan sponsors. Plan size ranged from $20 million to $50 million (11%) to more than $5 billion (8%), with an average plan size of approximately $1 billion and total plan assets across the entire survey of approximately $180.9 billion.

[2] The expected return on assets (EROA) for corporate DB plans, is a component of pension expense for the sponsor company's income statement. Public plans use EROAs to discount their funded future liabilities. EROAs are intended to be very long-term, typically 30 years, and based on median (expected) results.

[3] Source: JP Morgan Pension Pulse. March 2015. Historical data are based on Russell 3000 company 10-Ks and data from Bloomberg LP; data as of March 31, 2015. Estimates for 1Q15 are solely based on market and actuarial moves of assets and liabilities and do not include contributions, service costs and benefit payments.

[4] If a sponsor can borrow at a rate lower than its plan discount rate, and in some cases even if their borrowing rate is slightly higher than the plan discount rate, the sponsor may prefer to float debt to eliminate the plan deficit. Some of the key variables for the sponsor to consider in determining the financial benefit of borrowing to fund include: the Pension Benefit Guaranty Corporation variable premium/cap, corporate tax rates/tax deductibility of contributions compared with debt interest, the impact on company financials of structural change in loan, and expectations for future rates, market return, volatility, contributions.

[5] Regarding the uncertainty associated with using factors, Pappas et. al., 2016 note that there is "conjecture over whether the historical returns associated with certain factors will persist in the future. For example, Lo and MacKinlay (1990), Black (1993), and Harvey et al. (2014) contend that the empirical evidence is a result of data mining." Plan sponsors should maintain a clear understanding for either the risk explanation, behavioral explanation, or both, before implementing a tilt using one of these factors. For example, if the behavioral explanation holds for a factor, but the risk explanation does not, it may indicate a risk that the return premium may narrow if investors change their behavior in the future. Factor tilts also raise questions about how to implement that tilt—long-only, long-short, which is beyond the scope of this analysis.

[6] For example, the 2015 NACUBO Commonfund Study of Endowments found a passive/active mix for domestic equity of 29 percent/71 percent in 2015. See NACUBO (2015).

[7] Wallick et al. (2015) analyze the relationship between alpha and various quantitative portfolio characteristics. Only the expense ratio and portfolio turnover provide a statistically significant explanation of alpha. "More than any other quantifiable attribute we have examined, lower costs are associated with higher risk-adjusted future returns—or alpha." Simply selecting a fund from the lowest- rather than the highest-cost quartile increased the likelihood of outperforming a relevant index by in the subsequent five years by more than 50 percent (a 40 percent chance versus 26 percent).

[8] Wallick et. al. (2015) analyze funds-of-hedge funds, because these are professional managers who are paid to construct a high-quality collection of hedge funds for clients. This objective is similar to what numerous institutional investors would be attempting to do for their own portfolio. The authors also analyzed individual hedge funds over the same period using the same database and found that 56 percent outperformed a traditional portfolio of 60 percent equity and 40 percent fixed income.