Bill Carson, Associate, BlackRock Inc., New York, NY
Bill.Carson@BlackRock.com

Sara Shores, Managing Director, BlackRock Inc, New York, NY
Sara.Shores@BlackRock.com

Nicholas Nefouse, Managing Director, BlackRock Inc., New York, NY
Nick.Nefouse@BlackRock.com

Life Cycle Investing and Smart Beta Strategies

Bill Carson, Sara Shores, and Nicholas Nefouse

March 30, 2017

In traditional life cycle models, the *equity-bond glide path* shifts investment allocation from riskier assets to relatively safer assets as investors approach retirement. In this paper, we develop a *smart beta glide path* which seeks to take advantage of broad, persistent patterns within asset classes to identify securities with higher risk-adjusted returns than the market. Within equities, investors can shift from return-enhancing strategies—like value, momentum, size, and quality—to risk-reducing strategies like minimum volatility as they move through their life cycles. Adopting smart beta glide paths may improve Sharpe ratios by up to 20% over a standard equity-bond glide path.

Acknowledgements: The views expressed here are those of the authors alone and not of BlackRock, Inc. We thank Andrew Ang, Matt O'Hara, Michael Pensky, and Jennifer Oh for helpful comments. This material is not intended to be relied upon as a forecast, research or investment advice, and is not a recommendation, offer or solicitation to buy or sell any securities or to adopt any investment strategy. The opinions expressed are those of the authors, and may change as subsequent conditions vary.

1. Introduction

Modigliani and Brumberg (1954) developed the theory behind today's life cycle funds: as investors move towards retirement, their asset allocation shifts from riskier asset classes, like equities, to more conservative asset classes, like bonds. This pattern of life cycle savings is the *equity-bond glide path*, which is central to all target date funds.[1] Finance academics and practitioners have also long recognized that there are broad, persistent sources of return within asset classes: what are commonly known as smart beta or style factor strategies.[2] In equities, stocks with certain characteristics have tended to outperform the market over time—stocks that have low prices relative to fundamentals (value stocks), trending stocks (momentum), smaller stocks (small size), and stocks with stable earnings and solid balance sheets (quality). There are also stocks that seek to deliver market-like returns over the long run but with lower risk (minimum volatility strategies). We also see evidence of these style factors in fixed income, and can seek to further improve diversification and risk adjusted returns by balancing interest rate and credit exposures.

We apply smart beta strategies to life cycle investing and develop a *smart beta glide path*, which is an overlay on the traditional equity-bond glide path. While the equity-bond glide path determines the overall composition of equities and bonds and the age-appropriate risk levels over the life cycle, the smart beta glide path determines which *types* of equities and bonds are held within those asset classes. When the investor is young, the equity allocation is tilted towards smart beta factors which are designed to enhance returns (value, momentum, size, and quality), targeting approximately the same level of risk as the market. As the investor moves closer to retirement, there is a shift in equities from the return-enhancing strategies to minimum volatility strategies, which are designed to provide the same long-run return as the market with less risk. In fixed income, the smart beta strategies we consider are designed to provide greater diversification benefits and higher Sharpe ratios compared with standard market capitalization-based fixed income index strategies.

Taking the equity-bond glide path as given, we use a mean-variance optimization to construct the smart beta glide path. This solution is designed to incorporate the properties of excess

[1] The first target date funds were launch in November 1993 by Wells Fargo Investment Advisors, which later was acquired by Barclays Global Investors and is now part of BlackRock. This pattern of life-cycle asset allocation is optimal if an investor has labor income which is positively correlated with risk-free assets, as Bodie, Merton, and Samuelson (1992) show.

[2] For a comprehensive summary of smart beta and factor strategies, see Ang (2014). In this paper, we refer to smart beta and style factors interchangeably. Smart beta is technically the long-only implementation of style factor investing. The latter also includes long-short, multi-asset strategies. The life cycle applications we consider are restricted to long-only implementations of style investing.

returns, reduced risk, or both, delivered by smart beta strategies while matching the equity beta and duration of an index-based equity-bond glide path. This procedure allows some interaction between the equity-bond glide path and the smart beta glide path, allowing investors to hold a larger proportion of equities close to and at retirement while helping to ensure that the investor bears the same total and equity-related risk as in the index target date offering. This is advantageous because the inclusion of minimum volatility strategies may reduce the potential drawdown for a retiree, while maintaining the necessary equity exposure to help provide for the increasingly long post-retirement lifespan of the average investor.

Using index data, we estimate that including a smart beta glide path on top of an equity-bond glide path may add incremental returns of approximately 1% and increase Sharpe ratios by 0.08 to 0.15 across the portfolio vintages.[3] In particular, a 50-year old investor who is to retire around 2030 might expect his Sharpe ratio to increase from 0.30 using the traditional equity-bond glide path to 0.39 using the smart beta glide path. Similarly, a 25-year old investor, who is to retire around 2055, might see an increase in her Sharpe ratio from 0.19 to 0.27 overlaying a smart beta glide path on the traditional equity-bond glide path.

2. Smart Beta Strategies

Smart beta strategies screen for stocks with characteristics that make them more likely to beat the market over the long run. These types of screens have long been the staple of traditional active managers. The proliferation of data and technology in today's investment industry means that these same intuitive investment strategies can now be applied with scale and efficiency in a rules-based fashion: what the industry has come to know as smart beta. The focus on long-run returns and diversification, along with competitive fees in Exchange Traded Funds (ETFs) or mutual funds, make smart beta strategies potentially powerful tools in a target date context.

Our analysis includes both return-seeking and risk-reducing smart beta strategies in equities and a diversifying smart beta strategy in fixed income. Our analysis focuses on the smart beta indices published by MSCI and Barclays for equities and fixed income, respectively.[4] We refer to the index implementations of each factor with capitalized titles, for example, referring to the

---

[3] Indices are unmanaged and it is not possible to invest in an index. Appendix A lists the index launch date for smart beta indices used throughout the paper. Index data before index launch data is backtested and hypothetical. Past performance is no guarantee of future results.

[4] There are a proliferation of index-based smart beta strategies now available in the marketplace from a variety of index providers and asset managers. While many alternatives are available, strategies that sound similar may have different portfolio construction rules that can lead to different investment results. For more information on individual MSCI factors, reference https://www.msci.com/factor-indexes

MSCI USA Value index as Value. The Value index is an implementation of the value factor, and one that can be offered transparently, at low cost, and traded directly using ETFs. Appendix A contains a full list of indexes used to represent the smart beta factors.

2.1 Return-Enhancing Equity Smart Beta Strategies

We group value, quality, momentum, and small size factors as return-enhancing smart beta strategies. There is economic intuition behind each of these factors and they have a long academic history.

Value and quality investing try to identify cheaper and more profitable securities, respectively, with research dating from Graham and Dodd (1934). The value premium can result from a risk explanation: value firms have tended to underperform growth firms during economic downturns because they cannot easily redeploy fixed capital (see Zhang, 2005); or a behavioral bias as some investors tend to over-extrapolate and overpay for firms with recent high growth (see Lakonishok, Shleifer, and Vishny, 1994). In explaining the quality premium, Sloan (1996) argues that investors often fixate on top-line earnings numbers, without paying attention to the details in how those earnings are generated; those companies with more enduring earnings have tended to outperform.

The academic literature on momentum, which shows that positively trending stocks have tended to continue outperforming, began with Alexander (1961) and Levy (1967), and there is a great deal of attention in the finance literature after Jegadeesh and Titman (1993). Most academic explanations behind momentum are due to the behavioral biases of the average investor (see Daniel, Hirshleifer, and Subrahmanyam, 1998). The size effect is first shown by Banz (1981), where smaller and more nimble companies have tended to deliver higher returns than the broad market—but this is because they have tended to be more risky. Thus, the small size premium is due to bearing rewarded risk.

Each individual factor has a long history of delivering excess return over the market over the long run, but can be cyclical in the short run. The combination of several factors may therefore provide a more consistent return stream over time than could any individual factor. Our analysis includes the MSCI Diversified Multiple-Factor (DMF) Indices, which we refer to as Multi-Factor. The Multi-Factor index includes exposures to value, quality, momentum, and small size factors.

Exhibit 1 compares the MSCI USA DMF Index against the standard cap-weight MSCI USA Index (the "cap-weight market") over the past ten years through December 2016. Over this 10-year period, the US DMF Index out-performed the market by an average of 1.2% per year with an active risk of 3.6%. Multi-Factor benefits from its diversification across several factors: for example, exposures to value and size would have had a positive contribution to returns in 2009 as the market bottomed and investors became more risk seeking. In 2011, momentum would have made a strong positive contribution as market trends continued to strengthen throughout the year. Because the correlation across individual factors has tended to be low, combining several factors together in Multi-Factor may be an effective way to seek consistent incremental returns over the broad market.

2.2 Risk-Reducing Minimum Volatility Strategies

In the setting of a mean-variance frontier, the return-enhancing smart beta strategies are about moving north: they are designed to have approximately the same risk as the market, but because of their style tilts, they have offered higher returns than the cap-weighted index. In contrast, Minimum Volatility indices are designed to move west. Minimum Volatility strategies have historically provided market-like returns with less risk. An early reference to the relatively high risk-adjusted performance of minimum volatility strategies is Friend and Blume (1970), and there is a resurgence in the academic literature after Ang et al. (2006). Frazzini and Pedersen (2013) show that the effect can arise from certain institutional investors who overweight high risk securities in order to meet high total return targets when they cannot take leverage.

Minimum Volatility has gained popularity in recent years as a potential way to obtain smaller drawdowns than the broad market. This proposition is particularly valuable with increasing longevity and length of retirement: investors who must provide for many more years of retirement income and cannot tolerate a significant loss in capital. Minimum Volatility may also help address behavioral risks of investors abandoning investment objectives during a market downturn and forgoing the subsequent rebound.

The MSCI Minimum Volatility indices are designed to have the same broad market characteristics as their respective cap-weighted index. Empirically, the Minimum Volatility has a lower beta to the parent index of approximately 0.6 to 0.8 over the past ten years through December 2016. Exhibit 2 compares the MSCI USA Minimum Volatility Index against the standard cap-weighted MSCI USA Index over the past ten years through December 2016, where the Minimum Volatility index has experienced an annualized excess return of 0.7% while taking on 3.2% less risk. The potential drawdown protection of Minimum Volatility strategies was well demonstrated in 2008, when the broad market declined by just over 50%, while the Minimum Volatility index outperformed by approximately 9%.

2.3 Fixed Income Smart Beta

Style factors also manifest in fixed income markets. For instance, BB-rated bonds have had higher risk-adjusted returns than other high yield credit ratings because of a structural impediment that prevents many investors from buying bonds below investment grade (see Ilmanen, 2011). At the same time, high yield managers tend to underweight these bonds because they do not offer as attractive yields as other bonds. Another type of structural impediment leads leverage-constrained investors to underweight short-maturity, investment grade debt. In order to match long-term liabilities without being able to take leverage, these institutions tend to gravitate to the long-duration parts of the maturity spectrum. This is similar to the minimum volatility effect observed in equities.

While style factors are conceptually similar in equities and fixed income, implementation in fixed income may be more complex as a result of the more opaque nature of the bond market. As more smart beta fixed income strategies are researched and brought to market, there will be further potential for improvement in the fixed income exposures in target date funds. Here we focus on the potential benefits of well-diversified fixed income smart beta indices, the Barclays Fixed Income Balanced Risk (FIBR) indices (specifically the Barclays Constant Weights index in this family). Thus, for our analysis, we use FIBR as the fixed income smart beta strategy.

The most well-known fixed income index for US investors is the Barclays US Aggregate Index (the "Agg"). The Agg is dominated by interest rate, or duration, risk. A sensible approach to move away from the exposures of the Agg is to seek to balance risk between interest rates and credit, which is the objective of the FIBR index. Exhibit 3, Panel A shows the historical rolling three-year correlation between interest rate and credit risk from July 1991 to December 2016, with a long-term average correlation of -0.34. Staal et al. (2015) explain the negative correlation, and its resulting diversification benefits, as follows. Interest rate risk is generally rewarded during flight-to-quality periods while credit risk is generally rewarded during periods of increasing economic growth. Indeed, many active managers seek to boost returns by tilting into credit exposures. The FIBR index seeks to harvest these potential gains in diversification and incremental returns in a more transparent and cost effective manner.

By investing across five large, replicable bond sectors that have the potential to provide attractive yield and spread sector diversification, FIBR also builds in exposures to the most risk-efficient spread sectors, namely agency mortgages, 1-5 year Investment Grade debt, and BB rated bonds, in seeking to deliver an attractive and diversified source of yield with significantly *less* duration than traditional bond indexes. As of December 31, 2016, the FIBR index out-yielded the Agg by 0.9% with 1.9 years less duration.

Exhibit 3, Panels B and C summarize the performance of FIBR Index relative to the Barclays US Aggregate Index over the past ten years through December 2016. Over the sample, FIBR has an information ratio of 0.3 with an annualized excess return of 0.9%. During the start of the financial crisis, the FIBR index underperformed the Agg when investors flocked to safety and higher duration was rewarded, but outperformed during the recovery in 2009.

3. Integrating Smart Beta Strategies into the Glide Path

Our smart beta approach to target date funds builds off extensive research in target date glide path construction. We start by taking a benchmark glide path as given in Section 3.1. Over this equity-bond glide path, we overlay the smart beta optimization, which we describe in Section 3.2. In Sections 3.3 to 3.5, we discuss properties of the resulting smart beta glide path in the total equity allocation, within equities allocation, and bond allocation, respectively.

3.1 Benchmark Equity-Bond Glide Path

The benchmark equity-bond glide path defines the asset allocation by age, aiming to balance risky assets needed for capital accumulation against less risky assets needed for protection. A large literature follows Bodie, Merton, and Samuelson (1992) in using quantitative techniques to compute these allocations with the aims of smoothing consumption through an investor's full life cycle and reducing the volatility of spending outcomes. We take as a benchmark the equity-bond glide path developed by BlackRock (see O'Hara and Daverman, 2015), which links the expected returns and risk of the equity-bond glide path to those of the more granular asset classes using capital market assumptions as of December 2016.

Exhibit 4 shows our benchmark equity-bond glide path where we categorize US and international equity along with real estate as "equity," and group nominal and inflation linked bonds into "fixed income." The glide path gradually decreases equity allocations as an individual approaches retirement, followed by a constant equity allocation after retirement. For example, a 25-year old who aims to retire around 2055 would hold 99% of her portfolio in equity. In contrast, a 50-year old planning to retire around 2030 has an optimal equity allocation of 72%. His retirement portfolio has an equity landing point of 40%.

3.2 Optimization of the Smart Beta Glide Path

Taking the equity-bond glide path as given, we now overlay the smart beta glide path. This two-step approach avoids the curse of dimensionality in a one-step solution. That is, it allows for a separation of capital market assumptions: first the asset class assumptions and then the smart beta assumptions, which can be overlaid on the asset class expectations.

To summarize, our smart beta glide path endeavors to improve investment outcomes over a traditional glide path in the following ways:

- When the investor is young, the equity allocation is tilted towards smart beta factors which are designed to enhance returns (value, momentum, size, and quality factors comprising the Multi-Factor), targeting approximately the same level of risk as the market.
- As the investor moves to retirement, the optimization shifts the equity holdings from the return-enhancing strategies to Minimum Volatility, which is designed to provide the same long-run return as the market with less risk.
- In fixed income, the fixed income smart beta index, FIBR, seeks to provide greater diversification benefits (and higher Sharpe ratios) compared with the Agg.

The optimization procedure seeks to maximize the smart beta glide path's Sharpe ratio while maintaining a similar level of risk to the benchmark equity-bond glide path. We maintain an active risk within 3% of the equity-bond glide path. For equities, we constrain the smart beta glide path to have a beta to the Russell 1000 index and to the MSCI ACWI ex US IMI index that is within +/- 5% of the benchmark equity-bond glide path. This ensures we try to capture benefits from factor tilts and not introduce systematic over or underweights to the market. In fixed income, we constrain the duration of the smart beta portfolio to be within 0.05 years of the benchmark equity-bond portfolio. Similar to equities, we are concerned with matching the risk of the fixed income allocation. We follow Qualified Default Investment Alternative (QDIA) rules which require at least 1% in fixed income for all QDIA target date portfolios. The full optimization problem is detailed in Appendix B.

A further potential benefit of allowing the procedure to trade off the risk and return relative to the benchmark equity-bond glide path is that the optimizer can take the active risk in ways other than strictly adhering to the benchmark equity-bond capital allocations. In particular, the inclusion of Minimum Volatility exposure allows investors to hold a larger proportion of equities close to and at retirement, while still targeting the same total and equity-related risk as a traditional target date offering. This may be beneficial because it seeks to reduce the potential drawdown for a retiree, while also seeking to maintain the necessary equity risk for the increasingly long post-retirement lifespan of a typical investor.

Risk and Returns of the Smart Beta Strategies

In order to compute the smart beta glide path, the mean-variance optimization requires capital market assumptions of the smart beta indices. As a starting point, Exhibit 5 graphs the risk and returns of the smart beta indices in equities (Panel A) and fixed income (Panel B) for the period over the past ten years through December 2016. In each panel, we start with the market-cap index and use an arrow to point to the smart beta strategy.

For the Multi-Factor indices in Panel A, the arrow is more vertical, as Multi-Factor had similar levels of risk but higher return relative to the cap-weighted indices. For US returns in the upper left-hand corner, the cap-weighted MSCI USA index experienced a volatility of 15.3% with a return of 7.0%. We can move north with the DMF index to a volatility of 15.9% and a return of 8.2%. In the bottom left-hand corner, there have been further improvements in international markets. The MSCI World ex-USA index had a risk of 18.6% with a return of 0.9%. The Multi-Factor index in the international setting experienced the same volatility of 18.6% with a higher return of 3.5%.

The Minimum Volatility indices have produced a significant move west in Panel A. In the US market (upper left-hand corner), the Minimum Volatility index has returned 8.5% with a volatility of 12.1%. This compares to a return of 7.0% and risk of 15.3% for the cap-weighted market. There has also been significant risk reduction in international markets (lower right-hand corner): the MSCI EAFE Minimum Volatility Index has exhibited risk and average returns of 13.2% and 3.7%, respectively, compared to the risk and return of 18.6% and 0.8%, respectively, for the cap-weighted market. The outperformance of minimum volatility strategies is largely driven by the global financial crisis, when lower volatility portfolios outperformed in the pronounced risk-off environment. There has also been strong outperformance during 2014 and 2015, when volatile markets coincided with falling commodity prices and there were fears of a China slowdown.

Panel B of Exhibit 5 plots the risk and return of the smart beta fixed income strategy, FIBR, compared to the market-cap index (the Agg). The Agg exhibited a volatility and return of 3.3% and 4.4%, respectively, over the past ten years through December 2016. FIBR experienced a higher return of 5.3%, with a slightly higher volatility of 4.6% than the Agg, over the same sample.

Given the risk and returns in Exhibit 5, we make the following conservative assumptions for annualized excess returns of smart beta strategies:

Category	Excess Returns
MSCI Multi-Factor (DMF) Indices	1.00%
MSCI Minimum Volatility Indices	0.25%
Fixed Income Balanced Risk (FIBR)	0.25%

The excess return for the Multi-Factor indices range from 1.2% to 2.6%. Some of the outperformance is driven by the post-financial crisis period. We take a bound of 1.00% to be conservative, recognizing that this was an unusual event and such a rebound in the smart beta premiums may not be repeated in the future. The volatility of the Multi-Factor indices is similar to the comparable cap-weighted indexes, so we make no adjustment to volatilities.

Minimum Volatility indices are designed to have lower volatility than the cap-weighted indices and have had a beta of 0.6 to 0.8 relative to those cap-weighted indices. We downweight the strong performance of the Minimum Volatility indices during the financial crisis as well as during 2014 and 2015. We thus select a conservative excess return of 0.25% for Minimum Volatility relative to the *beta-adjusted* cap-weighted index return. This produces an expected return lower than the index performance.

Finally, we also make conservative risk and return assumptions for the fixed income smart beta index, FIBR. While Exhibit 5, Panel B shows that the historical alpha for FIBR was 0.9%, we conservatively select an excess return of 0.25% for FIBR in the smart beta glide path optimization. Note that all of the expected return assumptions for the smart beta strategies are significantly lower than the historically experienced returns.

3.3 Equities and Bonds in the Smart Beta Glide Path

Exhibit 6, Panel A graphs the smart beta glide path, where we have aggregated Multi-Factor indices, Minimum Volatility indices, and Real Estate (as represented by the FTSE EPRA/NAREIT Global REITs index) as “equity”. The “bond” component aggregates inflation-linked bonds, as represented by the Barclays US TIPS index, FIBR index, and the ICE 20+ Year US Treasury index. As expected, the equity allocation starts off near 100% when young and decreases towards retirement, at which point it remains constant. In the smart beta glide path, the equity allocation is 0 to 8% larger than the benchmark equity-bond glide path. For example, a 50-year old who is to retire around 2030 would hold 80% equities in the smart beta glide path, compared to 72% equities in the benchmark glide-path. The equity landing point in the smart beta glide path increases to 46%, compared to 40% in the benchmark glide-path.

Exhibit 6, Panel B compares the Sharpe ratio for the standard equity-bond glide path versus the smart beta glide path. Over the past ten years through December 2016, the addition of the smart beta glide path would have resulted in higher Sharpe ratios, increasing from 0.08 to 0.15 across the target retirement vintages. Younger individuals would have experienced larger improvements in Sharpe ratios. This is because young investors hold more equities in the benchmark equity-bond glide path. In the smart beta optimization, there is greater scope to switch these equity allocations to the Multi-Factor smart beta strategy. Older investors hold less equity in the equity-bond glide path and thus the potential improvements in switching the equity allocation to Multi-Factor are more limited.

Near retirement, the optimization prefers the risk-return properties of Minimum Volatility. Approximately 38% of capital in the smart beta retirement portfolio is allocated to Minimum Volatility strategies. Minimum Volatility indexes, however, have a beta that has ranged from 0.65 to 0.72 over the sample period, and so we require a higher capital allocation to Minimum Volatility to match the overall equity risk of the benchmark equity-bond glide path. This capital overweight to equities close to and at retirement is funded from the bond allocation. Portfolios nearer to retirement therefore have a higher equity landing point: the capital allocation to equities is 46% in the smart beta glide path versus 40% in the standard equity-bond glide path.

The higher equity landing point and increased credit exposure from the FIBR index does not mean that the risk in the smart beta glide path is higher than the benchmark equity-bond glide path. In fact, the smart beta retirement portfolio has a lower potential drawdown as a result of both the portfolio construction and the inclusion of Minimum Volatility: this is crucial for a portfolio held by a retiree who does not have the benefit of longevity to offset a drawdown.

We illustrate the risk reduction in Panels C and D of Exhibit 6, which compare the retirement portfolio from the benchmark equity-bond glide path with the retirement portfolio from the smart beta glide path over the past ten years through December 2016. The cumulated returns graphed in Panel C reflect the annualized excess return of 1.2% of the smart beta portfolio. In Panel D, we graph maximum drawdowns: the smart beta portfolio would have had a maximum drawdown during the financial crisis of 21.6%, compared to a maximum drawdown for the benchmark portfolio of 23.6%.

3.4 Equity Smart Beta Allocations

Exhibit 7 shows the glide path transition in the total equity allocation from return-enhancing smart beta strategies to risk-reducing strategies as an individual moves towards retirement. When an individual is young, the smart beta glide path allocates predominately to the return-seeking Multi-Factor. A 25-year old who is to retire around 2055 has an allocation split of 82% and 2% between Multi-Factor and Minimum Volatility, respectively. Near retirement, the optimization prefers Minimum Volatility for its risk-mitigating properties. In particular, for a 50-year old who is to retire around 2030, the allocation split between DMF and Minimum Volatility is 40% and 33%, respectively.

3.5 Fixed Income Smart Beta Allocations

In the smart beta glide path, we approximately match the overall duration of the traditional equity-bond glide path. Historically, the FIBR index has lower duration than a broad U.S. Agg, but has obtained a higher information ratio from greater yield and carry. If we held only FIBR as the investible fixed income asset, the discrepancy in duration may result in unintended interest rate sensitivity. We match the duration from the benchmark equity-bond glide path by using ICE 20+ Year US Treasury Index, and thus the smart beta fixed income allocation consists of FIBR and Long Treasuries.

Exhibit 8 shows the evolution of the fixed income allocation across the life cycle. In the equity-bond glide path, the inflation-linked bond allocation increases from 0% at the beginning of the life cycle to 8% at retirement. The smart beta glide path maintains the same inflation-linked bond allocation. The optimization procedure results in a combination of FIBR and Long Treasuries so that the portfolio holds as large an allocation to the high Sharpe ratio FIBR strategy as possible, but holds enough Long Treasuries to match the original duration from the equity-bond glide path. In particular, a 50-year old who is to retire around 2030 would have an allocation of 11% and 5% to FIBR and Long Treasuries, respectively.

One potential objection is: Do we return to the market—the original US Agg exposure—by adding back Long Treasuries to FIBR to go back to the original Agg duration? No. The fixed income portfolio combining Long Treasuries and FIBR has the same first-order duration risk as the broad cap-weighted index. However, the composition of the holdings is not the same. FIBR targets more efficient carry in agency mortgages, seeks to capture the low risk effect in 1-5 year Investment Grade credit securities, and seeks to diversify the rate risk of the cap-weighted index to include more spread exposure. For example, as of December 2016, FIBR had a 31% higher capital allocation to 1-5 year Investment Grade credit securities and a 17% higher capital allocation to agency mortgages than the Agg. The result is a more risk efficient portfolio: at the end of December

2016, the smart beta retirement portfolio out-yields the benchmark retirement portfolio by 0.9% with a lower duration.

4. Conclusion

Defined contribution plan sponsors find themselves challenged by two mandates. The first is the high fiduciary standards of today's environment, where there is considerable pressure to provide access to low-cost, transparent investment vehicles. The second challenge is the high returns observed in the past may not be repeated in the future, making it more difficult for individuals to save for retirement. Sources of excess returns can play an important role in helping individuals to save in retirement, but how can those sources be made available in cost-effective and transparent formats and be optimized for target date offerings?

Smart beta strategies seek to capture time-tested, academically researched sources of returns in a transparent, rules-based approach. These broad, persistent return drivers have historically out-performed the market over time by selecting value, momentum, small size, and quality stocks. In addition, minimum volatility strategies have historically reduced risk with the same long-run returns as the broad market. Including smart beta strategies within a target date glide path may increase returns and mitigate risk, while remaining transparent and less expensive than most actively managed alternatives.

We show how a traditional equity-bond glide path can be enhanced by incorporating smart beta strategies. In equities, younger individuals can benefit from holding a combination of value, momentum, size, and quality—a multi-factor smart beta index designed to enhance returns. Older individuals can use minimum volatility strategies to help reduce drawdown potential while maintaining equity exposure. In fixed income, smart beta strategies can potentially obtain more diversified exposure to interest rate and credit factors, which may enhance risk-adjusted returns and reduce the dependence on interest rate risk. These smart beta glide paths *within* equities and bonds are overlaid on the asset class *levels* of a traditional equity-bond glide path. Using index data, a smart beta glide path has improved the Sharpe ratio from 0.08 to 0.15 per vintage compared to a traditional equity-bond glide path.

References

Alexander, S.S. “Price Movements in Speculative Markets: Trends or Random Walks.” Industrial Management Review (pre-1986), Vol. 2, No. 2 (1961), pp. 7.

Ang, A. Asset Management: A Systematic Approach to Factor Based Investing. New York, NY: Oxford University Press, 2014.

Ang, A., R.J. Hodrick, Y. Xing, and X. Zhang. “The Cross-Section of Volatility and Expected Returns.” The Journal of Finance, Vol. 61, No. 1 (2006), pp. 259–299.

Banz, R. “The Relationship between Return and Market Value of Common Stocks.” Journal of Financial Economics, Vol. 9, No. 1 (1981), pp. 3-18.

Bodie, Z., R.C. Merton, and W.F. Samuelson. “Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model.” Journal of Economic Dynamics and Control, Vol. 16, No. 3-4 (1992), pp. 427-429.

Daniel, K., D. Hirshleifer, and A. Subrahmanyam. "Investor Psychology and Security Market Under-and Overreactions." The Journal of Finance, Vol. 53, No. 6 (1998), pp. 1839-1885.

Frazzini, A., and L.H. Pedersen. “Betting against beta.” Journal of Financial Economics, Vol. 111, No. 1 (2014), pp. 1-25.

Friend, I., and M. Blume. "Measurement of Portfolio Performance under Uncertainty." The American Economic Review, Vol. 60, No. 4 (1970), pp. 561-575.

Graham, B., and D. Dodd. Security Analysis: Principles and Technique. McGraw-Hill, 1934.

Ilmanen, A. Expected Returns: An Investor’s Guide to Harvesting Market Rewards. United Kingdom: John Wiley & Sons, 2011.

Jegadeesh, N., and S. Titman. “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency.” The Journal of Finance, Vol. 48, No. 1 (1993), pp. 65-91.

Lakonishok, J., A. Shleifer, and R.W. Vishny. “Contrarian Investment, Extrapolation, and Risk.” The Journal of Finance, Vol. 49, No. 5 (1994), pp. 1541-1578.

Levy, R. “Relative Strength as a Criterion for Investment Selection.” The Journal of Finance, Vol. 22, No. 4 (1967), pp. 595-610

Merton, R.C. “Lifetime Portfolio Selection under Uncertainty: The Continuous Time Case.” The Review of Economics and Statistics, Vol. 50, No. 1 (1969), pp. 247–257.

Modigliani, F., and R. Brumberg. “Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data.” Post Keynesian Economics, K. Kurihara, ed., Rutgers University Press, New Brunswick, 1954.

O’Hara, M. and T. Daverman. “Reexamining “To vs. Through”: What New Research Tells Us about an Old Debate.” The Journal of Retirement, Vol. 2, No. 4 (2015), pp. 30-37.

Samuelson, P. A. “Lifetime Portfolio Selection by Dynamic Stochastic Programming.” Review of Economics and Statistics, Vol. 51, No. 1 (1969), pp. 239–246.

Sloan, R. “Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings?” Accounting Review, Vol. 71, No. 3 (1996), pp. 289-315.

Sperandeo, M., M. Corsi, and S. Shores. “Influencing Retirement Saving: Smart Beta in Defined Contribution Default Options.” BlackRock, 2016.

Staal, A., M. Corsi, S. Shores, and C. Woida. “A Factor Approach to Smart Beta Development in Fixed Income.” The Journal of Index Investing, Vol. 6, No. 1 (2015), pp. 98-110.

Zhang, L. “The value premium.” The Journal of Finance, Vol. 60, No. 1 (2005), pp. 67-103.

Appendix

A. Smart Beta Indexes

Index	Index launch date
MSCI USA Diversified Multiple-Factor Index	2/17/2015
MSCI USA Minimum Volatility Index	6/2/2008
MSCI USA Small Cap Diversified Multiple-Factor Index	2/17/2015
MSCI World ex USA Diversified Multiple-Factor Index	2/17/2015
MSCI EAFE Minimum Volatility (USD Optimized) Index	12/1/2009
Barclays Constant Weights (Fixed Income Balanced Risk) Index	4/1/2015
ICE US Treasury 20+ Year Index	12/31/2015

- MSCI Diversified Multiple-Factor Indexes[5] use the Barra product risk tools to construct indexes that track the performance of four factors – Value, Momentum, Quality and Low Size – which have, over time, provided higher return than the overall market while keeping risk at the level of an underlying parent index.
- MSCI Minimum Volatility Indexes[6] reflect the performance characteristics of a minimum variance strategy focused on absolute returns as well as volatility with the lowest absolute risk. Each Minimum Volatility Index is calculated by optimizing a parent MSCI index to produce an index with the least volatility for a given set of constraints.
- Barclays Fixed Income Balanced Risk Indexes[7] measures the US taxable bond market while targeting an equal allocation between interest rate and spread risk. The index assigns an equal risk (volatility) weighting to five components of the US Universal Index: investment grade corporates (1-5 and 5-10 year), high yield corporates (Ba-rated, less than Ba-rated), and agency mortgage backed securities (MBS). The index then adjusts the benchmark's interest rate exposure to equal the spread risk of this allocation.
- ICE US Treasury Index[8] assesses the U.S. Treasury market. The Index is market value weighted and is designed to measure the performance of U.S. dollar-denominated, fixed rate securities with minimum term to maturity greater than twenty years.

[5] https://www.msci.com/msci-diversified-multi-factor-indexes
[6] https://www.msci.com/msci-minimum-volatility-indexes
[7] https://index.barcap.com/Home/Guides_and_Factsheets
[8] https://www.theice.com/marketdata/reports/210

B. Smart Beta Optimization

Optimization:

$$\max_{h} h'\mu - \gamma h'\Sigma h$$

Subject to:

(i) $h'_{active}\Sigma h_{active} \leq 3\%$

(ii) $h_{fixed\ income} \geq 1\%$

(iii) $abs\ (\beta\ (to\ Russell\ 1000)_{Smart\ Beta} - \beta\ (to\ Russell\ 1000)_{Benchmark}) \leq 5\%$

(iv) $abs\ (\beta\ (to\ MSCI\ ACWI\ IMI\ ex\ US)_{Smart\ Beta} - \beta\ (to\ MSCI\ ACWI\ IMI\ ex\ US)_{Benchmark}) \leq 5\%$

(v) $abs(Duration_{Smart\ Beta} - Duration_{Benchmark}) \leq 0.05yr$

(vi) $h_{Russell\ 2000_{Benchmark}} = h_{US\ Small\ Cap\ DMF_{Smart\ Beta}}$

(vii) $h_{Real\ Estate_{Benchmark}} = h_{Real\ Estate_{Smart\ Beta}}$

(viii) $h_{TIPS_{Benchmark}} = h_{TIPS_{Smart\ Beta}}$

(ix) $h'\mathbf{1} = 1$

(x) $h > 0\ \forall h$

(xi) $E[R]_{Long\_Tsy} = 0$

Explanation of Constraints:

(i) Active Risk Budget of 3% for Smart Beta portfolio vs. Benchmark

(ii) QDIA Rule: Must have minimum of 1% Fixed Income allocation

(iii) US Equity Beta, using the weighted sum of equity components and FIBR beta to Russell 1000 Index and setting the Beta of other Fixed Income products to 0, of Smart Beta portfolio within 5% of Benchmark

(iv) International Equity Beta, using the weighted sum of equity components and FIBR beta to MSCI ACWI ex-USA IMI Index and setting the Beta of other Fixed Income products to 0, of Smart Beta portfolio within 5% of Benchmark

(v) Duration of Smart Beta portfolio within 0.05 years of Benchmark

(vi) Match capital allocation of Smart Beta USA Small Cap DMF to US Small Cap (Russell 2000) capital allocation

(vii) Match Real Estate Allocation (ignoring implementation vehicle)

(viii) Match TIPS Allocation

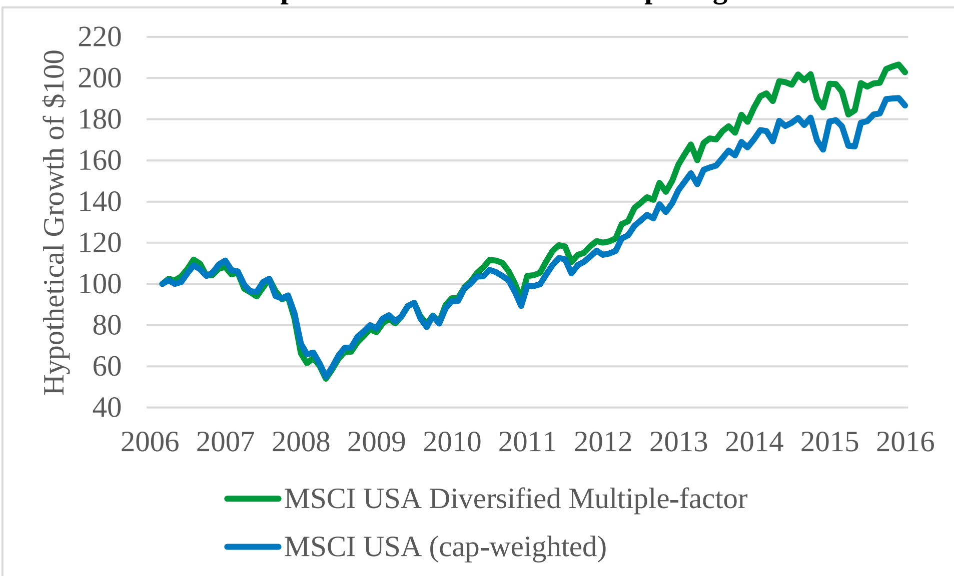
(ix) No leverage

(x) All non-negative allocations

(xi) Expected return of the ICE U.S. Treasury Long (20+) index = 0% for the optimization. In reality, we expect this asset to have a positive expected return. However, the 0% return assumption ensures that our optimization utilizes Long Treasuries for duration matching rather than for return enhancement.

Exhibit 1: MSCI Diversified Multiple-Factor (DMF) Index

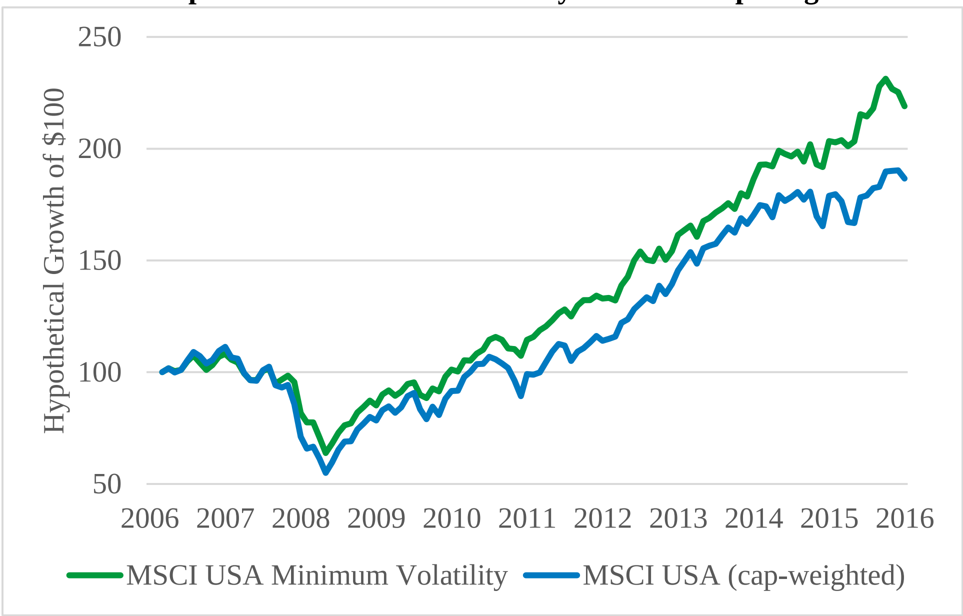
Panel A: Comparison of DMF Index vs. Cap-weighted Index



Panel B: Excess Returns (DMF Index minus Cap-weighted Index)

Exhibit 2: MSCI Minimum Volatility Index

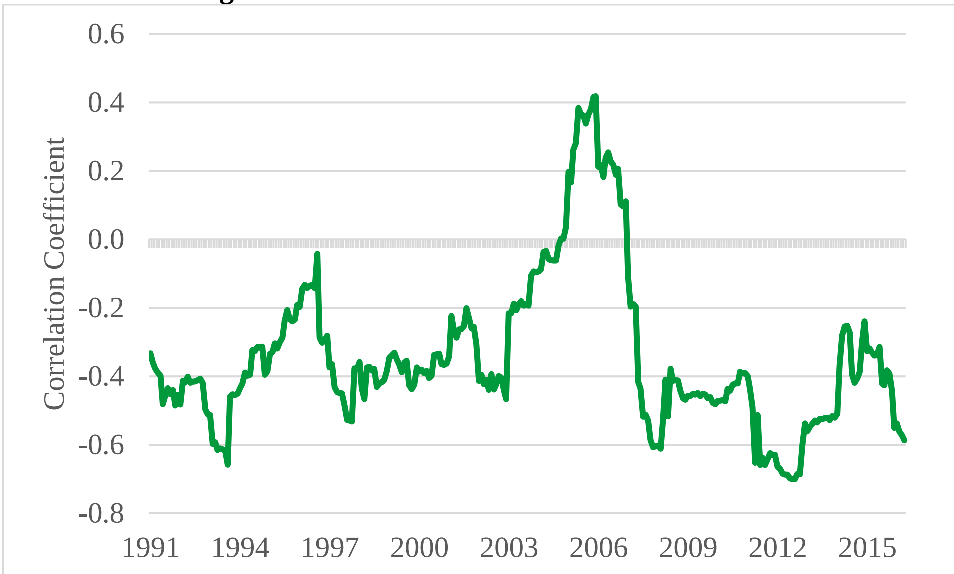
Panel A: Comparison of Minimum Volatility Index vs. Cap-weighted Index



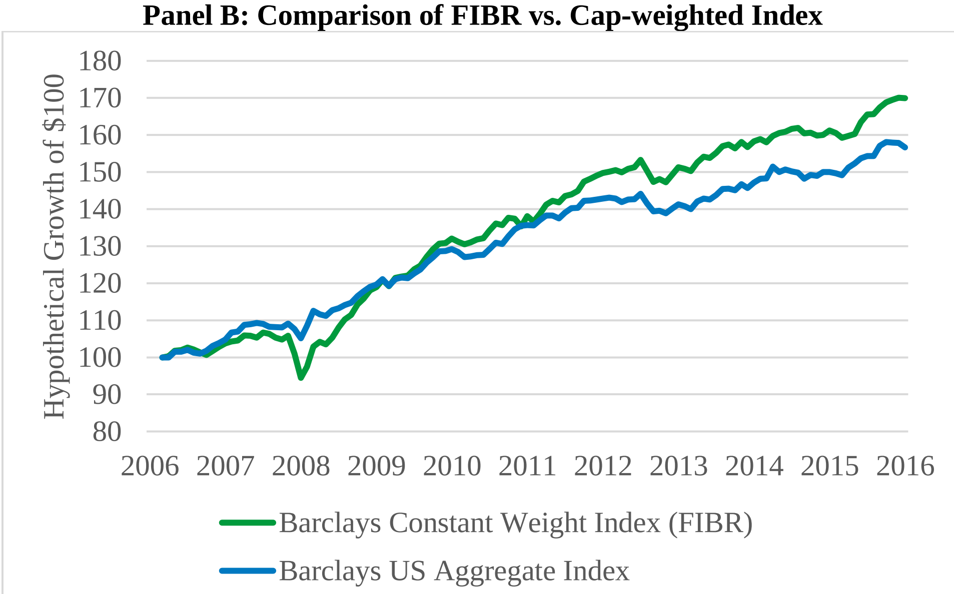
Panel B: Excess Returns (Minimum Volatility Index minus Cap-weighted Index)

Exhibit 3: Barclays Fixed Income Balanced Risk (FIBR) Index

Panel A: Rolling 36-Month Correlation of Interest Rate and Credit Risk[9]



Panel B: Comparison of FIBR vs. Cap-weighted Index



[9] Credit returns represented by excess total returns of Barclays US Aggregate Bond Index. Interest rate returns represented by total returns of the Barclays US Aggregated Bond Index minus 3-month T-bills minus credit returns as defined above.

Exhibit 3: Barclays Fixed Income Balanced Risk (FIBR) Index

Panel C: Excess Returns (FIBR Index minus Cap-weighted Index)

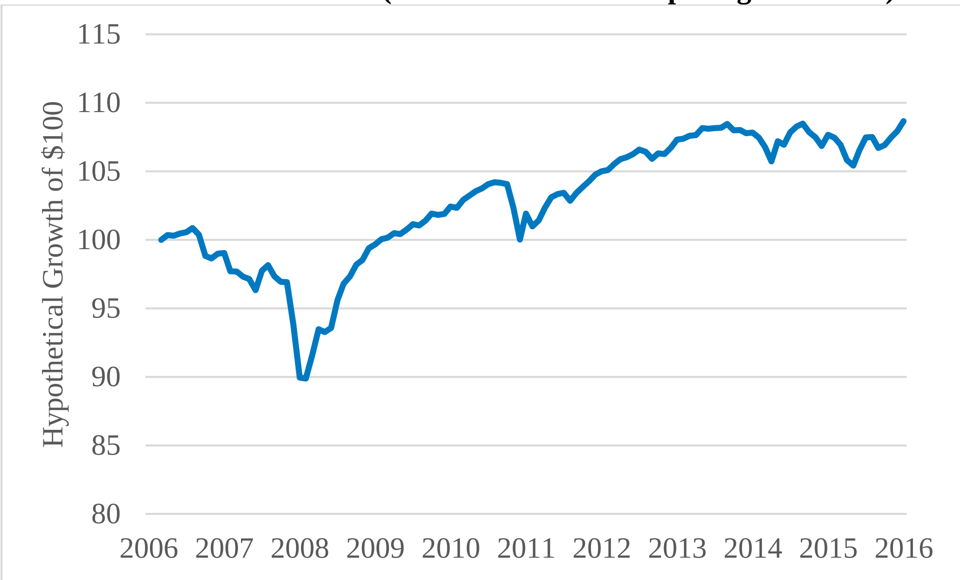


Exhibit 4: Traditional Equity-Bond Glide Path

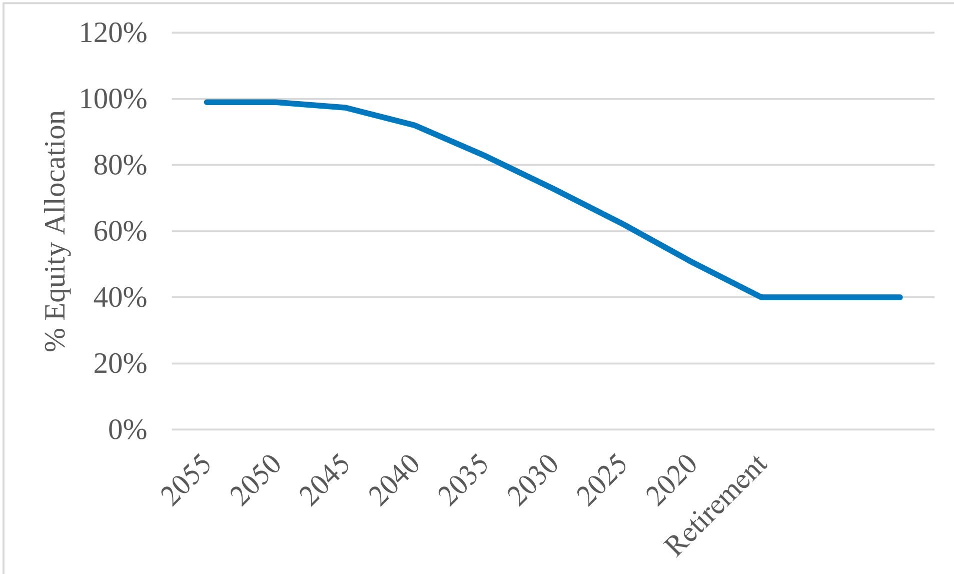
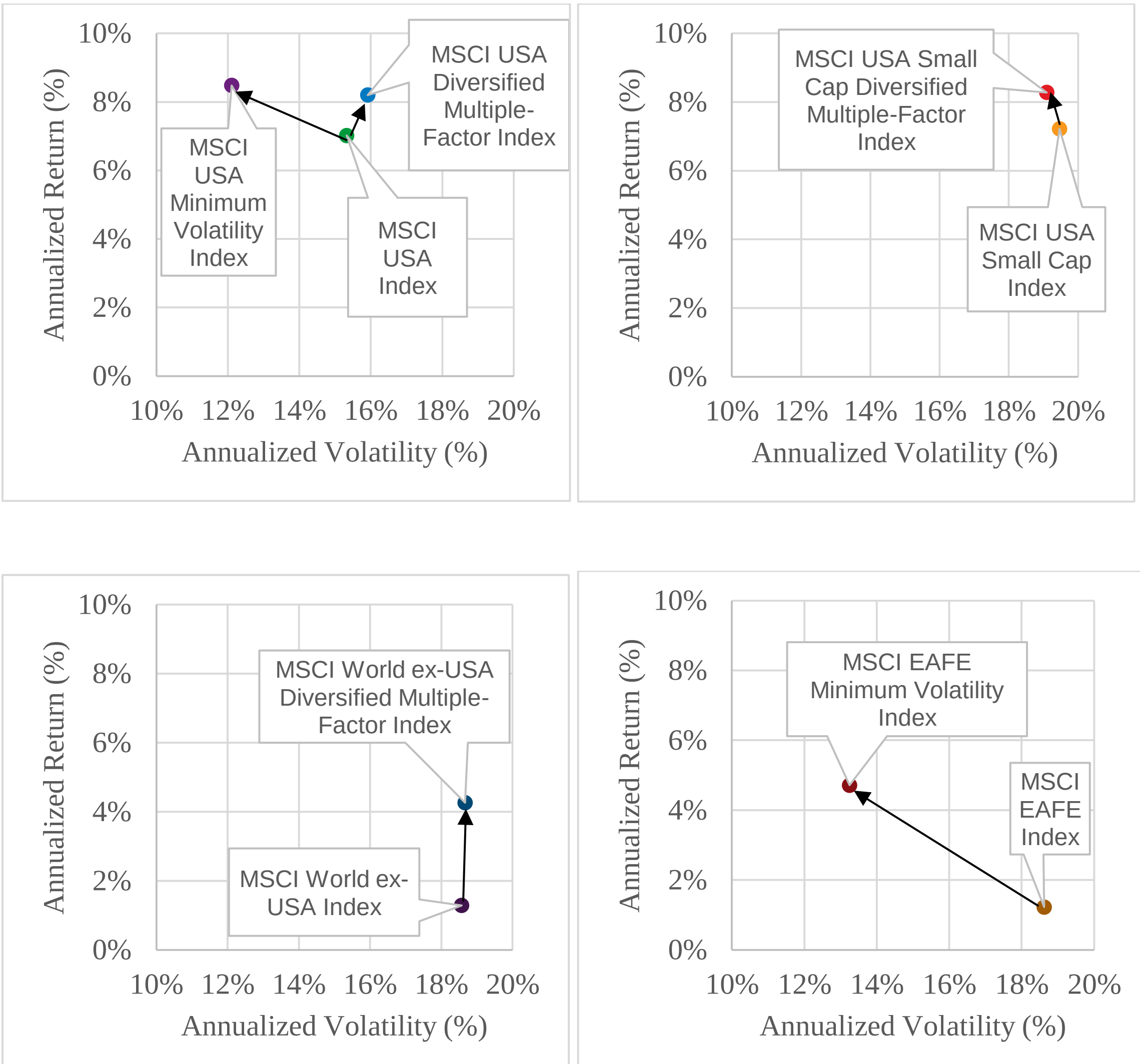


Exhibit 5: Smart Beta Indices Historical Risk and Returns

Panel A: Equity.
January 2007 – December 2016



Panel B: Fixed Income
January 2007 – December 2016

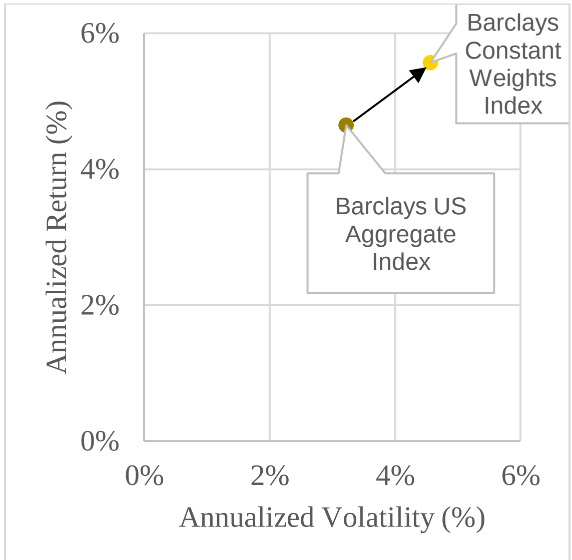
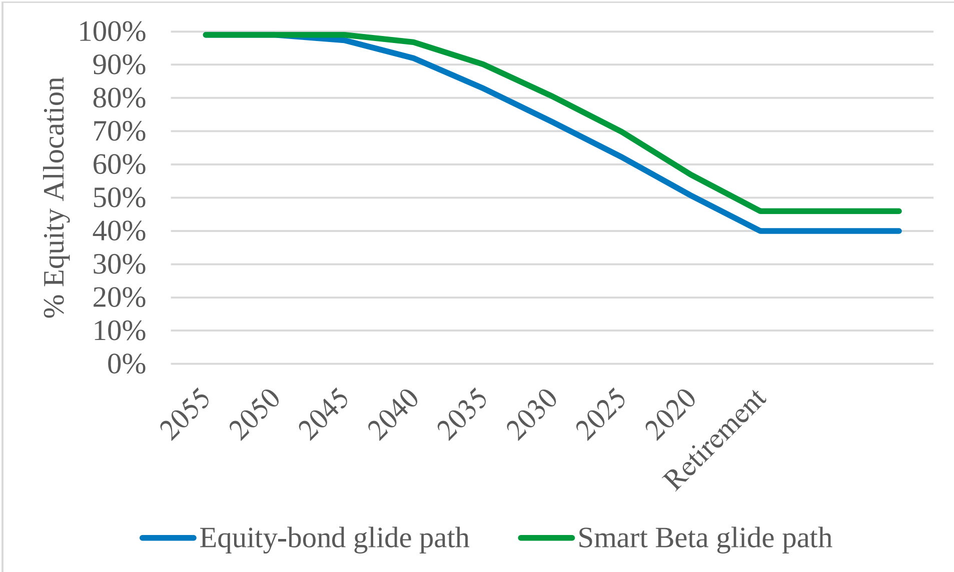


Exhibit 6: Comparing the Traditional and Smart Beta Equity-Bond Glide Paths

Panel A: Equity Allocations Over the Life Cycle



Panel B: Performance Metrics
January 2007 – December 2016

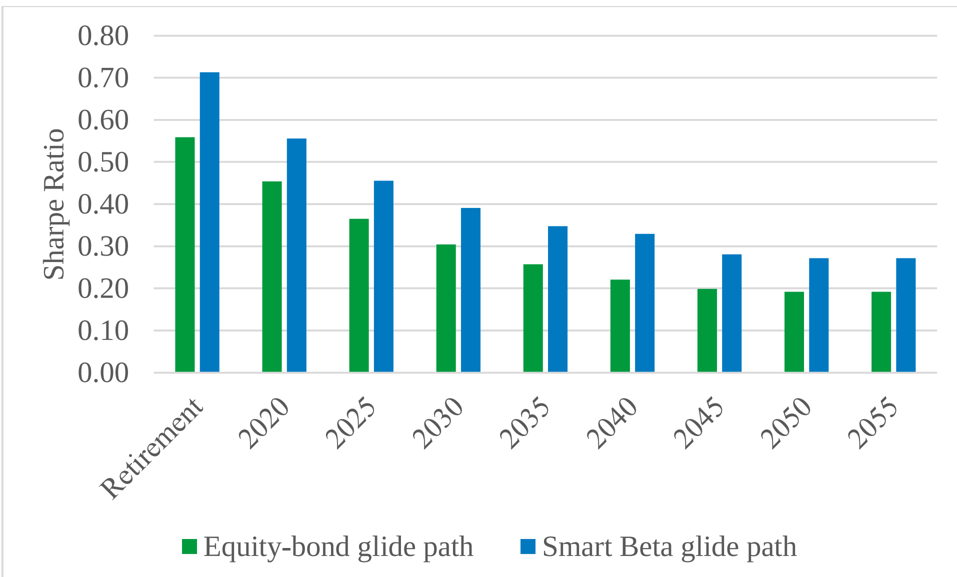
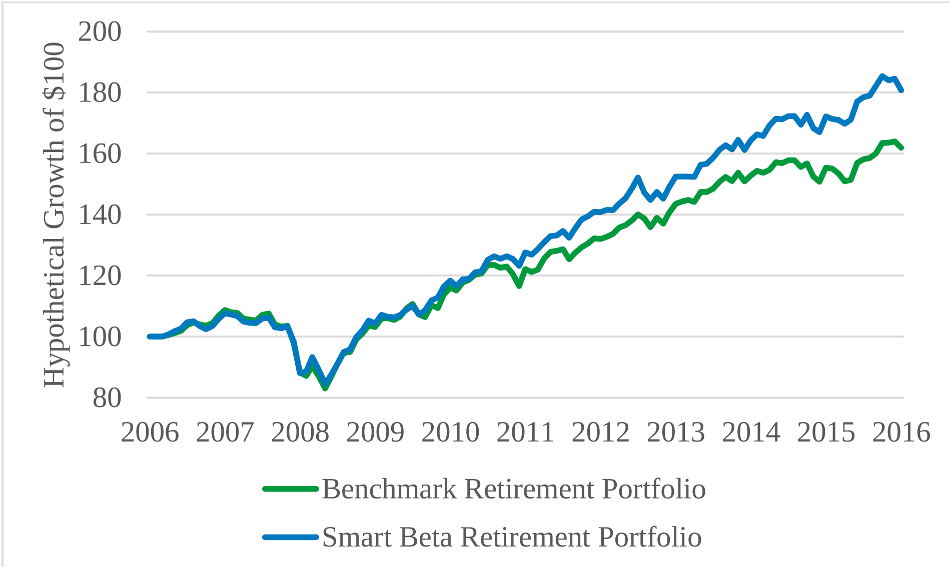


Exhibit 6: Comparing the Traditional and Smart Beta Equity-Bond Glide Paths

Panel C: Comparison of Returns for Retirement Portfolios



Panel D: Comparison of Maximum Drawdown for Retirement Portfolios

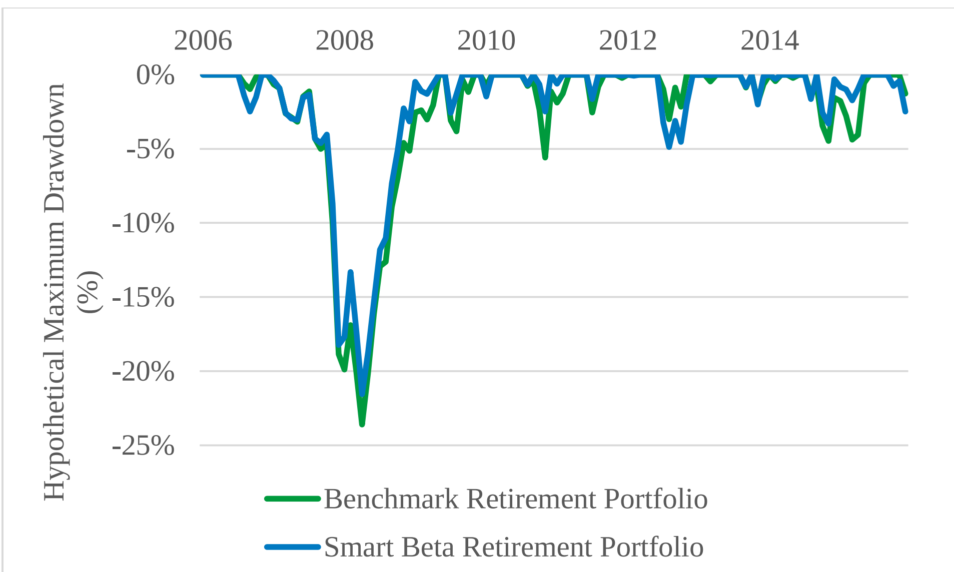


Exhibit 7: Equity Allocations in the Smart Beta Glide Path

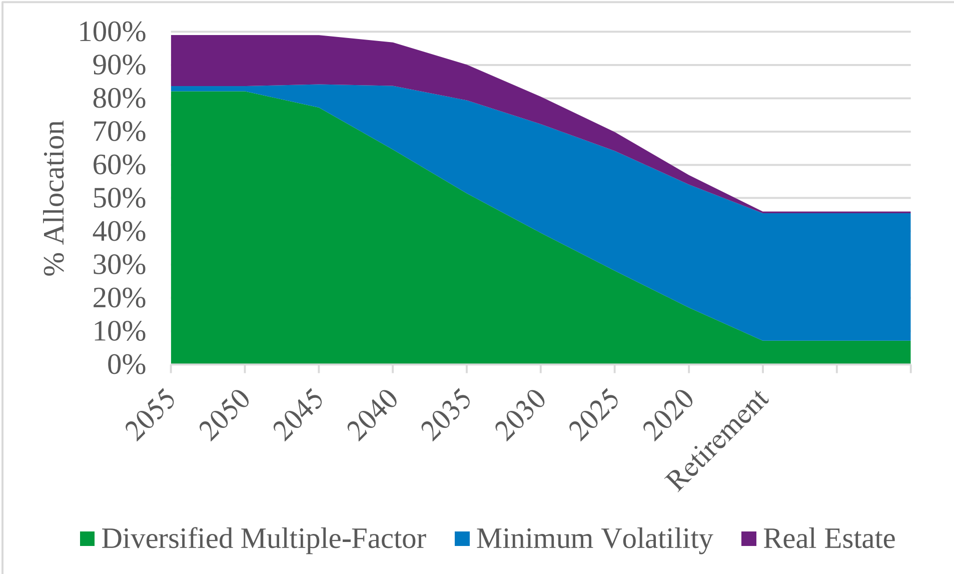


Exhibit 8: Fixed Income Allocations in the Smart Beta Glide Path