ABSTRACT

Market capitalization weighted indices have historically been the most widely used strategies to achieve a passive exposure to equities markets, or capture equities beta. However, we have seen a surge of strategies called alternative betas (or sometimes "smart betas") that, using different index construction methodologies, aim to provide a passive exposure to alternative sources of equity returns, or equity factors. This paper begins by reviewing the existing index construction methodologies used to achieve equity market beta exposure, and then turns to analyzing alternative beta strategies that aim to provide exposure to Value, Momentum, Low Volatility, and Quality as alternative sources of equity risk premia in a passive, index-like way.

INTRODUCTION

Index funds and other passive equity strategies can be utilized to achieve very broad diversification with low management fees and low operating costs. For example, by owning an S&P 500 index fund, an investor can be assured that a portion of his portfolio will track the performance of the large capitalization segment of the U.S. domestic stock market cheaply and efficiently.

Historically, capitalization-weighted indices have been most widely used by investors. The first market-capitalization equity index was introduced by Standard & Poor's in 1923. However, particularly in recent years, investors have increasingly questioned whether capitalization-weighted indices are the best option for passive investment in equity and fixed income securities. Alternatively weighted, or "alternative beta" indices, which are also known as "smart beta" indices, have gained traction in the investment community. These types of equity indices are constructed using different weighting methodologies, such as market cap weights with a factor tilt, fundamental weights, and optimization-based indices.

Alternative beta strategies are often constructed with specific objectives in mind. These objectives may include achieving a value, momentum, or quality exposure, lowering portfolio volatility, or reducing stock-specific risks. By targeting specific objectives or alternative equity return factors they may also be able to offer superior risk-adjusted performance than the traditional market cap weighted index.

Some high-profile funds have moved significant assets into alternative beta strategies. Pensions & Investments recently reported that the $28 billion United Parcel Service defined benefit plan had moved 40% of the equity portfolio into alternatives to market capitalization indices.[1]

This examination of alternative beta indices focuses on equity indices. Alternative index methodologies for investing in other asset classes also exist, but are not discussed in this paper. We start our analysis with a review of the main index construction methodologies used to capture equity market beta. Next, we examine alternative beta strategies that target Value, Momentum, Low Volatility, and Quality/Profitability. We then review several

[1] Source: Pensions & Investments, July 21, 2014, "UPS is looking for smart beta to deliver."

implementation characteristics of the strategies and analyze the benefits of adding or combining alternative beta exposures with a market exposure. We close our paper with a summary and recommendations.

INDEX CONSTRUCTION METHODOLOGIES

MARKET-CAP WEIGHTED INDICES

Market capitalization weighting is the most important and most widely used method of index construction. First, it reflects the relative importance of companies in the stock market, where higher weights are assigned to the most valuable companies. Second, it has macro-consistency: if all investors held a market cap weighted index and there were no active investors, all stocks would be held with none left over. For other weighting schemes it is mathematically impossible for all investors to hold the index.

In a CAPM world, the market portfolio (often proxied by a market cap weighted index) is the most efficient portfolio (maximum Sharpe Ratio) that all investors can have, and it should be combined with a risk free asset to achieve the desired level of risk. It is worth noting that CAPM assumptions negate the existence of alpha and thus the relevance of active investing. Even though empirical experience has demonstrated that CAPM does not hold in practice, this model can serve as an initial building block into understanding the basics of equities investing.

Furthermore, since market-cap weighted indices of broad equity markets are consistent with a buy and hold strategy, there is no need to rebalance for corporate events like stock splits, only to reinvest dividends. They also satisfy most of the characteristics required of a good index or benchmark, which make them easy to replicate at low costs. Market cap weighted indices are comprehensive, investable, have objective construction rules, and exhibit very low turnover.

However, market-cap weighted indices have disadvantages, the main one being that more overpriced securities have greater influence in the index, which can result in an overly concentrated portfolio that is prone to larger drawdowns during market corrections.

PRICE WEIGHTED INDICES

The main advantage of price weighted indices is their simplicity; they are very easy to construct and thus can have the longest track records. However, they are overly influenced by high-priced securities which do not necessarily reflect the economic importance of each company.

Furthermore, corporate events such as stock splits create problems for the index. For example, in a price-weighted index a 2-for-1 stock split will cause the weight of a security to drop in half due to the price drop created by the split, substantially modifying the index exposure. However, the split did not cause any economic change to the company, because the decline of its stock price by half is compensated by doubling the number of stocks issued. As we mentioned before, a market cap weighted index does not require any adjustment for corporate events such as stock splits.

EQUAL WEIGHTED INDICES

This type of index aims to provide better diversification than market cap weighted indices by giving equal weights to all the securities in the investable universe. Equal weights translate into giving smaller (larger) weights to large cap (small cap) securities than cap weighted indices. This weighting scheme can translate into less concentrated (sometimes referred to as better diversified) indices than market cap weighted because very large and expensive companies will not dominate the weights of the index as they do in market cap weighted indices.

A disadvantage of equal weighted indices is that fluctuations in weights need to be rebalanced back to the target equal weights regularly, which translates to higher transaction costs and the need for explicit and objective rules regarding rebalancing in order to be considered a useful benchmark. However, this need for rebalancing can be an important source of returns, as rebalancing a portfolio to target weights has a positive impact on returns in mean-reverting markets.

The following tables evaluate the performance and factor exposures of four well known broad equity market indices, the S&P 500 and Russell 1000 (market weighted), the Dow Jones Industrial Average (price weighted) and the S&P 500 Equal Weighted Index.

Table 1. Performance Statistics of Market Indices

Monthly Returns: April 1995 – March 2015

	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	7.3%	16.5%	0.45	52.6%	1.00
Russell 1000	7.6%	16.7%	0.46	52.7%	1.00
S&P 500 Equal Weighted	9.5%	18.7%	0.51	56.4%	0.94
Dow Jones Industrial Average	7.5%	16.1%	0.47	49.3%	0.95

As we can observe above the S&P 500 Equal Weighted index was the best performer over the last twenty years in both absolute and risk adjusted terms (Sharpe Ratio). However, as we argued before, the Equal Weighted index has a higher exposure to smaller issues, so its performance shows the highest volatility and drawdown level of the group. Furthermore, a fund tracking the Equal Weighted index will most likely incur higher trading and transaction costs as compared to funds that track market weighted indices due to the higher turnover and more frequent rebalancing required.

Table 2. Factor Exposure of Market Indices[2]

Monthly Returns: April 1995 – March 2015

	Market Beta	Small Cap Beta	Value Beta	Momentum Beta	Profitability/ Quality Beta	Volatility Beta	R-Squared
S&P 500	**1.00**	**-0.15**	**0.03**	**-0.03**	**0.06**	-0.01	99%
Russell 1000	**1.00**	**-0.11**	**0.04**	**-0.02**	**0.04**	0.00	100%
S&P 500 Equal Weighted	**1.02**	**0.11**	**0.28**	**-0.16**	**0.15**	0.01	96%
Dow Jones Industrial Average	**0.99**	**-0.14**	0.07	**-0.06**	0.11	**-0.10**	91%

We find interesting results when evaluating the factor exposures of the indices. As expected, all four indices have significant Market factor betas of close to one, the main factor to which they try to get exposure. Furthermore, we observe that the Equal Weighted index is the only one with positive exposure to Small Cap beta, supporting the fact that the market weighted and price indices give higher weights to the most valuable firms and to overpriced securities, resulting in underexposure to small caps. All four indices have relatively low and varying exposures to the rest of the factors, but it is worth pointing out that collectively the factors do a good job of explaining the returns of the indices (with R-squared greater than 90% in all cases), a result that characterizes beta strategies.

ALTERNATIVE BETAS

The index construction methodologies we have reviewed so far are designed to provide broad equity market exposure, or beta. We have seen that market cap weighted indices have been the most popular and most successful type of indices to serve as market benchmarks due to their macro-consistency, relevance to academic theory (CAPM), lower turnover and lower costs required for replication.

However, as many academics and investors have found, Market beta (provided by the market cap weighted indices) is not the only source of equity risk premia available in the asset class. It is well documented that there are additional "factors" that provide investors with attractive risk–return tradeoffs that can complement, and in some cases even compete with the traditional market cap weighted benchmark. In this section we will take a closer look at some of these additional factors of equity returns.

Some factors are well known and understood in the investment community, such as the Value premium and Momentum, while others are still more debated as to their efficacy and justification such as Low Volatility and Quality/Profitability.

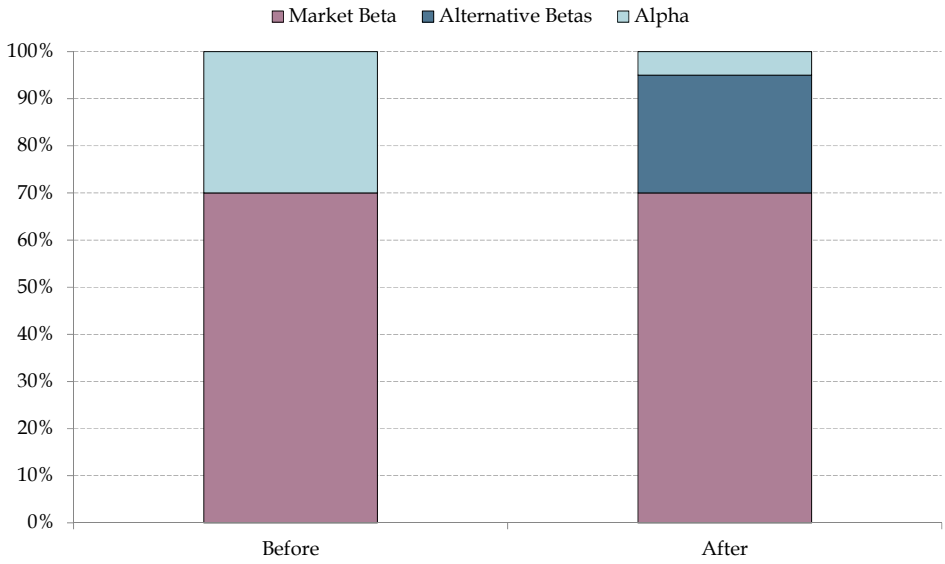
We must point out however, that the name "alternative betas" given to these equity factors comes from the evolution of the investment management industry. Decades ago, active investment returns were driven by many of these factors, and up until today that continues

[2] Source: Fama-French Factors for Market, Small Cap, Value, Momentum and Profitability/Quality betas and Analytic Investors for Volatility beta. Please refer to the appendix for more explanation on sources and characteristics. Figures in bold are statistically significant at a 99% confidence level.

to be the case; however, advances in technology and in the robustness of markets (especially in the U.S.) have allowed for the proliferation of strategies that can provide exposure to these factors in an index-like or passive way. This is what we refer to as alternative beta: index construction methodologies that provide passive/rules-based exposure to alternative risk premia or return factors in the equities market.

The graph below illustrates this point, as the empirical discovery of additional sources of returns in equities has provided better understanding of the factors driving performance in the asset class.

Graph 3. Evolution of Sources of Returns in Equities[3]



In this section we will explore four alternative betas: Value, Momentum, Low Volatility, and Quality/Profitability. We will review the theoretical and empirical support for their claimed existence and evaluate the characteristics and performance of strategies that aim to capture these factors in a passive, index-like way.

I. Value

The Value premium is one of the most widely recognized risk premia in the equity space. It admits various definitions, but generally, stocks that have low ratios of price to book value, price to earnings, or price to cash flows are classified as value stocks. Several researchers have found value stocks to outperform their counterparts (called growth stocks), and at times even the market, over long periods of time and across different geographies.[4]

[3] Sources of Returns levels are for illustrative purposes only and do not represent any equity security or strategy.

[4] Eugene Fama and Kenneth French, 1992; "The Cross-Section of Expected Stock Returns," The Journal of Finance: Vol. 47, No. 2, pp. 427-465.

Although no one denies the existence of this premium, researchers and academics have debated the reasons for its existence. There are two main explanatory frameworks. The first, based on market efficiency, states that the Value effect is a different source of risk premium in equities not explained by the market; put it another way, there are common variations in the returns of value stocks that are not explained by the returns of the market. The second view, a more "behavioral" perspective, argues that investors consistently undervalue value stocks and overvalue growth stocks for several reasons, including overconfidence, extrapolation of past returns, etc., which gives value stocks more opportunity for appreciation than growth stocks when they revert to their "true" fundamental valuation.

To analyze the implementation of index-like strategies that aim to provide exposure to the value factor we take a look at the FTSE RAFI 1000, the MSCI Value Weighted Index, and the S&P 500 Pure Value.

Table 4. Performance Statistics of Value Indices

Monthly Returns: April 1995 – March 2015

	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0%)	Maximum Drawdown	Correlation to S&P 500
S&P 500	7.3%	16.5%	0.45	52.6%	1.00
FTSE RAFI 1000	9.4%	17.6%	0.53	57.5%	0.94
MSCI VALUE Weighted	7.6%	17.1%	0.44	58.1%	0.97
S&P 500 Pure Value	8.8%	22.9%	0.39	72.0%	0.79

Overall returns of the three value strategies over the last twenty years were superior to the broad market index. However, one might counter that the value premium is an additional source of risk in stocks, because all of the above strategies have also exhibited higher standard deviations and maximum drawdowns than the market index.

Table 5. Factor Exposure of Value Indices

Monthly Returns: April 1995 – March 2015

	Market Beta	Small Cap Beta	Value Beta	Momentum Beta	Profitability/ Quality Beta	Volatility Beta	R-Squared
S&P 500	**1.00**	**-0.15**	**0.03**	**-0.03**	**0.06**	**-0.01**	99%
FTSE RAFI 1000	**0.99**	-0.01	**0.39**	**-0.13**	**0.11**	0.00	98%
MSCI Value Weighted	**1.02**	**-0.08**	**0.24**	**-0.13**	**0.06**	**-0.07**	98%
S&P 500 Pure Value	**1.07**	**0.29**	**0.82**	**-0.25**	0.14	-0.01	92%

Reviewing the factor exposures we see a clear and significant exposure of all value strategies to the Value beta that is significantly higher than the market index's exposure. It is worth pointing out that the market beta for all strategies is statistically significant as well and close to one, which is to be expected given their high correlation to the market index. We further observe a slight bias (betas ranging from 6% to 14%) to the Profitability beta which may indicate Quality factor screenings or objectives incorporated into the index construction methodologies.

The final point that closes the circle on the characteristics of the value indices is their exposure to Momentum. As we have learned, the value premium is based on investing in a contrarian way, which means targeting stocks with depressed multiples (e.g., low P/E or low P/B) with the belief that mean reversion in the markets will deliver higher performance in the future. This strategy contrasts with Momentum, which as discussed below, involves buying prior winners. As we see from the table, the value indices all have statistically significant negative exposure to Momentum, demonstrating a contrarian nature.

Finally, a strategy that is contrarian in nature has advantages in implementation, because contrarian strategies aim to buy stocks that the market, in general, wants to sell (at depressed multiples) and sell stocks that the market wants to buy. This permits lower transaction costs through better execution.

II. Momentum

Momentum can be another important source of returns in equities. It involves buying prior winners and, if permitted, selling prior losers, based on the assumption that the winners will continue to do well and the losers will continue to do poorly. As opposed to value stocks that are defined as such by characteristics inherent to their company accounting such as earnings, cash flows, or book value, Momentum is defined only in terms of price; it does not consider any other company specific characteristic.

Regarding the source of Momentum, there is more debate about why Momentum exists, and whether it should continue to exist in the future, than there is for the Value premium. Behavioral finance argues that Momentum exists mostly due to investor under-reaction to information, which implies that prices take time to incorporate new information and thus a trend or Momentum is created. Traditional finance argues that Momentum is yet another source of risk premia in equity that is not explained by the market, but given that Momentum is only determined by price movements, it is more difficult to construct a rational economic explanation for it. Nevertheless, academics and practitioners have found evidence of equity returns being explained by momentum[5] across several time periods and different geographies, contributing to its validity as a source of return.

In the following table we show the performance results and factor exposures of two Momentum strategies, AQR Momentum Index and MSCI USA Momentum, compared to a market cap weighted equity market index, the S&P 500.

[5] Tobias J. Moskowitz, Yaho Hua Ooi, and Lasse Heje Pedersen, 2012; "Time series momentum," Journal of Financial Economics: 104 (2012), pp. 228-250.

Table 6. Performance Statistics of Momentum Indices

Monthly Returns: April 1995 – March 2015

	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	7.3%	16.5%	0.45	52.6%	1.00
AQR Momentum	10.3%	20.1%	0.51	51.0%	0.86
MSCI USA Momentum	11.5%	18.6%	0.62	52.7%	0.88

Performance of the Momentum indices was superior to the market index on an absolute basis with much higher annualized returns and on a risk adjusted basis with superior Sharpe Ratios. Volatility (standard deviation) is higher as well which points to the Momentum indices taking additional risks, but as of the last twenty years, investors were compensated for them. Drawdown levels are similar between the Momentum indices and the market and correlations are relatively low at 0.86 and 0.88 respectively.

Table 7. Factor Exposure of Momentum Indices

Monthly Returns: April 1995 – March 2015

	Market Beta	Small Cap Beta	Value Beta	Momentum Beta	Profitability/ Quality Beta	Volatility Beta	R-Squared
S&P 500	**1.00**	**-0.15**	**0.03**	**-0.03**	**0.06**	-0.01	99%
AQR Momentum	**1.06**	**-0.09**	0.02	**0.38**	**0.08**	**0.17**	94%
MSCI USA Momentum	**1.01**	**-0.19**	0.08	**0.31**	**0.33**	**0.21**	90%

Exposures of the indices to the Momentum factor is high and significant as expected, and given the characteristics of Momentum that are based on "riding the waves of the market," we see significant Market betas above one and significant positive exposure to the Volatility beta, which translates to having invested in relatively volatile stocks. Also, there is negative exposure across the board to Small Cap beta, which may point to these indices being focused on larger cap stocks. Finally exposure to the Value factor is low or statistically insignificant.

The Momentum indices' negative exposure to Small Cap beta may be a result of the trading constraints of the strategy. By aiming to buy current winners and quickly get rid of current losers when the trends break, Momentum strategies can generate high turnover and high costs, because trading is done at inconvenient times for pricing. Put another way, a Momentum strategy is a liquidity-taking trade and thus may face higher costs than a market strategy. Given this fact, indices that aim to regulate turnover and transaction costs may target investing in larger securities to take advantage of their better liquidity and potentially achieve better execution, thus underweighting exposure to small caps.

III. Low Volatility

Low Volatility is an alternative beta not based on a formal equity return factor but rather defined as an anomaly that has been found empirically.[6] Finance theory is based on the relationship between return and risk; to achieve higher returns one needs to take more risk and vice versa. Extending to the CAPM model, we find that riskier stocks (defined as high-beta stocks) have higher expected returns than less risky or lower beta stocks. However, the low volatility anomaly found that, over long periods of time, portfolios of low volatility or low beta stocks have outperformed portfolios of higher volatility or higher beta stocks, i.e., with lower risk, they obtained higher returns. This contradicts CAPM and most of the bases of finance theory, but behavioral finance and real-world market dynamics offer important insights into why this anomaly exists and why it may continue to exist in the future.

Justification for the low volatility anomaly is expressed in the following manner: The risk return relationship that holds in CAPM is based on the fact that if an investor wants to take more risk, he should lever up his position by borrowing at the risk-free rate and investing the proceeds in the most efficient portfolio (the market portfolio). However, in reality most institutional investors are restricted from taking direct leverage, so to take more equity risk they need to invest more in higher beta stocks. This causes lower risk, lower beta stocks to be undervalued relative to the overvalued, high beta securities. The argument for why this anomaly is sustainable comes from a real world limit to arbitrage. If the market identified high beta stocks to be overvalued, the theoretical arbitrage that follows would be to short the overvalued stocks. In reality, most investors are also restricted from shorting, either by regulations, costs, or self-imposed constraints, so the high beta stocks remain overvalued with respect to the low beta, lower risk stocks, thus sustaining the anomaly.

Continuing the methodology we have followed in previous sections, in the tables below we examine the performance and factor exposure of two Low Volatility indices, the MSCI USA Minimum Volatility and the S&P 500 Low Volatility Index.

Table 8. Performance Statistics of Low Volatility Indices

Monthly Returns: April 1995 – March 2015

	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	7.3%	16.5%	0.45	52.6%	1.00
MSCI USA Min Volatility	7.4%	12.6%	0.59	44.6%	0.92
S&P 500 Low Volatility	11.1%	12.7%	0.88	35.4%	0.73

The last twenty years of performance of the Low Volatility indices seem to support the existence of the Low Volatility anomaly, as both indices achieved higher return with much lower volatility than the market index, resulting in superior risk-adjusted performances. Furthermore, the Low Volatility indices have maximum drawdowns that are substantially better than the market indices and the Momentum and Value index strategies we have

[6] Roger Clark, Harindra de Silva, and Steven Thorley, 2010; "Minimum Variance Portfolio Composition," Journal of Portfolio Management, Vol. 37, No. 2, pp. 31-45.

reviewed previously. This is a targeted characteristic of these indices because by investing in less volatile stocks they should protect more returns during market corrections. On the other hand, the exposure to lower volatility or lower beta stocks will likely cause them to lag the market during turnarounds and prolonged bull markets.

Table 9. Factor Exposure of Low Volatility Indices

Monthly Returns: April 1995 – March 2015

	Market Beta	Small Cap Beta	Value Beta	Momentum Beta	Profitability/ Quality Beta	Volatility Beta	R-Squared
S&P 500	**1.00**	**-0.15**	**0.03**	**-0.03**	**0.06**	-0.01	99%
MSCI USA Min Volatility	**0.83**	**-0.09**	**0.10**	0.00	0.04	**-0.15**	**90%**
S&P 500 Low Volatility	**0.76**	0.04	**0.19**	-0.04	0.05	**-0.31**	76%

The exposures of the Low Volatility indices are perhaps the most straightforward to understand and analyze. The indices aim to hold a lower risk portfolio than the market index by holding less volatile stocks, so they target a lower Market beta and a negative exposure to the Volatility factor. The table above confirms this, as both Low Volatility indices have Market betas of 0.83 and 0.76 as well as statistically significant negative exposures to the Volatility factor (a negative value indicates lower volatility).

Low Volatility indices are similar to Value indices in that they are strategies that can achieve lower costs and lower turnover when implemented compared to, for example, Momentum indices.

IV. Quality/Profitability

Quality is the last equity factor we will review and is perhaps the most controversial. Targeting stocks based on a perceived quality or profitability measure is a well-established investment process but there is no universal agreement on how to define it. Some investors define quality through quantitative profitability metrics such as ROE or ROIC, others by growth and stability of earnings, or using leverage measures such as levels of debt in the balance sheet. Still other investors think of subjective rather than objective measures for quality, such as market positioning, barriers to entry of the business, or the recurring nature of a company's earnings.

Regardless of the definition used, the Quality factor in equities has been an identifiable source of returns. From a fundamental standpoint, quality businesses are expected to be consistent performers in the long run with the ability to protect value better in economic downturns. Additionally, empirical studies[7] have found that a Quality factor has explained variability in the returns of equities not previously explained by other factors like Value or Momentum.

[7] Clifford Asness, Andrea Frazzini, and Lasse Heje Pedersen, 2014; "Quality Minus Junk," Available at SSRN: http://ssrn.com/abstract=2312432.

Below we review the performance and factor exposure of two Quality alternative beta indices: the MIG QSI Index® (Quality, Stability, and Income®) and the FTSE USA Quality Index.

Table 10. Performance Statistics of Quality/Profitability Indices

Monthly Returns: October 2001 – March 2015

	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	5.2%	15.6%	0.33	52.6%	1.00
MIG QSI Index®	8.9%	14.5%	0.61	43.0%	0.98
FTSE USA Quality Index	8.7%	14.3%	0.61	41.0%	0.98

Both Quality indices have exhibited performance superior to the market index. All statistics are positive, with Quality indices having higher returns and lower standard deviations that translate into Sharpe Ratios nearly double that of the broad market index, and also with better maximum drawdowns, meaning they protected well in market corrections. It is worth noting that this superior performance was achieved with a very high correlation to the market index (0.98 for both Quality indices).

Table 11. Factor Exposure of Quality/Profitability Indices

Monthly Returns: October 2001 – March 2015

	Market Beta	Small Cap Beta	Value Beta	Momentum Beta	Profitability Quality Beta	Volatility Beta	R-Squared
S&P 500	**1.01**	**-0.13**	**0.02**	**-0.01**	-0.01	**-0.03**	100%
MIG QSI Index®	**0.95**	0.03	0.00	**-0.04**	**0.09**	**-0.13**	98%
FTSE USA Quality Index	**0.96**	**-0.16**	**-0.12**	**0.04**	**0.15**	0.01	98%

Moving to the factor exposure we notice that, aside from their market exposure, the biggest exposure of the quality indices is to the Profitability/Quality beta. However, looking at the complete picture of exposures we find that these two Quality indices have different factor exposures, reaffirming our earlier point about Quality having various definitions.

In addition to the Quality factor exposure, the FTSE USA Quality Index has a large cap bias (negative Small Cap beta), growth bias (negative Value beta), and positive momentum exposure. The MIG QSI Index®, however, is neutral to Small Cap exposure, neutral to Value exposure, and has negative exposure to both Momentum and Volatility which means holding less volatile stocks. Even though the return and risk summary statistics are similar for the two indices, their returns are explained by different exposures to equity factors.

As we see from the example above, quality can have different meanings and can be implemented in different ways in terms of exposures to equity risk factors. Investors need to be careful when considering a quality based index or strategy so that the exposures that are targeted or the definition of quality that is pursued coincides with the investor's beliefs.

IMPLEMENTATION

Having reviewed the alternative equity betas and exposures of the indices that target them, we continue our analysis by looking at some characteristics related to implementation of the alternative beta indices: Weighting Schemes, Rebalancing, Costs, and International Alternative Betas.

I. Weighting Schemes

The alternative beta indices can achieve their exposures by implementing different weighting schemes. As we saw with the broad market indices that use market cap, price or equal weights and achieve different exposures, so do the alternative beta indices. The main types of weighting schemes used are:

- **Market Cap with Factor tilt**: this weighting scheme is closest to pure market cap. It enhances market cap weighting by either multiplying the weights by a ranking or factor score methodology based on a given factor signal, or utilizing a market cap weight but for only a subset of the universe (based on a screening methodology). As the neutral weights in this case are the market cap weights, they tend to be more stable and easier to replicate, requiring less rebalancing and transaction costs, but at the expense of having lower exposure to the intended factors than other weighting schemes, as well as potential for higher unintended exposure to other factors.
- **Fundamental Weights**: this weighting scheme is based on the definition of the targeted factor, usually obtained by screening and ranking the universe of stocks given a variety of measures related to the targeted factor. One example would be ranking stocks based on book to price (the inverse of price-to-book ratio) for a value index, where the stock with the highest book to price, all else equal, would receive the highest weight in the index.

  Alternative beta indices constructed with Fundamental Weights can get greater exposure to the targeted factor because weights differ completely from the market cap index. However, ranking or stock screen based weights are less stable than market cap weights with factor tilts, so the index would require stricter rules to handle rebalancing to keep turnover controlled.
- **Optimization based weights:** this weighting scheme is based on the result of running a mean-variance optimization on the stock universe. This process enables the user to incorporate constraints that limit portfolio turnover or sector exposure, but requires estimations of expected returns and covariance for the entire universe.

  This weighting scheme can result in the most efficient factor exposure with controlled turnover, however, it is the most computationally expensive process, because it needs to control for the stability of inputs to achieve robust results.

Table 12. Summary of Weighting Schemes

Weighting Schemes	Pure Factor Exposure	Stability of Weights	Rebalancing	Customization
Market Cap with factor tilt	Lower	High	Very Little	Low/None
Fundamental weights	High	Somewhat	Somewhat	Somewhat
Optimization-based weights	Highest	Depends on Inputs	Customizable	High

II. Rebalancing versus Buy and Hold

One of the main differences between the alternative beta indices and the market cap weighted index is that the former need to rebalance their weights periodically in order to consistently target the desired factors, whereas the market cap index is consistent with a buy and hold strategy and seldom needs to rebalance.

Rebalancing to target weights by alternative beta indices can be a source of better risk adjusted returns in mean reverting markets; the portfolio effectively sells high and buys low, as opposed to a buy-and-hold strategy that would overweight the highest priced (overvalued) securities. A rebalancing strategy will remain closer to target allocations than a buy and hold strategy which will see its weights drift away from the initial allocation as time passes and asset returns diverge.

Equity markets can show short term, low volatility trending periods, but over the long term equity returns tend to be mean reverting. We therefore state that holding all else equal; a rebalancing strategy would be preferred to a buy-and-hold strategy in equities.[8] However, when implementing any of these strategies, rebalancing is not free. It comes with a tradeoff, called transaction costs, which if left unregulated can quickly erode any profitability obtained from targeting alternative sources of returns in the space.

The alternative beta indices we have reviewed must establish rebalancing strategies that can minimize transaction costs by looking at factors such as rebalancing frequency (lower frequency would lead to lower costs), and the size and liquidity of the investable universe (larger and more liquid securities are cheaper to trade), to allow them to reap the benefits of rebalancing while lowering the drag caused by transaction costs.

The table below shows the impact of turnover and transaction costs to the performance of alternative beta indices. As expected, Momentum strategies incur the highest levels of turnover and thus face the largest performance drags at 98.3 basis points (bp) annually assuming transaction costs of 50 bp. On the other extreme, a passive market cap weighted index such as the MSCI USA incurs the lowest level of turnover with a performance drag of 3.6 bp. As expected, Value, Low Volatility and Quality Indices fall somewhere in between, closer to the passive market cap weighted index than to the Momentum Index.

[8] Please refer to the Appendix for a quantitative exercise comparing a rebalancing versus a buy-and-hold strategy.

Table 13. Performance Drag (in basis points) due to Turnover[9]

November 2001 – September 2015

Index	MSCI USA	MSCI USA Value Weighted	MSCI USA Momentum	MSCI Minimum Volatility Index	MSCI USA Quality Index
Annual one way turnover	1.8	8.1	49.1	12.8	12.3
Annual two way turnover	3.6	16.2	98.3	25.6	24.6
Annual performance drag (at 25 bp)	1.8	8.1	49.1	12.8	12.3
Annual performance drag (at 50 bp)	**3.6**	**16.2**	**98.3**	**25.6**	**24.6**
Annual performance drag (at 75 bp)	5.4	24.2	147.4	38.4	36.9

The "performance drag" figures shown above represent a conservative estimate based on the realized turnover of the alternative beta indices. Funds that track the performance of these indices may be able to achieve lower turnover ratios or lower transaction costs, both of which can reduce performance drag during implementation. Nevertheless, these figures represent a good starting point to understand that indices that rebalance regularly will face higher turnover and thus higher performance drag than market cap weighted indices.

The table below shows how the performance drag generated by turnover can affect the returns of alternative beta indices relative to the market cap weighted benchmark.

Table 14. Impact of Transaction Costs[10]

October 2001 – March 2015

	Type	Annualized Return	Net Returns, Transaction Costs at: 25 bp	50 bp	75 bp
S&P 500	Market Cap Weighted	5.2%	5.2%	5.2%	5.2%
Russell 1000	Market Cap Weighted	5.7%	5.7%	5.7%	5.7%
FTSE RAFI 1000	Value Index	7.0%	6.9%	6.8%	6.7%
MSCI VALUE Weighted	Value Index	5.1%	5.0%	5.0%	4.9%
S&P 500 Pure Value	Value Index	8.9%	8.8%	8.8%	8.7%
AQR Momentum	Momentum Index	8.1%	7.6%	7.1%	6.6%
MSCI USA Momentum	Momentum Index	8.1%	7.6%	7.1%	6.6%
MSCI USA Min Volatility	Low Volatility Index	5.4%	5.2%	5.1%	5.0%
S&P 500 Low Volatility	Low Volatility Index	9.6%	9.5%	9.3%	9.2%
MIG QSI Index®	Quality Index	8.9%	8.8%	8.7%	8.5%
FTSE USA Quality Index	Quality Index	8.7%	8.6%	8.4%	8.3%

[9] Source: MSCI.

[10] Net Return = Annualized Return – Annual performance drag at given trading cost assumption for each type of alternative beta index.

III. Management Costs

One of the main benefits of passive, market cap weighted index funds is that they are cheap to implement for most institutional investors. However, alternative beta indices can be implemented at higher, yet still very competitive fees.

It is worth noting that differences in alternative beta strategies such as weighting schemes, rebalancing policies, and investable universe will cause dispersion among index prices.

Table 15. Alternative Beta Indices Estimated Management Costs[11]

Index	Type	Cost (bp)
S&P 500	Market Cap Weighted	4-7
Russell 1000	Market Cap Weighted	4-7
FTSE RAFI 1000	Value Index	14
MSCI VALUE Weighted	Value Index	11
S&P 500 Pure Value	Value Index	11
AQR Momentum	Momentum Index	11
MSCI USA Momentum	Momentum Index	11
MSCI USA Min Volatility	Low Volatility Index	13
S&P 500 Low Volatility	Low Volatility Index	11
MIG QSI Index®	Quality Index	11
FTSE USA Quality Index	Quality Index	14

IV. International Alternative Betas

Although the focus of this paper is on alternative betas of US equities, the existence of the factors reviewed extends to international equity markets as well. Several research papers[12] have documented the presence of Value, Momentum, Low Volatility, and Quality as sources of equity risk premia in international developed and emerging markets. As of the writing of this paper alternative beta strategies implemented on international developed equity markets are widely available to investors. However, due to the idiosyncrasies of emerging markets, such as higher costs, lower liquidity, reduced investable universe, and shorter available returns history, there are fewer available alternative beta strategies on emerging market equities.

[11] SSGA estimates as of 11/19/2015. For the alternative beta indices, assumptions are a $50 million investment subject to a minimum annual fee of $25,000 for a commingled fund vehicle and $125,000 for a separate account. Institutional investors may be able to negotiate lower fees.

[12] Eugene F. Fama and Kenneth R. French, 1998; "Value versus Growth: The International Evidence," The Journal of Finance, Vol. 53, No. 6.
Tobias J. Moskowitz, Yao Hua Ooi, and Lasse Heje Pedersen, 2012; "Time series momentum," Journal of Financial Economics: 104 (2012), pp. 228-250.
Tzee-man Chow, Jason C. Hsu, Li-Lan Kuo, and Feifei Li, 2013; "A Study of Low Volatility Portfolio Construction Methods," Available at SSRN: http://ssrn.com/abstract=2298117.
Clifford Asness, Andrea Frazzini, and Lasse Heje Pedersen, 2014; "Quality Minus Junk," Available at SSRN: http://ssrn.com/abstract=2312432.

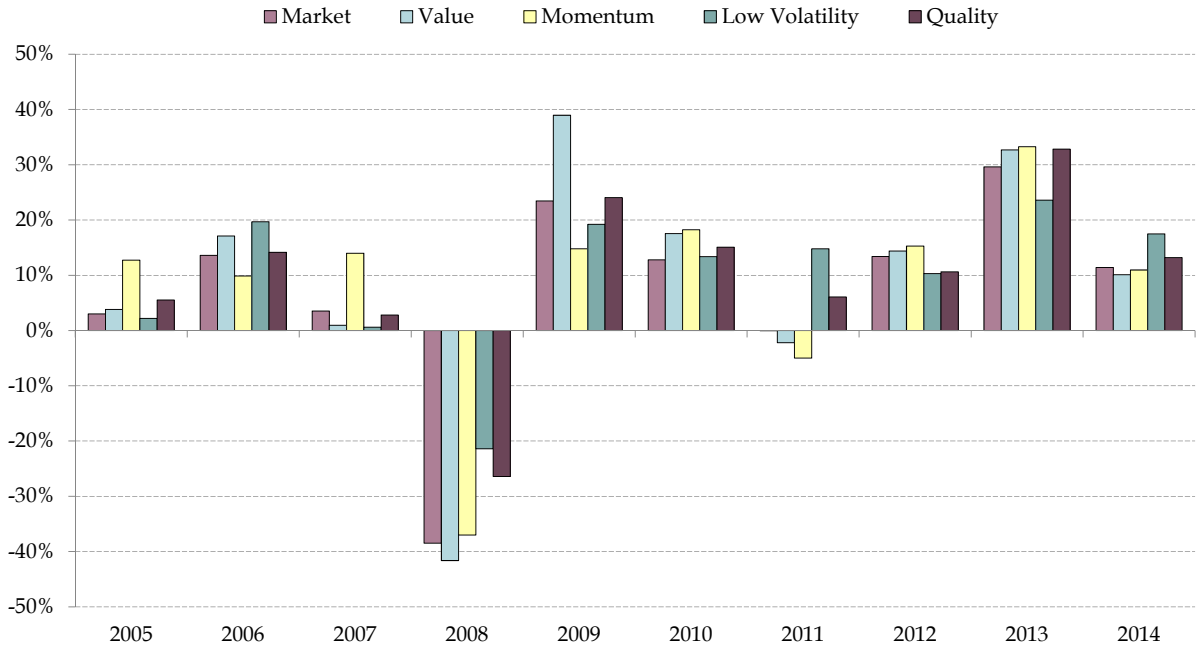
ALTERNATIVE BETAS VERSUS MARKET EXPOSURE

Throughout our analysis of the different alternative betas we have seen that each type of strategy aims for a better risk adjusted performance than the market cap weighted index, but they are constructed with the specific objective of targeting distinct equity risk factors like value, momentum, low volatility, or quality. It follows from this that the performance of the alternative beta indices versus the market cap index will be tied to the performance of the factors targeted versus the market performance.

Investors considering an alternative beta index as a substitute for the market need to be aware that performance comes from different sources of risk premia, and periods of outperformance by the alternative beta indices may be followed by periods of underperformance. The graph below shows the annual performance of a sample of the alternative beta indices reviewed in the paper over the last ten years.

Graph 16. Performance of Alternative beta Indices[13]

Annual Returns: 2005 – 2014



Although the majority of alternative beta strategies reviewed achieved better returns than the market over the last 20 years, we can clearly observe that on a year by year basis, returns of the alternative betas versus the market greatly varies. The characteristics of these equity risk factors further suggest that they perform better in different market environments. For example, low volatility aims to provide a smoother return stream by protecting returns on the downside in exchange for lagging in market rebounds. On the other hand, momentum

[13] Market is S&P 500, Value is FTSE RAFI 1000, Momentum is AQR Momentum, Low Volatility is S&P 500 Low Volatility, and Quality is MIG QSI Index.

will most probably outperform during bull markets but at the expense of getting hit harder during reversals.

The table below further supports this case, as we see low correlations between alternative beta indices over the period considered which points to diversification benefits in a portfolio setting.

Table 17. Correlation of Alternative Beta Indices[14]

Monthly Returns: October 2001 – March 2015

	Market	Value	Momentum	Profitability/ Quality	Low Volatility
Market	1.00				
Value	0.97	1.00			
Momentum	0.90	0.84	1.00		
Profitability/Quality	0.98	0.96	0.88	1.00	
Low Volatility	0.85	0.84	0.78	0.87	1.00

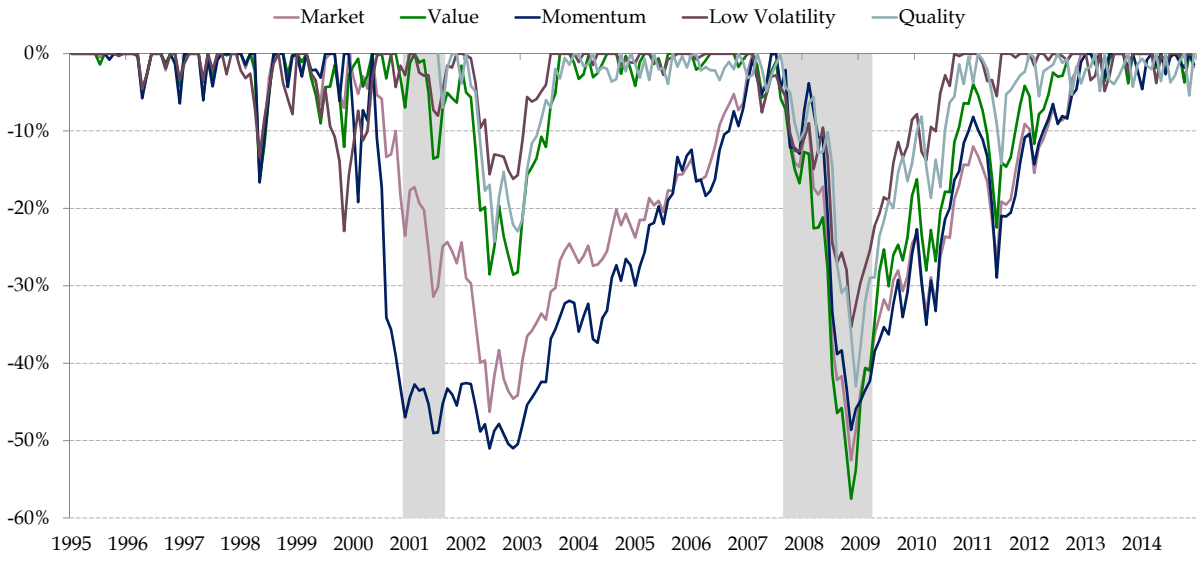
In addition to providing performance streams that are different from the market exposure given their targeting of alternative sources of equity risk premia, alternative beta indices can also provide different performance during bear markets.

The graph below shows the drawdowns of four alternative beta indices relative to the Market. We observe that, as expected, Low Volatility strategies perform best during equity market drawdowns, protecting the most returns. Momentum strategies are at the opposite end of the spectrum; given their high beta characteristics they experienced worse drawdowns than the market. The Quality index was also able to protect returns, supporting the belief that a Quality bias can outperform in bear markets. Finally, the Value strategy, like the equity risk premium that it targets, can hold its ground during mild market corrections but has suffered the most in periods of deep and prolonged economic recessions, as evidenced during the Global Financial Crisis, which caused this strategy to have the worst drawdown level of all the alternative beta strategies considered.

[14] Market is S&P 500, Value is FTSE RAFI 1000, Momentum is AQR Momentum, Low Volatility is S&P 500 Low Volatility, and Quality is MIG QSI Index.

Graph 18. Drawdowns of Alternative Beta Indices[15]

Monthly Returns: April 1995 – March 2015



ALLOCATIONS TO ALTERNATIVE BETAS

Having shown that Alternative Beta indices can provide diversification benefits to passive equity allocations, in this section we evaluate three allocation scenarios to this group of strategies that can provide guidance for investors when considering alternative beta investments.

All allocation scenarios detailed below seek to maximize returns while minimizing risk, defined as both standard deviation and tracking error to the market portfolio. To be as close to reality as possible, the modeled performance of all cases incorporates the costs of investing in alternative betas, the performance drag generated by trading costs, and an estimation of trading costs[16] generated by trading in and out of strategies when rebalancing occurs.

The first two scenarios represent static allocations that rebalance annually to initial targets. The third scenario is based on an allocation framework[17] that dynamically incorporates new information to adjust the strategy weights so that the resulting portfolio is the optimal allocation given an investor's preferences of returns, volatility, tracking error, owning the market index, transaction costs, and factor diversification.

[15] Market is S&P 500, Value is FTSE RAFI 1000, Momentum is AQR Momentum, Low Volatility is S&P 500 Low Volatility, and Quality is MIG QSI Index.

[16] The estimation of trading costs for rebalancing between the strategies is estimated as the bid-ask spread of U.S. equities at the time rebalancing is done.

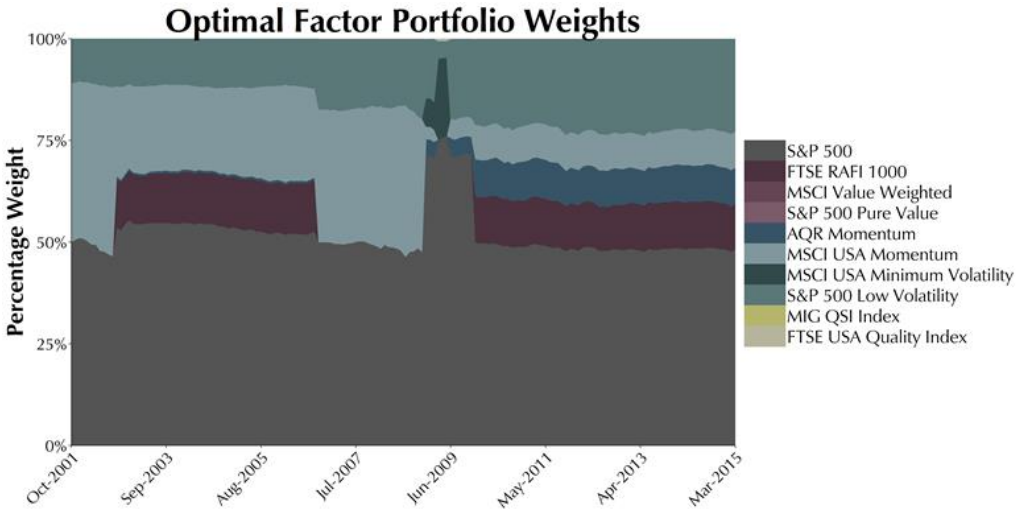
[17] Please refer to the appendix for further details and examples about the characteristics of the allocation framework.

I. 75% Market Static Portfolio: This allocation represents a conservative first step to alternative beta investments because it is restricted to hold at least a 75% weight in the market index at all times, with the additional objectives of maximizing return, reducing overall portfolio volatility, and minimizing tracking error.

II. 50% Market Static Portfolio: This second allocation scenario relaxes the tracking error and market holding constraints by allowing allocations of up to 50% in alternative beta indices, while still aiming to maximize returns and minimize risk.

III. 50% Market Dynamic Portfolio: This final example still enforces an investment of at least 50% in the market index. In addition, it incorporates a dynamic allocation framework that can adjust weights given new information to achieve the optimal factor diversification while maintaining the objectives of maximizing returns and reducing risk.

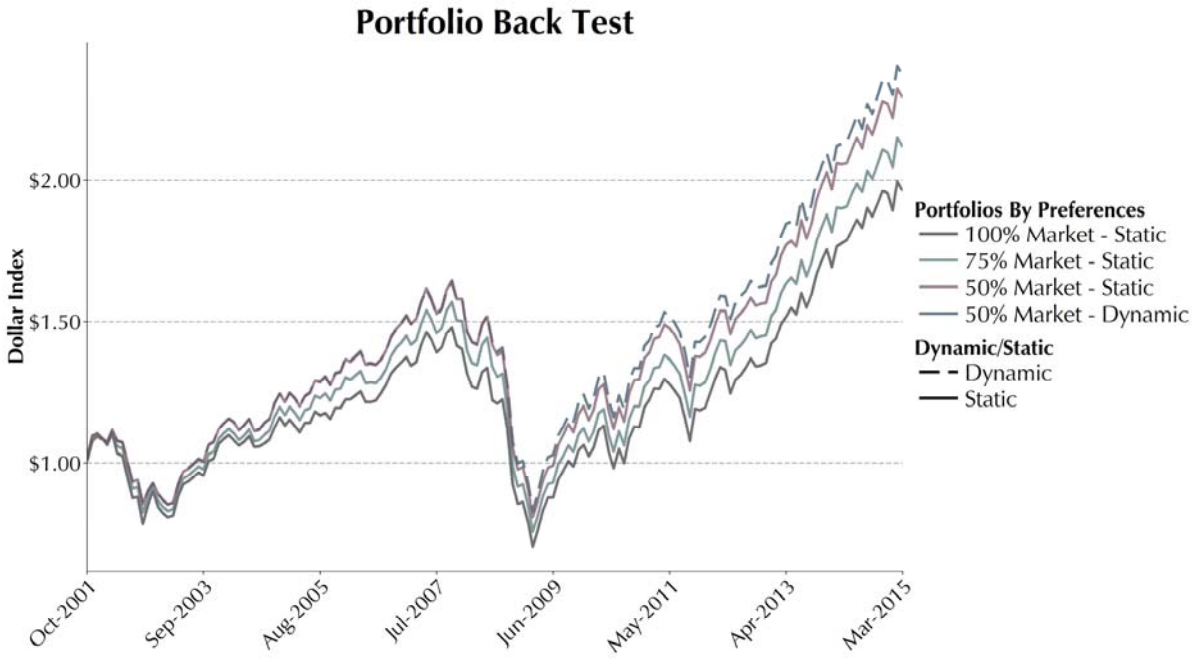
Graph 19. 50% Market Dynamic Portfolio Scenario - Allocation Weights



The graph above illustrates the behavior of the dynamic portfolio allocation framework. The portfolio as constructed allocates at least 50% to the market vehicle (S&P 500 index) throughout the sample while also investing in Value, Momentum, and Low Volatility alternative beta indices. However, given that this framework dynamically incorporates new information to maintain the optimal factor diversification and achieve its return targets, the weights to alternative betas throughout the sample vary. Note that the pro-rata weighting can cause the market weight to go briefly below 50%.

Graph 20. Growth of a Dollar

Monthly Returns: April 1995 – March 2015



All three allocation scenarios achieved better performance, net of fees, than the market index. Note that the higher the allocation allowed to alternative betas, the better the overall performance; furthermore, the implementation of the dynamic portfolio allocation framework (scenario III) achieves the highest outperformance of all.

Table 21. Summary of Results

Monthly Returns: April 1995 – March 2015

	S&P 500	75% Market Static	50% Market Static	50% Market Dynamic[18]
Annualized Net Return[19]	6.3%	6.8%	7.4%	7.6%
Standard Deviation	14.7%	14.1%	13.8%	13.6%
Sharpe Ratio	0.43	0.48	0.53	0.56
Tracking Error	-	1.8%	2.5%	2.6%
Number of Trades	-	20[20]	20[20]	6
Maximum Drawdowns	52.3%	51.9%	50.9%	49.4%
% of Underperforming Periods[21]	-	16.7%	5.6%	3.2%
Market/Alternative Beta Weights (%)				
Market	100	75	50	50
Value	-	-	10	0-10
Momentum	-	20	28	0-40
Low Volatility	-	5	12	0-25
Quality	-	-	-	-
Factor Exposures				
Market Beta	1	0.99	0.98	0.97
Small Cap Beta	-0.14	-0.14	-0.11	-0.11
Value Beta	0.03	0.05	0.10	0.10
Momentum Beta	-0.03	0.04	0.06	0.05
Profitability/Quality Beta	0.06	0.11	0.12	0.10
Volatility Beta	-0.02	0.02	0.01	-0.01

The table above shows summary results and exposures for the three allocation examples considered. We can observe that the strategies achieved better absolute and risk adjusted performance the more the tracking error and market holding constraints were relaxed, further confirming the value of alternative betas in an equities portfolio. Furthermore, the allocation framework of scenario III achieved the best overall performance with a still very reasonable level of tracking error and rebalancing only five times throughout the studied period.

Finally, as weights to alternative beta strategies are increased we can achieve a more balanced exposure to alternative beta factors, such as increasing exposure to quality value and momentum betas, while slightly reducing the market beta exposure.

We close this section pointing out that the allocation framework presented can be customized to incorporate the real world objectives and constraints of any investor and thus produce the optimal portfolio that can achieve the best factor diversification while still maximizing expected returns. Please refer to the appendix for further discussion.

[18] Since the allocation framework can adjust weights given new information, its weights are presented as the realized ranges.

[19] Returns are net of management costs (table 15), trading costs within alternative beta indices (Table 13: performance drag at 50 bp) and trading costs from rebalancing between indices (S&P 500 bid-ask spread).

[20] The static portfolio allocations rebalance annually to their target weights.

[21] Based on 126 rolling 36-month periods.

CONCLUSIONS

We have found that Value, Momentum, Quality/Profitability, and Low Volatility are persistent and legitimate alternative sources of risk and return in equities. Further, there has been a proliferation of strategies that use alternative index construction methods to seek to capture these betas in a systematic, passive manner.

Our analysis showed that the sample of alternative beta strategies did a good job of achieving exposure to their targeted factors and also offering attractive risk-adjusted returns compared to the market cap weighted index. Furthermore, we observed that the fact that these strategies need to rebalance their weights periodically can be a source of outperformance vs. the market cap weighted index in a mean reverting market. However, rebalancing is not free, so funds that aim to track the performance of the alternative beta indices reviewed will incur higher transaction costs than market cap weighted index funds. However, the value added was significant even after these transaction costs were taken into account.

The table below summarizes our main findings for each of the alternative beta strategies and factors we analyzed in this paper:

Table 22. Summary of Empirical Findings

Alternative Beta/Factor	Positives	Negatives
Value	• Most widely recognized alternative equity beta • Liquidity providing trading strategy that is less costly to implement	• Will offer the highest drawdowns in periods of acute and prolonged economic recessions
Momentum	• Highest returns over period studied • Superior performance in trending markets	• Highest standard deviation • Provides worse drawdowns than market • Liquidity taking trading strategy that is costly to implement
Low Volatility	• Best protection in drawdowns • Lower transaction cost to implement due to Contrarian trading strategy	• Will lag the market during turnarounds and prolonged bull markets
Quality/Profitability	• Expected to provide attractive returns in all market conditions • Can protect return in drawdowns	• Admits several definitions which may lead to different factor exposures • Highest correlations to the market

As their names suggest, these strategies target sources of return in equities that are alternative to the market, and as such they will achieve performance patterns that differ from the market index. Alternative beta strategies will have periods of out- and under-performance relative to the market, which, coupled with their correlation profiles, point to alternative betas as attractive diversifiers to market beta allocations, as well as sources of outperformance for a long-term investor.

To conclude our paper, the table below shows a useful guidance for static allocations to alternative beta indices, based on the same methodology used for the back tested examples

shown previously, but assuming a current start date.[22] For a dynamic allocation, initial weights are determined once investor preferences and objectives are fully incorporated to the framework.

Table 23. Allocation Recommendations

Indices / Allocation	75% Static	50% Static	Comments
Market	75%	50%	• The higher the exposure, the lower the tracking error of the overall equity allocation to peers
Value	0%	0%	• Proven over performance over long term cycles • Likely to be targeted by active managers
Momentum	11%	20%	• Provides highest expected return potential but also highest risk and cost
Low Volatility	14%	20%	• Reduces overall portfolio volatility while providing outperformance in the long term • Can provide exposure to value factor • Pairs well with Momentum exposures
Quality	0%	10%	• Most similar exposure to market so it can be seen as its most direct substitute • Flipping market for quality exposure can give better drawdown protection

[22] As of March 31, 2015.

APPENDIX A

TABLE 24. CHARACTERISTICS OF STUDIED INDICES

Index	Type	Weighting Scheme	Signals	Rebalancing	Universe
S&P 500	Market Index	Market Cap	• Market beta	Reconstituted Annually	Index selects the 500 leading companies in leading industries of the United States economy. Index has served as a proxy for the total market.
Russell 1000	Market Index	Market Cap	• Market beta	Reconstituted Annually	Index selects the top 1000 stocks as measured by their market capitalization.
S&P 500 Equal Weighted	Market Index	Equal Weighted	• Market beta	Quarterly	Index has the same constituents as the S&P 500, but each company is allocated a fixed weight of 0.20% at each quarterly rebalancing.
Dow Jones Industrial Average	Market Index	Price Weighted	• Market beta	As needed	Price weighted index of 30 U.S. based "blue-chip" companies, covering all industries with the exception of transportation and utilities. Stock selections is not governed by quantitative rules.
FTSE RAFI 1000	Value Index	Fundamental Weights	• Sales averaged over prior five years • Cash flow average over last five years (Defined as Operating Income plus Depreciation and Amortization • Book Value • Dividend: total dividend distributions averaged over last five years	Annually	Index is comprised of the 1000 companies with the largest fundamental value from the FTSE US All Cap Index.
MSCI VALUE Weighted	Value Index	Fundamental Weights	• Sales averaged over last three years • Earnings averaged over last three years • Cash earnings averaged over last three years • Book Value	Semi-Annually	The Index is constructed by reweighting all the constituents of the parent MSCI Investable Market Index.
S&P 500 Pure Value	Value Index	Fundamental Weights	• Sales to Price Ratio • Earnings to Price Ratio • Book Value to Price Ratio	Annually	Index selects stocks that represent one quarter of the market cap of the parent S&P 500 index with the highest value style based on the given signals. Maximum stock weight is capped at 2%.

APPENDIX A

TABLE 25. CHARACTERISTICS OF STUDIED INDICES (CONTINUED)

Index	Type	Weighting Scheme	Signals	Rebalancing	Universe
AQR Momentum	Momentum Index	Market Cap with Factor Tilt	• Highest total return of the stock over prior 12 months excluding the last month	Quarterly	Index selects 333 stocks that rank in the top 33% of the universe, which is the Top 1000 companies based on market capitalization.
MSCI USA Momentum	Momentum Index	Market Cap with Factor Tilt	• 12 month and 6-month Momentum Score. • Momentum Score equals ratio of excess return over risk free rate to annualized volatility	Semi-Annually	Index selects 500 stocks on the MSCI USA index based on their Momentum Score and caps the maximum weight.
MSCI USA Min Volatility	Low Volatility Index	Optimization based Weights	• Minimize risk of parent index employed constrained MVO based on Barra Equity Model factor covariance matrix • Cap one way turnover at maximum of 10%	Semi-Annually, with conditional rebalancing during regime shifts	Index selects around 200 stocks on the MSCI USA index and caps their maximum weight with several constraints at the security and sector level relative to the parent index.
S&P 500 Low Volatility	Low Volatility Index	Fundamental Weights	• Inverse of volatility of daily returns over the prior one year of trading days	Quarterly	Index measures the performance of the 100 least volatile stocks in the S&P 500 Index based on the defined volatility signal.
MIG QSI Index®	Quality Index	Fundamental Weights	• Beta • Debt to Equity Ratio • Downside Deviation of Earnings • Compounded Annual Growth of Earnings • Dividend Yield and Compounded Annual Growth of Dividends and with Zero Dividends • Percent of Quarters with Negative Earnings	Semi-Annually	Index selects approximately 200 stocks out of the Russell 3000 Index constituents and weights them based on their QSI score. Index is constrained to be sector and market cap neutral to the parent Russell 3000 Index.
FTSE USA Quality Index	Quality Index	Market Cap with Factor Tilt	• Profitability measured as Return on Assets • Efficiency measured as Change in Asset Turnover • Earnings Quality • Leverage	Annually	Index selects 277 stocks out of the FTSE USA Index, which represents large and mid-cap US companies. Weights of the stocks are determined by multiplying their factor score by their market cap weight.

APPENDIX B

EQUITY FACTORS

The Equity factors used to test exposures of the alternative beta indices throughout the paper were obtained from Kenneth French Library[23] and Analytic Investors[24] and they are constructed as follows:

- Market Beta: The return on the market; market cap weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ, minus the one month Treasury Bill Rate.
- Small Cap Beta: Fama-French Small Minus Big (SMB) factor, is the average return of nine small stock portfolios minus the average return on nine big stock portfolios. The monthly size breakpoint is the median NYSE market cap.

$$SMB = \frac{1}{3}\left(SMB_{\frac{B}{M}} + SMB_{OP} + SMB_{INV}\right)$$

where

$$SMB = \frac{1}{3}(Small\ Value + Small\ Neutral + Small\ Growth) - \frac{1}{3}(Big\ Value + Big\ Neutral + Big\ Growth)$$

- Value Beta: Fama-French High Minus Low (HML) factor; is the average return of two value portfolios minus the average return of two growth portfolios. The monthly size breakpoint is the median NYSE market cap. The monthly value breakpoints are the 30th and 70th NYSE percentiles.

$$HML = \frac{1}{2}(Small\ Value + Big\ Value) - \frac{1}{2}(Small\ Growth + Big\ Growth)$$

- Momentum Beta: Fama-French Momentum (MOM) factor; is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios, based on six value-weight portfolios formed on size and prior returns (prior twelve months of returns excluding the most recent month, i.e. 2-12). The monthly size breakpoint is the median NYSE market cap. The monthly prior return breakpoints are the 30th and 70th NYSE percentiles.

$$Mom = \frac{1}{2}(Small\ High + Big\ High) - \frac{1}{2}(Small\ Low + Big\ Low)$$

[23] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html. Eugene F. Fama and Kenneth R. French, September 2014; "A Five-Factor Asset Pricing Model" Available at SSRN: http://ssrn.com/abstract=2287202.

[24] Roger Clarke, Harindra De Silva, and Steven Thorley, 2010; "Know your VMS Exposure," Journal of Portfolio Management, Vol. 36 No. 2.

- Quality/Profitability Beta: Fama-French Robust Minus Weak (RMW) factor; is the average return on the two robust operating profitability[25] portfolios minus the average returns on the two weak operating profitability portfolios. The monthly size breakpoint is the median NYSE market cap. The monthly operating profitability breakpoints are the 30th and 70th NYSE percentiles.

$$RMW = \frac{1}{2}(Small\ Robust + Big\ Robust) - \frac{1}{2}(Small\ Weak + Big\ Weak)$$

- Volatility Beta: Analytic Investors Volatile Minus Stable (VMS) factor; is the average return on two volatile portfolios minus the average return on two stable portfolios, based on six value-weight portfolios formed on size and volatility (prior sixty months standard deviation of the stock's idiosyncratic returns). The monthly size breakpoint is the median NYSE market cap. The monthly volatility return breakpoints are the 30th and 70th NYSE percentiles.

$$VMS = \frac{1}{2}(Small\ Volatile + Big\ Volatile) - \frac{1}{2}(Small\ Stable + Big\ Stable)$$

[25] Operating profitability is defined as annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity.

APPENDIX C

PERFORMANCE AND FACTOR EXPOSURES

The tables below show performance and factor exposure of the strategies reviewed in the paper throughout different time periods. We observe that although performance fluctuates given different market conditions, exposures to the factors remain relatively robust to different time periods measurements.

I. Full sample: 20 year time period (April 1995 – March 2015)

Table 26. Performance Statistics of All Indices

Monthly Returns: April 1995 – March 2015

April 1995 - March 2015	Type	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	Market Cap Weighted	7.3%	16.5%	0.45	52.6%	1.00
Russell 1000	Market Cap Weighted	7.6%	16.7%	0.46	52.7%	1.00
S&P 500 Equal Weighted	Equal Weighted	9.5%	18.7%	0.51	56.4%	0.94
Dow Jones Industrial Average	Price Weighted	7.5%	16.1%	0.47	49.3%	0.95
FTSE RAFI 1000	Value Index	9.4%	17.6%	0.53	57.5%	0.94
MSCI VALUE Weighted	Value Index	7.6%	17.1%	0.44	58.1%	0.97
S&P 500 Pure Value	Value Index	8.8%	22.9%	0.39	72.0%	0.79
AQR Momentum	Momentum Index	10.3%	20.1%	0.51	51.0%	0.86
MSCI USA Momentum	Momentum Index	11.5%	18.6%	0.62	52.7%	0.88
MSCI USA Min Volatility	Low Volatility Index	7.4%	12.6%	0.59	44.6%	0.92
S&P 500 Low Volatility	Low Volatility Index	11.1%	12.7%	0.88	35.4%	0.73
MIG QSI Index®	Quality Index					
FTSE USA Quality Index	Quality Index					

Table 27. Factor Exposure of All Indices

Monthly Returns: April 1995 – March 2015

April 1995 - March 2015	Intercept	Beta MKT	Beta SMB	Beta HML	Beta MOM	Beta RMW	Beta VOL	R-Squared
S&P 500	-0.16%	1.00	-0.15	0.03	-0.03	0.06	-0.01	99%
T-Stat	*-6.98*	*154.76*	*-17.28*	*3.88*	*-5.75*	*4.77*	*-1.68*	
Russell 1000	-0.14%	1.00	-0.11	0.04	-0.02	0.04	0.00	100%
T-Stat	*-8.65*	*212.51*	*-18.20*	*5.82*	*-5.24*	*4.24*	*-0.15*	
S&P 500 Equal Weighted	-0.06%	1.02	0.11	0.28	-0.16	0.15	0.01	96%
T-Stat	*-0.91*	*53.78*	*4.44*	*10.69*	*-12.75*	*4.20*	*0.59*	
Dow Jones Industrial Average	-0.13%	0.99	-0.14	0.07	-0.06	0.11	-0.10	91%
T-Stat	*-1.43*	*38.13*	*-4.11*	*1.96*	*-3.43*	*2.19*	*-2.81*	
FTSE RAFI 1000	-0.06%	0.99	-0.01	0.39	-0.13	0.11	0.00	98%
T-Stat	*-1.14*	*69.41*	*-0.40*	*19.86*	*-13.57*	*4.04*	*0.06*	
MSCI VALUE Weighted	-0.14%	1.02	-0.08	0.24	-0.13	0.06	-0.07	98%
T-Stat	*-3.37*	*85.44*	*-5.33*	*14.65*	*-16.08*	*2.65*	*-4.18*	
S&P 500 Pure Value	-0.17%	1.07	0.29	0.82	-0.25	0.14	-0.01	92%
T-Stat	*-1.38*	*30.91*	*6.32*	*16.97*	*-10.66*	*2.14*	*-0.26*	
AQR Momentum	-0.18%	1.06	-0.09	0.02	0.38	0.08	0.17	94%
T-Stat	*-2.04*	*42.30*	*-2.89*	*0.45*	*22.32*	*1.64*	*5.02*	
MSCI USA Momentum	-0.12%	1.01	-0.19	0.08	0.31	0.33	0.21	90%
T-Stat	*-1.17*	*33.14*	*-4.79*	*1.95*	*14.81*	*5.86*	*5.20*	
MSCI USA Min Volatility	-0.08%	0.83	-0.09	0.10	0.00	0.04	-0.15	90%
T-Stat	*-1.15*	*39.24*	*-3.15*	*3.55*	*-0.05*	*1.13*	*-5.46*	
S&P 500 Low Volatility	0.24%	0.76	0.04	0.19	-0.04	0.05	-0.31	76%
T-Stat	*2.12*	*23.37*	*0.90*	*4.24*	*-1.69*	*0.82*	*-7.10*	
MIG QSI Index®								
T-Stat								
FTSE USA Quality Index								
T-Stat								

II. Full sample for quality indices (October 2001 – March 2015)

Table 28. Performance Statistics of All Indices

Monthly Returns: October 2001 – March 2015

October 2001 - March 2015	Type	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	Market Cap Weighted	5.2%	15.6%	0.33	52.6%	1.00
Russell 1000	Market Cap Weighted	5.7%	15.9%	0.36	52.7%	1.00
S&P 500 Equal Weighted	Equal Weighted	8.8%	19.3%	0.46	56.4%	0.97
Dow Jones Industrial Average	Price Weighted	5.3%	14.9%	0.36	49.3%	0.97
FTSE RAFI 1000	Value Index	7.0%	18.0%	0.39	57.5%	0.97
MSCI VALUE Weighted	Value Index	5.1%	17.1%	0.30	58.1%	0.99
S&P 500 Pure Value	Value Index	8.9%	25.3%	0.35	72.0%	0.87
AQR Momentum	Momentum Index	8.1%	16.6%	0.49	48.6%	0.90
MSCI USA Momentum	Momentum Index	8.1%	16.4%	0.49	52.7%	0.86
MSCI USA Min Volatility	Low Volatility Index	5.4%	12.1%	0.44	44.6%	0.93
S&P 500 Low Volatility	Low Volatility Index	9.6%	11.3%	0.85	35.4%	0.85
MIG QSI Index®	Quality Index	8.9%	14.5%	0.61	43.0%	0.98
FTSE USA Quality Index	Quality Index	8.7%	14.3%	0.61	41.0%	0.98

Table 29. Factor Exposure of All Indices

Monthly Returns: October 2001 – March 2015

October 2001 - March 2015	Intercept	Beta MKT	Beta SMB	Beta HML	Beta MOM	Beta RMW	Beta VOL	R-Squared
S&P 500	-0.19%	1.01	-0.13	0.02	-0.01	-0.01	-0.03	100%
T-Stat	*-11.50*	*195.83*	*-18.25*	*2.81*	*-2.98*	*-0.47*	*-4.41*	
Russell 1000	-0.17%	1.01	-0.09	0.01	0.00	0.01	0.00	100%
T-Stat	*-13.14*	*243.54*	*-15.78*	*2.39*	*-1.48*	*1.53*	*-0.32*	
S&P 500 Equal Weighted	-0.02%	1.01	0.16	0.11	-0.12	0.03	0.05	98%
T-Stat	*-0.39*	*59.77*	*6.77*	*4.59*	*-9.94*	*0.91*	*2.50*	
Dow Jones Industrial Average	-0.13%	1.01	-0.19	0.00	-0.04	0.00	-0.15	94%
T-Stat	*-1.55*	*39.24*	*-5.29*	*-0.08*	*-2.23*	*0.07*	*-4.57*	
FTSE RAFI 1000	-0.11%	0.98	-0.01	0.35	-0.13	0.05	0.02	98%
T-Stat	*-2.07*	*56.31*	*-0.49*	*14.49*	*-10.02*	*1.26*	*0.95*	
MSCI VALUE Weighted	-0.20%	1.04	-0.10	0.19	-0.10	-0.04	-0.07	99%
T-Stat	*-6.45*	*104.39*	*-7.36*	*13.71*	*-13.37*	*-2.03*	*-5.69*	
S&P 500 Pure Value	-0.14%	1.10	0.31	0.76	-0.36	0.26	-0.04	94%
T-Stat	*-1.00*	*25.41*	*5.01*	*12.75*	*-11.60*	*2.79*	*-0.78*	
AQR Momentum	-0.12%	1.02	0.09	0.02	0.35	0.09	0.14	96%
T-Stat	*-1.62*	*43.09*	*2.56*	*0.49*	*20.68*	*1.68*	*4.56*	
MSCI USA Momentum	-0.15%	0.96	-0.07	0.09	0.34	0.36	0.29	89%
T-Stat	*-1.27*	*25.26*	*-1.32*	*1.71*	*12.41*	*4.35*	*5.98*	
MSCI USA Min Volatility	-0.07%	0.83	-0.10	0.11	-0.01	0.01	-0.19	89%
T-Stat	*-0.73*	*28.21*	*-2.44*	*2.74*	*-0.29*	*0.09*	*-5.07*	
S&P 500 Low Volatility	0.33%	0.73	0.00	0.05	0.01	-0.08	-0.28	79%
T-Stat	*2.80*	*19.68*	*0.04*	*1.04*	*0.50*	*-0.95*	*-5.79*	
MIG QSI Index®	0.07%	0.95	0.03	0.00	-0.04	0.09	-0.13	98%
T-Stat	*1.49*	*59.61*	*1.29*	*-0.13*	*-3.06*	*2.62*	*-6.28*	
FTSE USA Quality Index	0.08%	0.96	-0.16	-0.12	0.04	0.15	0.01	98%
T-Stat	*1.66*	*62.00*	*-7.49*	*-5.64*	*3.46*	*4.54*	*0.38*	

III. 10 year time period (April 2005 – March 2015)

Table 30. Performance Statistics of All Indices

Monthly Returns: April 2005 – March 2015

April 2005 - March 2015	Type	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	Market Cap Weighted	5.8%	15.8%	0.37	52.6%	1.00
Russell 1000	Market Cap Weighted	6.2%	16.1%	0.38	52.7%	1.00
S&P 500 Equal Weighted	Equal Weighted	8.0%	19.3%	0.42	56.4%	0.97
Dow Jones Industrial Average	Price Weighted	5.4%	14.6%	0.37	49.3%	0.97
FTSE RAFI 1000	Value Index	6.9%	18.7%	0.37	57.5%	0.97
MSCI VALUE Weighted	Value Index	5.3%	17.3%	0.30	58.1%	0.99
S&P 500 Pure Value	Value Index	7.6%	26.3%	0.29	72.0%	0.89
AQR Momentum	Momentum Index	7.2%	17.3%	0.41	48.6%	0.92
MSCI USA Momentum	Momentum Index	7.7%	17.5%	0.44	52.7%	0.89
MSCI USA Min Volatility	Low Volatility Index	6.1%	12.4%	0.49	44.6%	0.93
S&P 500 Low Volatility	Low Volatility Index	9.4%	11.5%	0.81	35.4%	0.86
MIG QSI Index®	Quality Index	8.9%	14.8%	0.60	43.0%	0.98
FTSE USA Quality Index	Quality Index	9.9%	14.4%	0.69	41.0%	0.98

Table 31. Factor Exposure of All Indices

Monthly Returns: April 2005 – March 2015

April 2005 - March 2015	Intercept	Beta MKT	Beta SMB	Beta HML	Beta MOM	Beta RMW	Beta VOL	R-Squared
S&P 500	-0.20%	1.01	-0.13	0.04	0.00	0.03	-0.03	100%
T-Stat	*-11.50*	*191.46*	*-15.90*	*4.74*	*-1.25*	*1.93*	*-5.06*	
Russell 1000	-0.18%	1.01	-0.09	0.02	0.00	0.02	0.00	100%
T-Stat	*-11.00*	*205.86*	*-11.69*	*2.24*	*-0.83*	*1.32*	*-0.29*	
S&P 500 Equal Weighted	-0.07%	1.02	0.15	0.04	-0.14	0.07	0.06	99%
T-Stat	*-1.19*	*60.00*	*5.41*	*1.71*	*-10.92*	*1.48*	*2.78*	
Dow Jones Industrial Average	-0.19%	1.00	-0.22	0.08	-0.02	0.07	-0.16	96%
T-Stat	*-2.36*	*41.11*	*-5.62*	*2.09*	*-0.87*	*1.13*	*-5.24*	
FTSE RAFI 1000	-0.06%	0.98	-0.06	0.32	-0.14	0.00	0.04	98%
T-Stat	*-0.96*	*49.59*	*-2.00*	*10.63*	*-9.78*	*-0.06*	*1.81*	
MSCI VALUE Weighted	-0.21%	1.04	-0.11	0.18	-0.10	-0.02	-0.07	99%
T-Stat	*-6.48*	*103.64*	*-6.93*	*11.84*	*-13.48*	*-0.58*	*-5.24*	
S&P 500 Pure Value	0.01%	1.09	0.18	0.60	-0.43	0.05	-0.01	96%
T-Stat	*0.07*	*25.01*	*2.56*	*9.16*	*-13.43*	*0.47*	*-0.16*	
AQR Momentum	-0.20%	1.05	0.04	-0.03	0.34	0.11	0.14	97%
T-Stat	*-2.63*	*44.95*	*1.20*	*-0.86*	*19.46*	*1.74*	*4.80*	
MSCI USA Momentum	-0.17%	0.99	-0.18	-0.03	0.31	0.28	0.34	91%
T-Stat	*-1.26*	*24.04*	*-2.77*	*-0.50*	*10.09*	*2.56*	*6.71*	
MSCI USA Min Volatility	-0.04%	0.82	-0.12	0.09	-0.02	0.06	-0.19	88%
T-Stat	*-0.33*	*23.50*	*-2.20*	*1.70*	*-0.82*	*0.70*	*-4.45*	
S&P 500 Low Volatility	0.31%	0.73	-0.08	0.02	0.00	-0.10	-0.27	79%
T-Stat	*2.22*	*17.14*	*-1.22*	*0.30*	*0.12*	*-0.91*	*-5.15*	
MIG QSI Index®	0.06%	0.94	0.05	0.03	-0.03	0.14	-0.15	98%
T-Stat	*1.05*	*55.69*	*1.85*	*1.25*	*-2.45*	*3.04*	*-7.32*	
FTSE USA Quality Index	0.08%	0.95	-0.13	-0.11	0.05	0.23	0.00	98%
T-Stat	*1.73*	*63.39*	*-5.42*	*-4.81*	*4.43*	*5.82*	*-0.23*	

IV. 5 year time period (April 2010 – March 2015)

Table 32. Performance Statistics of All Indices

Monthly Returns: April 2010 – March 2015

April 2010 - March 2015	Type	Annualized Return	Annualized Standard Deviation	Sharpe Ratio (Rf = 0)	Maximum Drawdown	Correlation to S&P 500
S&P 500	Market Cap Weighted	12.1%	14.6%	0.83	17.0%	1.00
Russell 1000	Market Cap Weighted	12.4%	14.9%	0.84	17.8%	1.00
S&P 500 Equal Weighted	Equal Weighted	13.9%	16.5%	0.84	20.4%	0.99
Dow Jones Industrial Average	Price Weighted	10.4%	13.4%	0.77	14.8%	0.98
FTSE RAFI 1000	Value Index	12.0%	15.4%	0.78	19.3%	0.99
MSCI VALUE Weighted	Value Index	12.1%	15.4%	0.79	18.9%	0.99
S&P 500 Pure Value	Value Index	15.2%	19.8%	0.77	21.9%	0.94
AQR Momentum	Momentum Index	13.3%	17.3%	0.77	22.6%	0.94
MSCI USA Momentum	Momentum Index	15.0%	14.5%	1.04	13.8%	0.93
MSCI USA Min Volatility	Low Volatility Index	12.8%	10.4%	1.23	8.1%	0.87
S&P 500 Low Volatility	Low Volatility Index	15.2%	10.4%	1.46	6.5%	0.77
MIG QSI Index®	Quality Index	14.8%	13.8%	1.07	14.2%	0.98
FTSE USA Quality Index	Quality Index	15.5%	14.0%	1.11	12.4%	0.98

Table 33. Factor Exposure of All Indices

Monthly Returns: April 2010 – March 2015

April 2010 - March 2015	Intercept	Beta MKT	Beta SMB	Beta HML	Beta MOM	Beta RMW	Beta VOL	R-Squared
S&P 500	-0.19%	1.01	-0.12	0.04	0.00	0.03	-0.05	100%
T-Stat	*-7.31*	*128.40*	*-8.76*	*3.19*	*0.08*	*1.51*	*-3.56*	
Russell 1000	-0.17%	1.01	-0.08	0.02	0.01	0.00	-0.03	100%
T-Stat	*-7.34*	*141.74*	*-6.19*	*1.57*	*1.23*	*0.08*	*-2.51*	
S&P 500 Equal Weighted	-0.07%	1.04	0.10	0.04	-0.04	-0.05	-0.05	99%
T-Stat	*-1.06*	*48.53*	*2.54*	*1.06*	*-1.25*	*-1.00*	*-1.32*	
Dow Jones Industrial Average	-0.26%	0.96	-0.15	0.06	-0.02	0.12	-0.12	95%
T-Stat	*-2.35*	*27.96*	*-2.38*	*1.08*	*-0.34*	*1.38*	*-2.17*	
FTSE RAFI 1000	-0.11%	1.00	-0.03	0.27	-0.03	-0.01	-0.06	99%
T-Stat	*-2.66*	*77.37*	*-1.49*	*12.04*	*-1.53*	*-0.47*	*-2.74*	
MSCI VALUE Weighted	-0.12%	1.01	-0.06	0.21	-0.08	0.00	-0.05	100%
T-Stat	*-3.68*	*105.34*	*-3.62*	*12.65*	*-6.20*	*-0.16*	*-3.53*	
S&P 500 Pure Value	0.21%	1.07	0.19	0.40	-0.36	0.06	0.07	96%
T-Stat	*1.41*	*23.37*	*2.32*	*5.10*	*-5.75*	*0.54*	*0.95*	
AQR Momentum	-0.43%	1.10	0.00	-0.13	0.48	0.02	0.06	97%
T-Stat	*-4.07*	*33.73*	*0.00*	*-2.34*	*10.63*	*0.26*	*1.11*	
MSCI USA Momentum	-0.17%	0.99	-0.28	-0.29	0.39	0.01	0.05	95%
T-Stat	*-1.48*	*27.61*	*-4.41*	*-4.68*	*8.03*	*0.09*	*0.82*	
MSCI USA Min Volatility	0.07%	0.77	-0.19	-0.04	0.15	0.03	-0.30	83%
T-Stat	*0.40*	*15.03*	*-2.13*	*-0.48*	*2.10*	*0.23*	*-3.60*	
S&P 500 Low Volatility	0.37%	0.70	-0.17	0.14	0.19	-0.07	-0.43	72%
T-Stat	*1.75*	*10.92*	*-1.47*	*1.26*	*2.13*	*-0.42*	*-4.17*	
MIG QSI Index®	0.08%	0.92	0.07	0.06	0.00	0.14	-0.13	97%
T-Stat	*0.91*	*35.87*	*1.58*	*1.27*	*0.04*	*2.18*	*-3.15*	
FTSE USA Quality Index	-0.01%	0.99	-0.18	-0.09	0.06	0.27	-0.04	99%
T-Stat	*-0.09*	*50.58*	*-5.09*	*-2.71*	*2.28*	*5.63*	*-1.16*	

APPENDIX D

ALTERNATIVE BETAS SEMI-ACTIVE AND ACTIVE MANAGEMENT

The alternative beta strategies we have analyzed in this paper are all designed to be passive index like exposures to either the equity market beta or specific alternative equity betas. However, many active managers offer factor-targeting and rules-based strategies that aim to further improve performance by introducing an "alpha overlay" to their passive index engine. An example of this may be a low volatility strategy that is combined with an alpha generator that targets added returns by overweighting value stocks. However, as with all active vs. passive strategies the alpha overlays or the active return tilts will come at a higher cost.

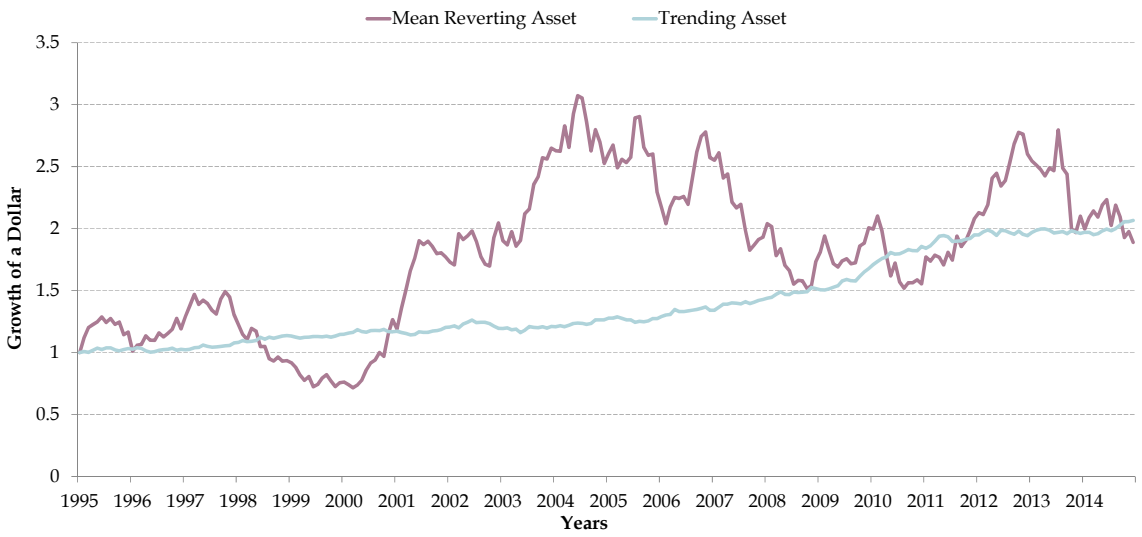
Investors need to carefully consider if the additional active piece offered by a manager in an alternative beta strategy is worth paying the extra cost over the simpler index like alternative beta index.

APPENDIX E

REBALANCING VERSUS BUY AND HOLD

In the paper we make the argument that a rebalancing strategy would be preferred to a buy and hold strategy in a mean reverting market. To visualize this, the example below shows the performance of a buy and hold strategy versus a rebalancing strategy (quarterly rebalancing) in two twenty year simulated scenarios[26] where we assume only two assets exist, a risk free asset with 2% expected return and a risky asset with 4% expected return. The first scenario is a trending risky asset (4% standard deviation), and the second is a more volatile and mean reverting risky asset (20% standard deviation). The graph below shows the performance of both risky asset scenarios.

Graph 34. Simulated Performance of Risky Asset
Growth of a Dollar: 2005 – 2014



To evaluate the performance of a rebalancing versus and buy and hold strategy in these two cases we start with an allocation of 60% to the risky asset and 40% to the risk free asset. The buy and hold strategy will not rebalance during the 20 year period whereas the rebalancing strategy will do so quarterly. The table below shows the results of this exercise.

[26] In this example we show the results of one pair of simulated paths, however, the results are robust to increasing the number of simulations to 1,000.

Table 35. Buy and Hold versus Rebalancing Results

Monthly Simulated Returns: April 1995 – March 2015

Scenario	Trending Risky Asset			Mean Reverting Risky Asset		
Strategy	Risky Asset	Buy and Hold	Rebalance	Risky Asset	Buy and Hold	Rebalance
Annualized Return	3.81%	2.85%	2.62%	3.36%	2.54%	2.84%
Annualized Volatility	3.70%	2.39%	2.18%	21.98%	15.01%	12.89%
Sharpe Ratio	0.76	0.78	0.75	0.11	0.10	0.14
Maximum Drawdown	8.03%	4.83%	4.52%	52.07%	40.25%	34.15%

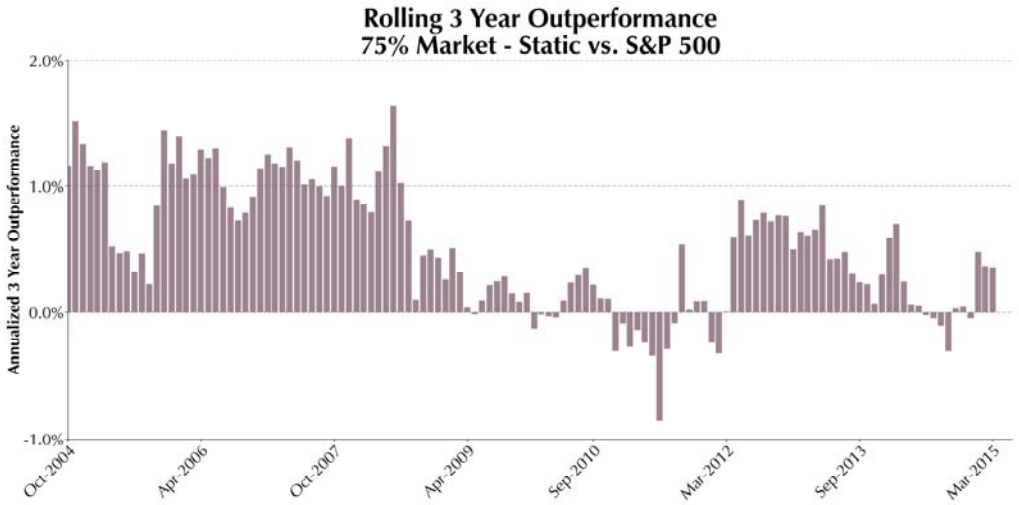
As we can see in the table above, a rebalancing strategy clearly outperforms buy and hold when the risky asset is more volatile and mean reverting, offering higher returns, lower standard deviation, and lower drawdowns. However, in a trending market, a rebalancing strategy lags in returns but still provides lower standard deviation and drawdowns.

APPENDIX F

STATIC ALLOCATION – ADDITIONAL RESULTS

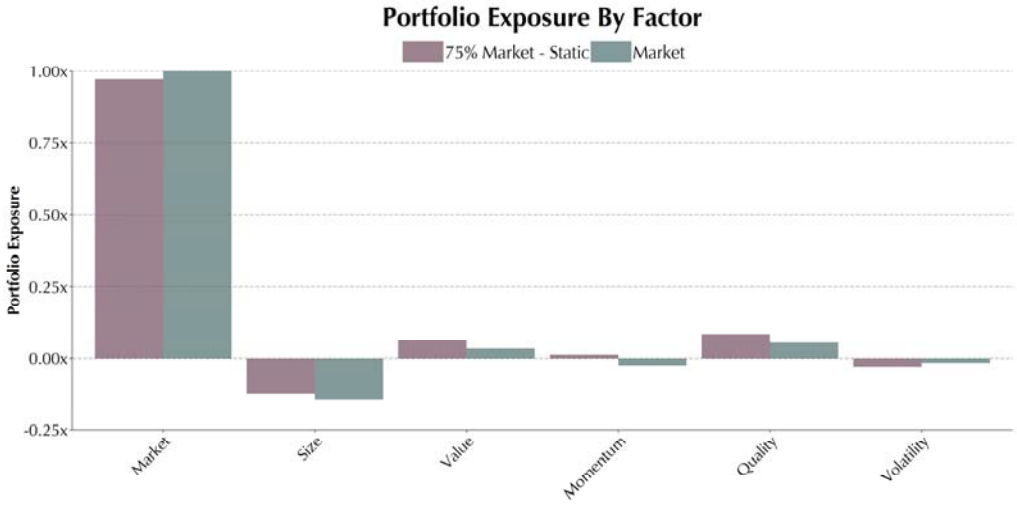
This appendix provides additional charts of the allocation examples covered in the paper.

Graph 36: Static 75% Market – Rolling Performance



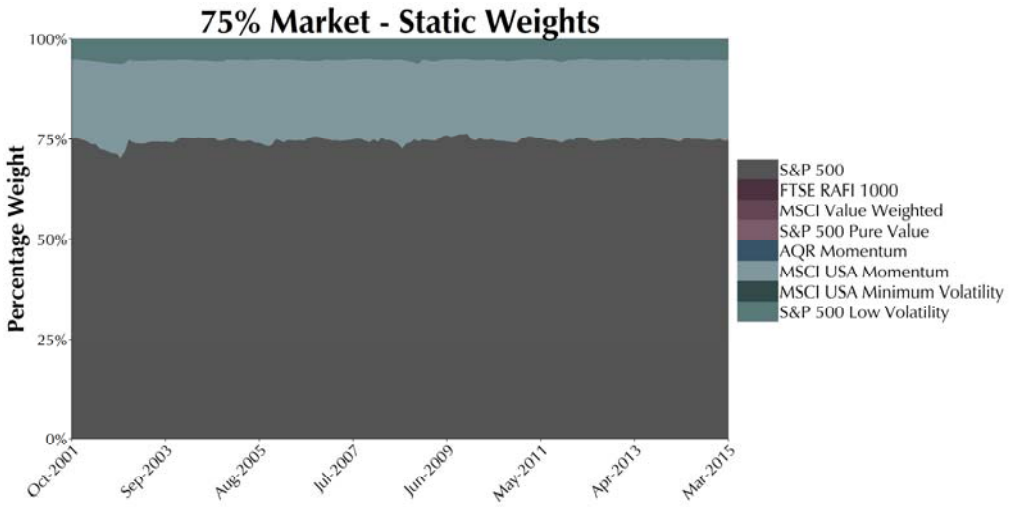
Looking at rolling 3 year periods, we can see consistent outperformance with only twenty periods of underperformance that never reached 1%.

Graph 36: Static 75% Market – Portfolio Exposures



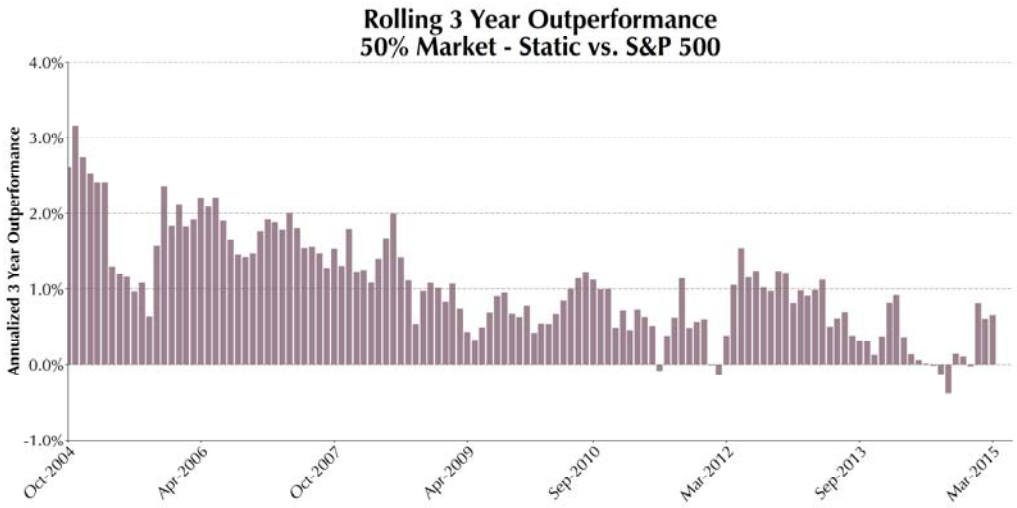
Furthermore, this portfolio provides similar yet more balanced exposure to factors. By slightly reducing market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

Graph 37: Static 75% Market – Portfolio Weights



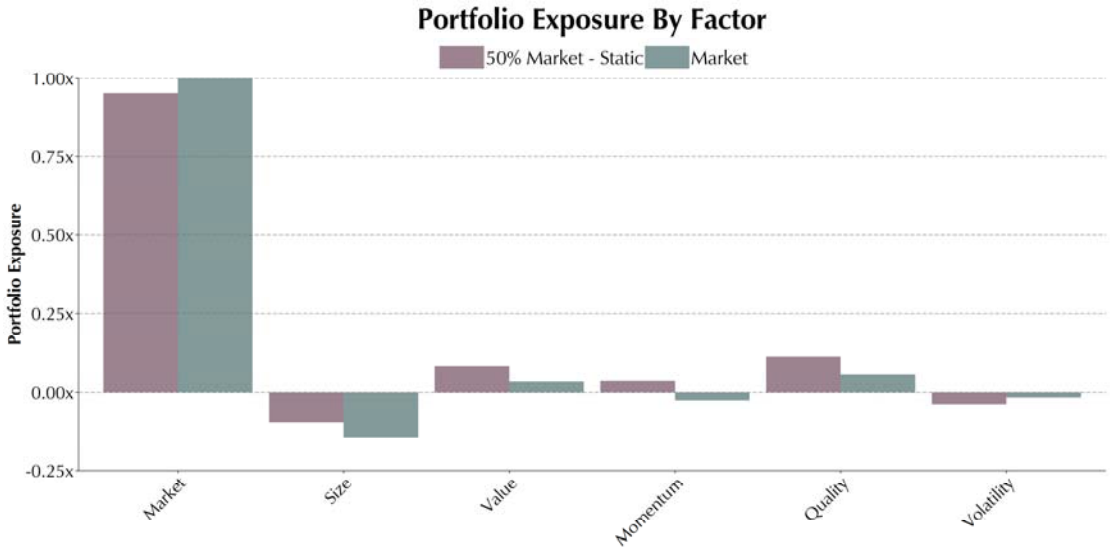
We can observe the static weights of 75% exposure to the market index, 20% to momentum, and 5% to low volatility.

Graph 38: Static 50% Market – Rolling Performance



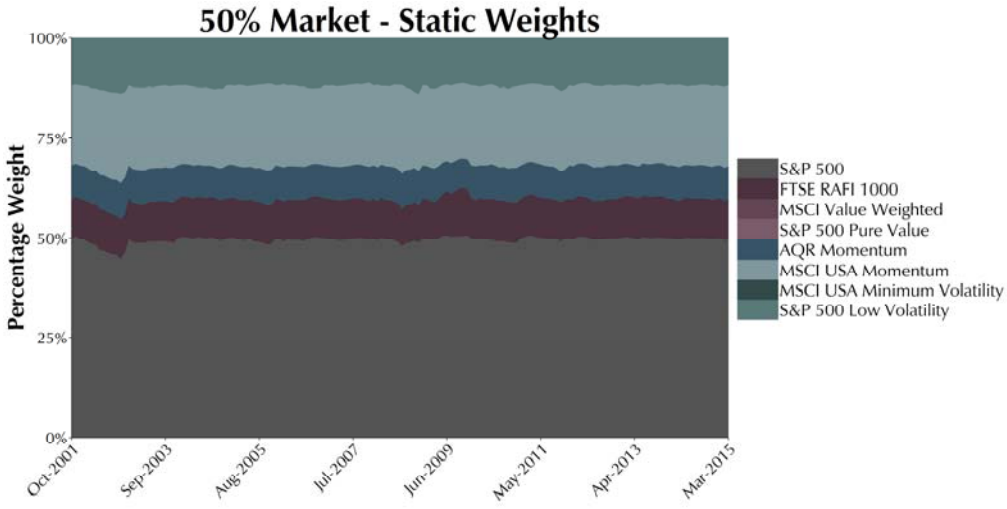
Looking at rolling 3 year periods, a higher allocation to alternative beta indices resulted in more consistent outperformance, with only five periods of underperformance that never reached 1%.

Graph 39: Static 50% Market – Portfolio Exposures



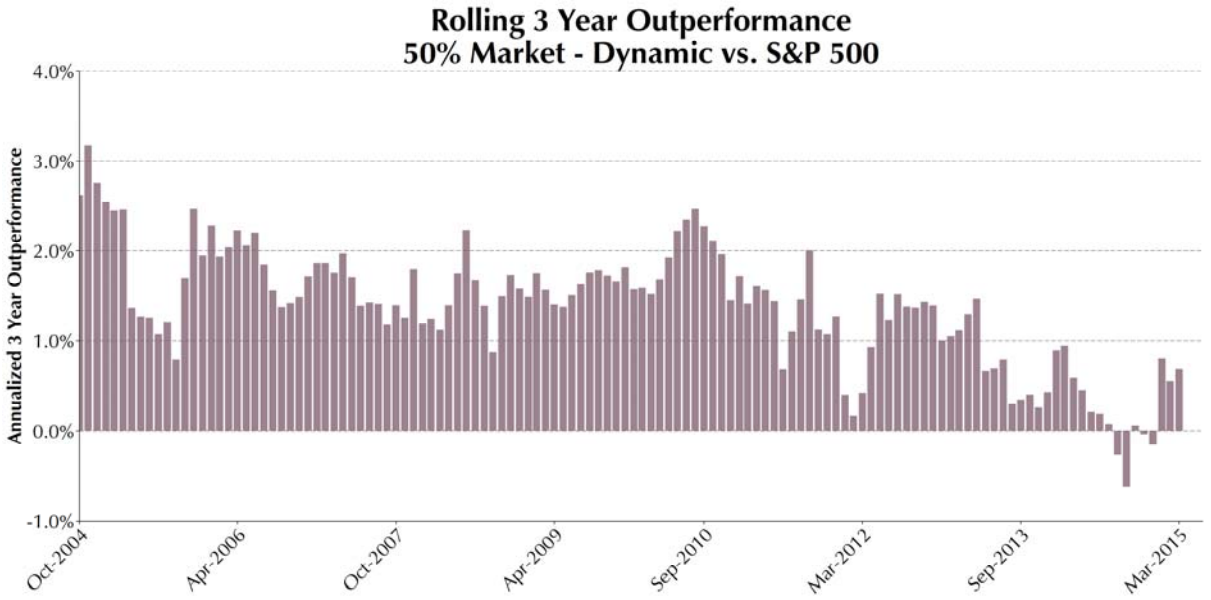
Furthermore, this portfolio provides an even more balanced exposure to factors. By having more freedom to reduce market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

Graph 40: Static 50% Market – Portfolio Weights



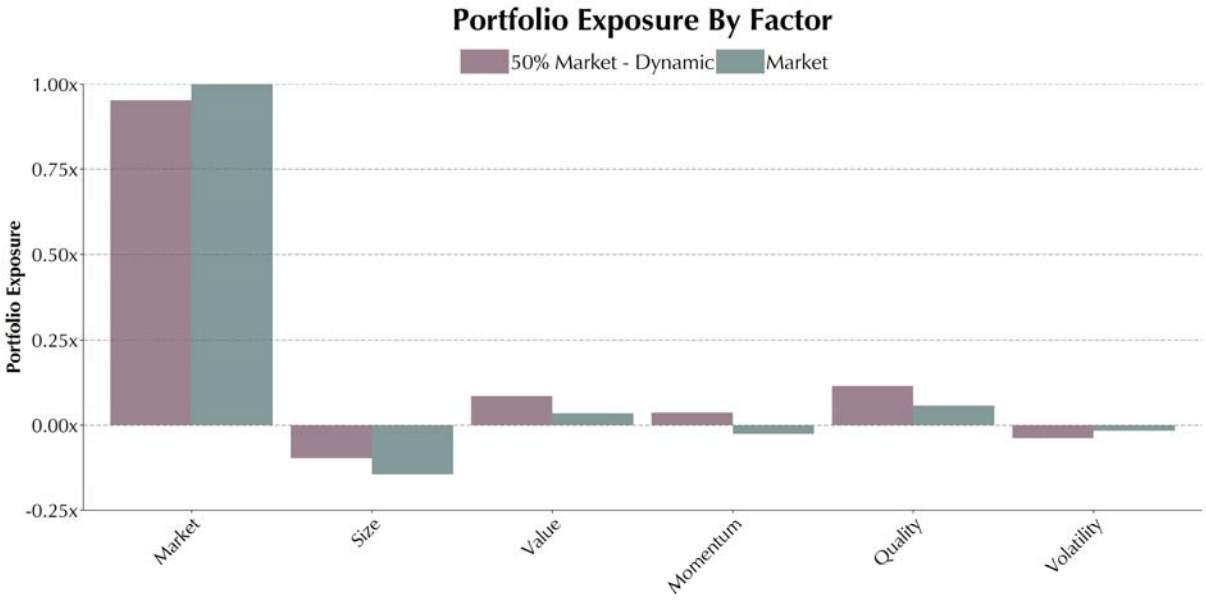
We can observe the static weights of 50% exposure to the market index, 10% to value, 28% to momentum (through two alternative beta vehicles), and 12% to low volatility.

Graph 41: Dynamic 50% Market – Rolling Performance



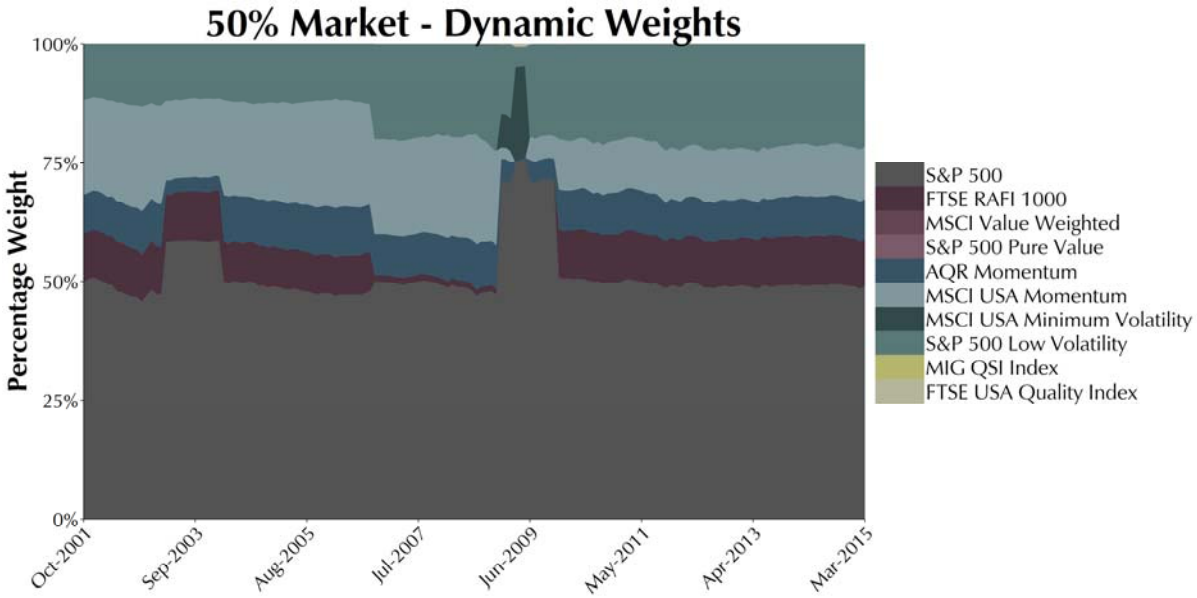
Looking at rolling 3 year periods, we can see consistent outperformance with only four periods of underperformance.

Graph 42: Dynamic 50% Market – Portfolio Exposures



Furthermore, this portfolio provides the most balanced exposure to factors. By having the most freedom to reduce market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

Graph 43: Dynamic 50% Market – Portfolio Weights



The portfolio as constructed allocates at least 50% to the market vehicle (S&P 500 Index) throughout the sample while also investing in value, momentum, and low volatility indices. We can clearly differentiate the dynamism of the framework in how weights and allocations to alternative beta indices will vary depending on current information.

APPENDIX G

DYNAMIC ALLOCATION FRAMEWORK – ADDITIONAL RESULTS

The purpose of this appendix is to elaborate on the description of the allocation framework used on the third example of the alternative beta allocations and present additional examples to illustrate how flexible and customizable this approach to investing can be.

The framework works as follows: using monthly data we make forward estimates of excess return over the risk free rate, covariance and factor sensitivities for the alternative beta indices, incorporating new information monthly but using a one-month lag for reasonability. Furthermore the implementation includes the estimated performance drag for alternative beta strategies that is a function of turnover. The objective of the framework is to build a portfolio with a realistic set of objectives:

- Target return that is 1.5 times the estimate of the market return
- Minimize standard deviations, trading, trading costs and tracking error to the market
- Minimize sensitivity to factor exposure which is equivalent to achieving the best possible Sharpe ratio per unit of equity factor risk assumed

Given the proposed framework, we have the flexibility to test allocations given different assumptions or investor preferences. Below we show three examples, but it is worth stressing the fact that the framework can be customized to incorporate any range of investor views and objectives as well as real-world constraints, such as rebalancing frequencies and rules, minimum trading thresholds and time periods elapsed between the moment a trade decision is made and when it is actually implemented, to name a few.

I. Conservative Case: Our first example of the allocation has the most conservative assumptions. Objectives are to find the portfolio with the best possible return given constraints that care about holding the market cap weighted index, minimizing tracking error, trading and diversifying factor exposures with the same degree of importance.

II. Tracking Error Targeted: This example of the allocation framework aims to be a middle ground of optimal factor allocations. As its name suggests the objective of this case is to always be conscious of tracking error to the market cap weighted index but caring less about holding the market index, while still trying to maximize returns and minimize risk and trading costs.

III. Benchmark Agnostic Case: In this final example we want to maximize returns but we don't worry about tracking error or holding the market cap weighted index. However we continue to aim to minimize standard deviation and achieve optimal factor diversification.

Graph 44. Summary of Allocation Framework Examples

Case /Objective	Return	Standard Deviation	Tracking Error	Hold the Market	Trading Costs	Factor Diversification
Conservative	1.5 Times the Market	Minimize	Minimize	High	Minimize	Optimize
Tracking Error Targeted	1.5 Times the Market	Minimize	Minimize	-	Minimize	Optimize
Benchmark Agnostic	1.5 Times the Market	Minimize	-	-	Minimize	Optimize

Graph 45. Growth of a Dollar

Monthly Returns: April 1995– March 2015

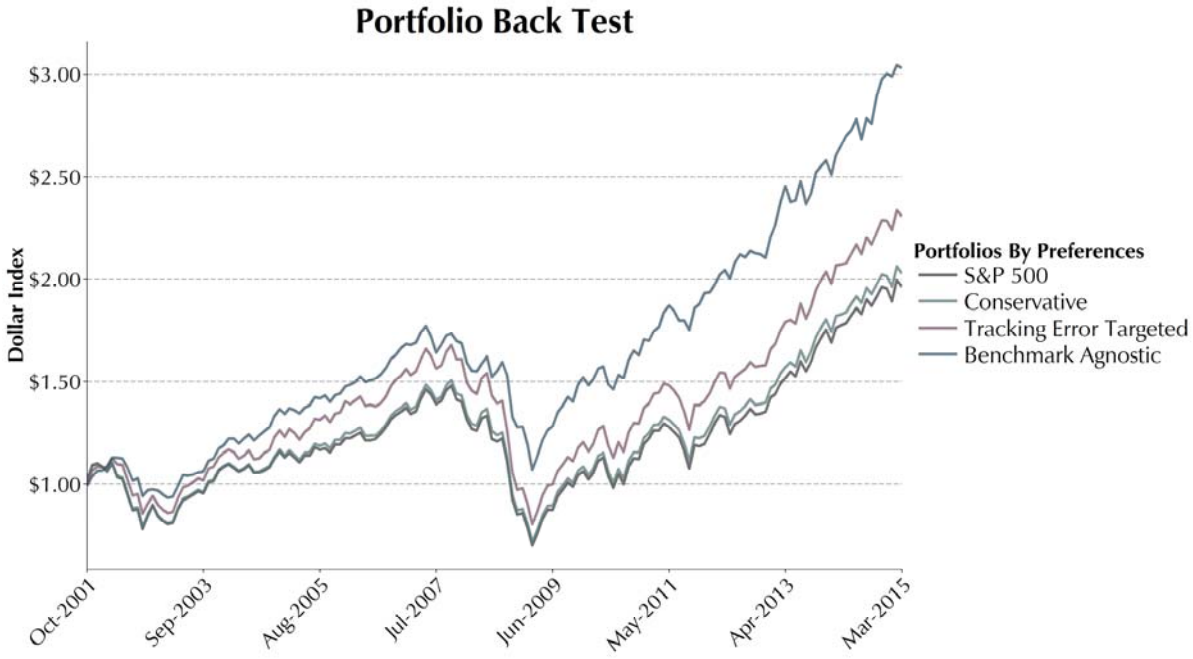


Table 46. Summary of Results

Monthly Returns: April 1995– March 2015

	S&P 500	Conservative Case	Tracking Error Target Case	Benchmark Agnostic Case
Annualized Net Return[27]	6.3%	6.5%	7.4%	9.2%
Standard Deviation	14.7%	14.4%	13.9%	10.7%
Sharpe Ratio	0.43	0.45	0.53	0.86
Tracking Error	-	0.7%	2.7%	6.9%
Number of Trades	-	2	7	14
Maximum Drawdown	-52.3%	-52%	-52%	-40%
% Underperforming Periods[28]	-	4.8%	11.9%	6.3%
Factor Exposures				
Market Beta	1	1.00	0.97	0.80
Small Cap Beta	-0.14	-0.14	-0.09	-0.01
Value Beta	0.03	0.04	0.16	0.17
Momentum Beta	-0.03	0.00	0.04	0.01
Profitability/Quality Beta	0.06	0.08	0.12	0.07
Volatility Beta	-0.02	-0.01	0.00	-0.22
Risk Free	1.25	1.19	1.01	0.74

As we can observe from the results displayed above, all examples from the asset allocation framework achieve better performance and factor exposures than the market cap weighted index. We can further notice that as we care less about tracking error and holding the market index we can achieve more balanced factor exposures and superior Sharpe ratios.

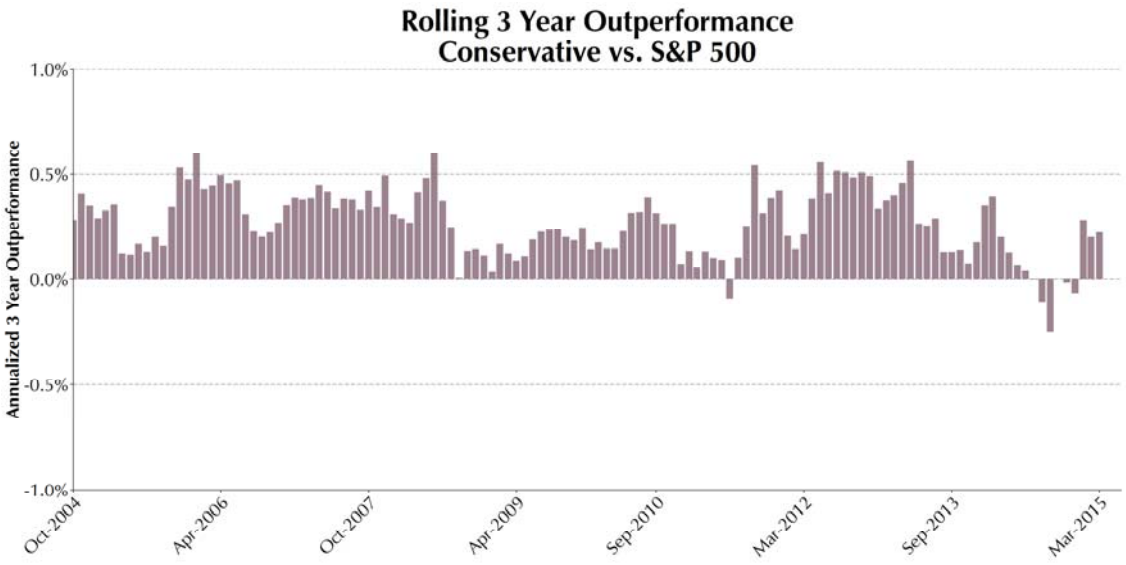
[27] Returns are net of management costs (table 15), trading costs within alternative beta indices (Table 13: performance drag at 50 bp) and trading costs from rebalancing between indices (S&P 500 bid-ask spread).

[28] Based on 126 rolling 36-month periods.

The sections below show additional performance and exposure charts for the allocation examples considered.

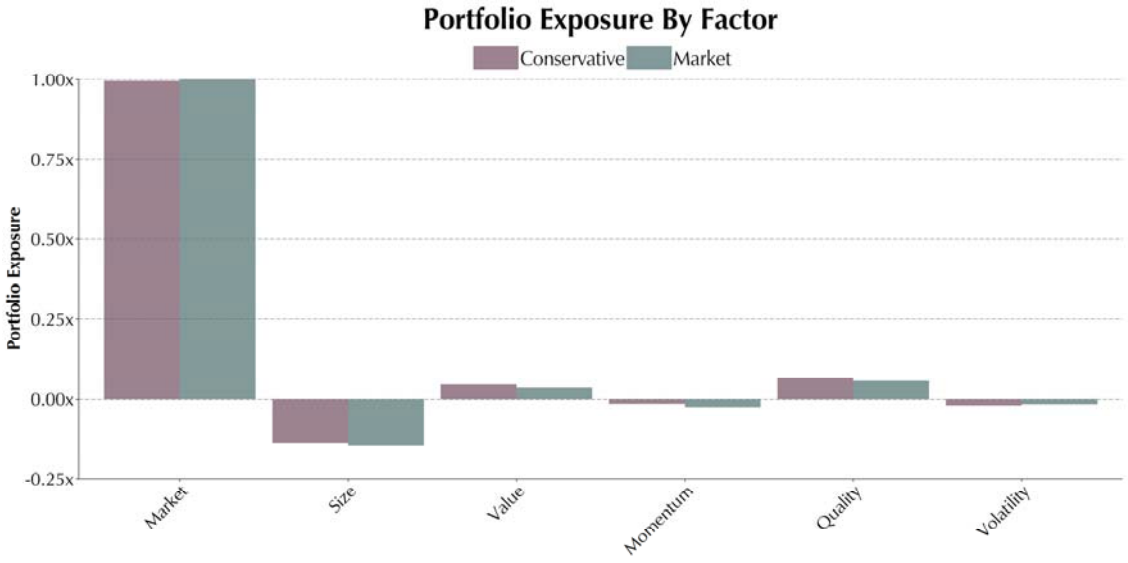
I. Conservative Case:

Graph 47: Conservative Case – Rolling Performance



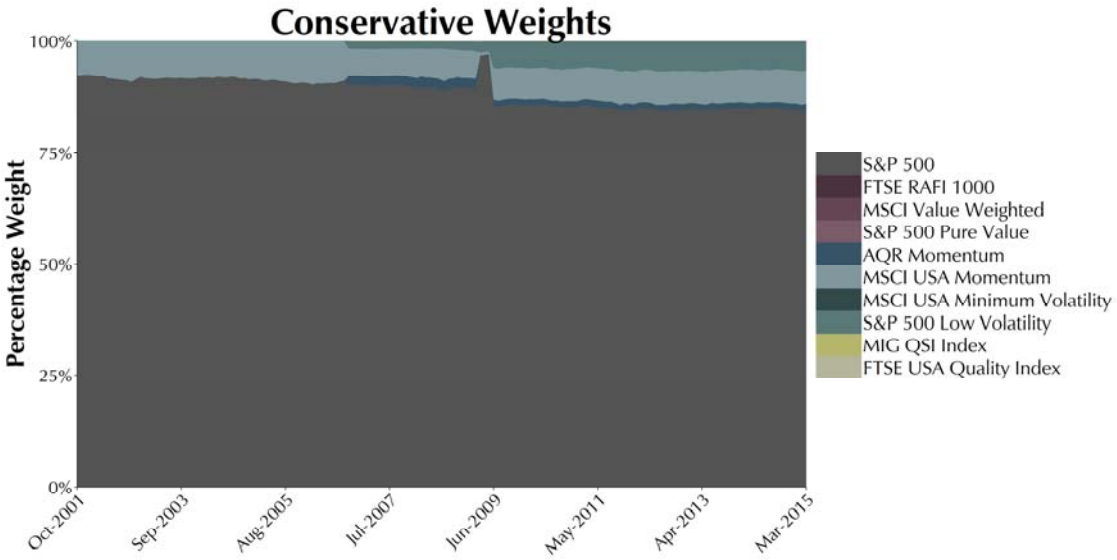
Looking at rolling 3 year periods, we can see consistent outperformance with only four periods of underperformance.

Graph 48: Conservative Case – Portfolio Exposures



Furthermore, the conservative case provides similar yet more balanced exposure to factors. By slightly reducing market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

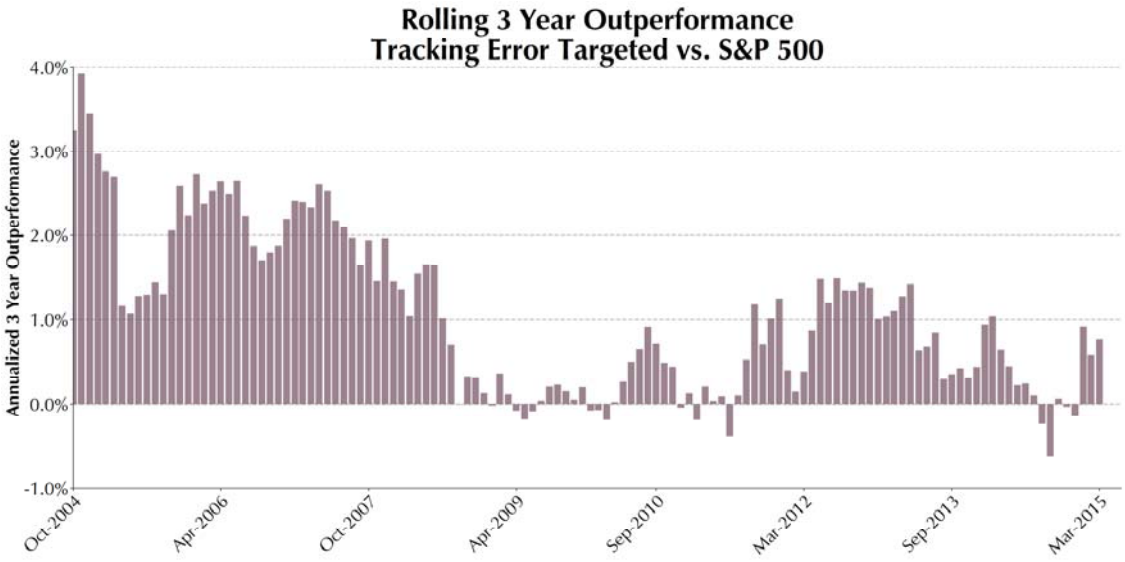
Graph 49. Conservative Case – Portfolio Weights



By being sensitive to tracking error and holding the market vehicle, outperformance is achieved by adding some exposure to momentum and low volatility alternative betas.

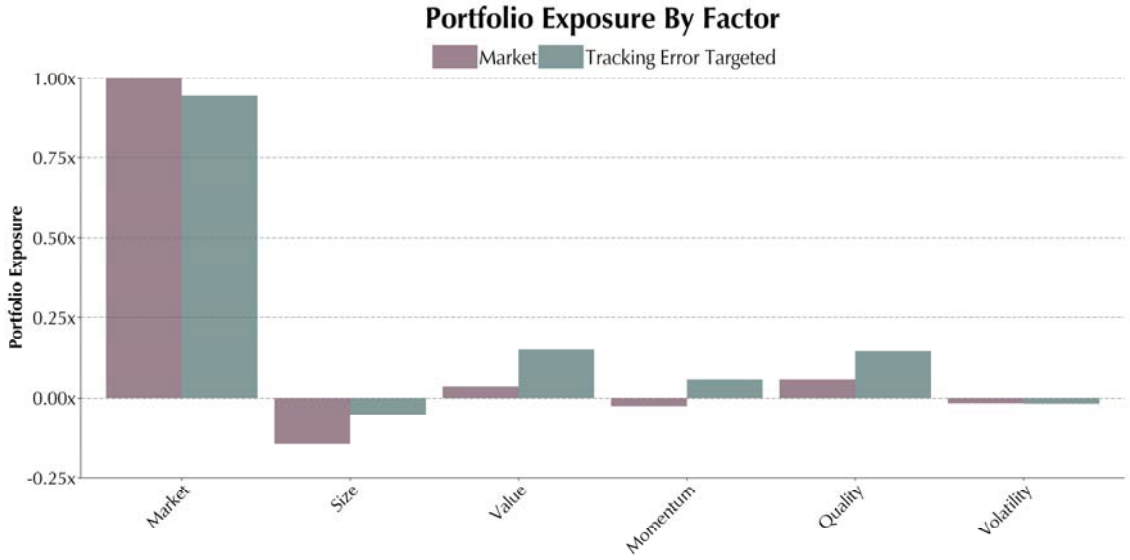
II. Tracking Error Targeted Case

Graph 50. Tracking Error Targeted Case – Rolling Performance



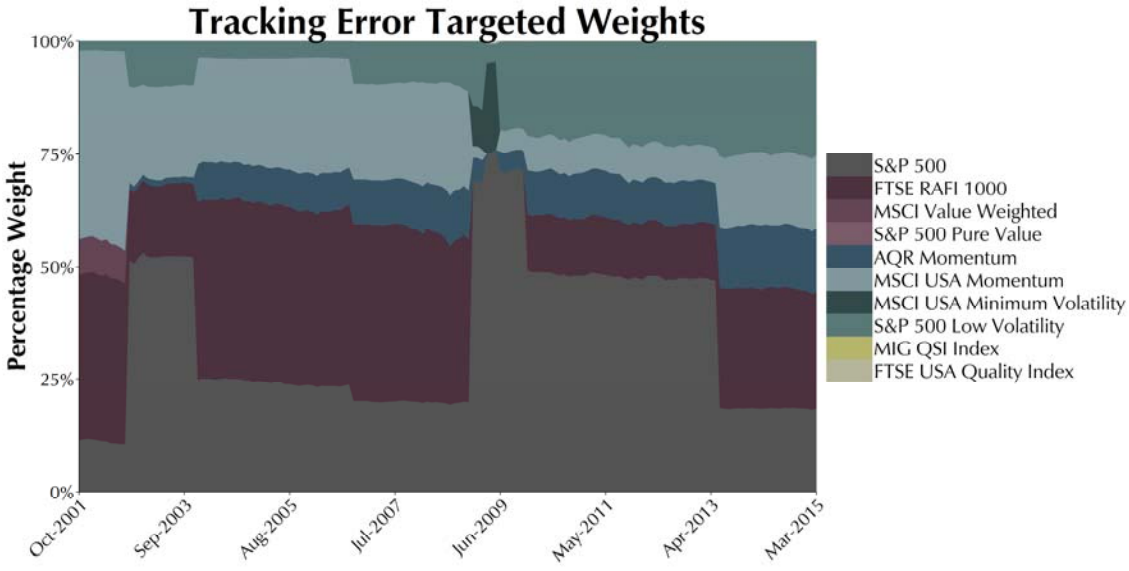
Looking at rolling 3 year periods we can see consistent strong outperformance and only five periods of underperformance.

Graph 51. Tracking Error Targeted Case - Portfolio Exposures



The tracking error targeted portfolio investment also provides a more balanced exposure to factors. We see again that by reducing market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

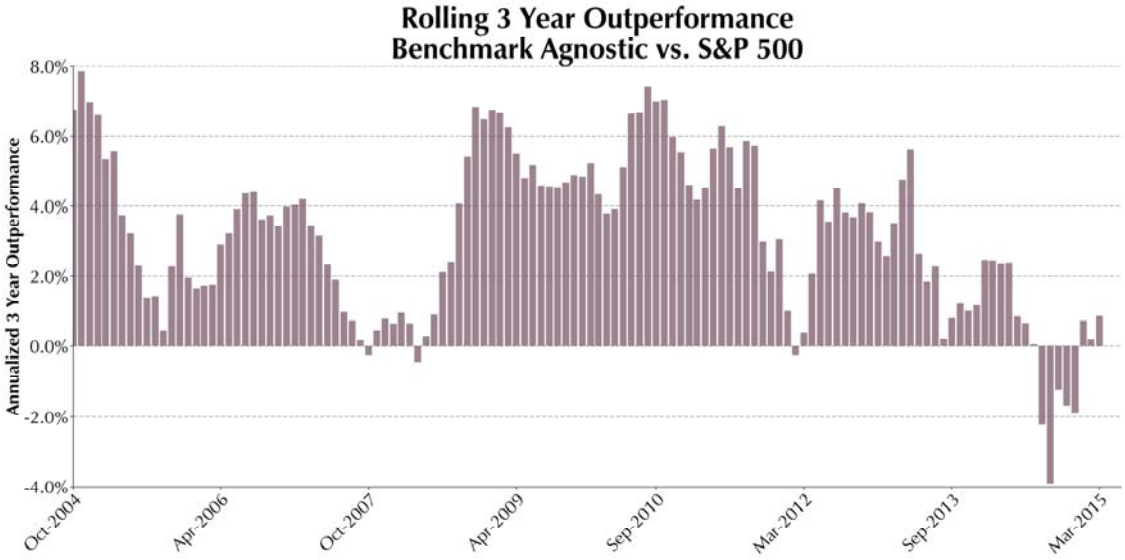
Graph 52. Tracking Error Targeted Case - Portfolio Weights



By not caring about tracking error but not about holding the market index we observe that the portfolio has the freedom to allocate to value, momentum, and low volatility indices and at times be able to reduce allocations to the market index to less than 25%.

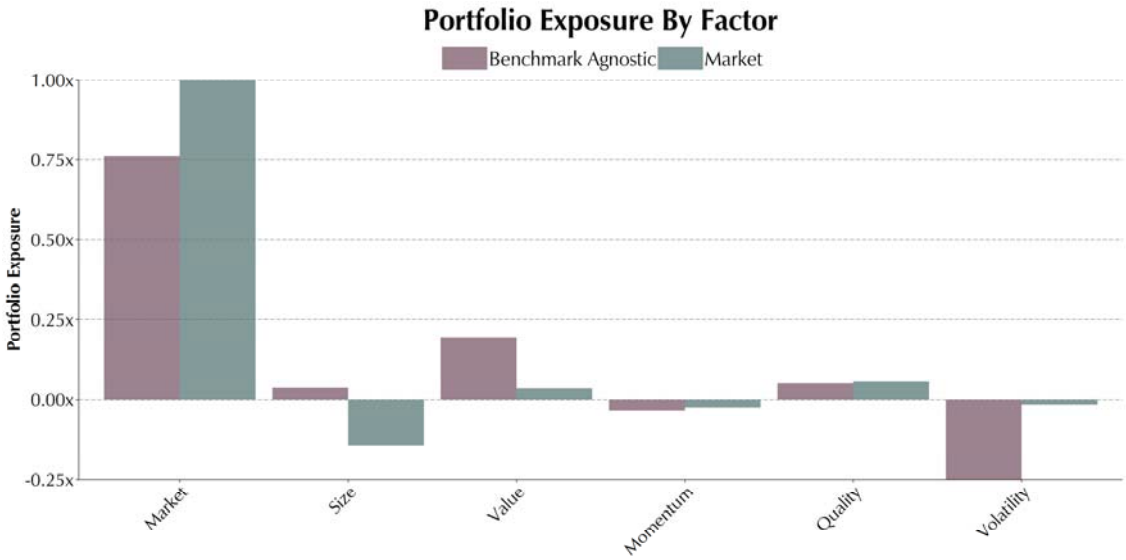
III. Benchmark Agnostic Case

Graph 53. Benchmark Agnostic Case – Rolling Performance



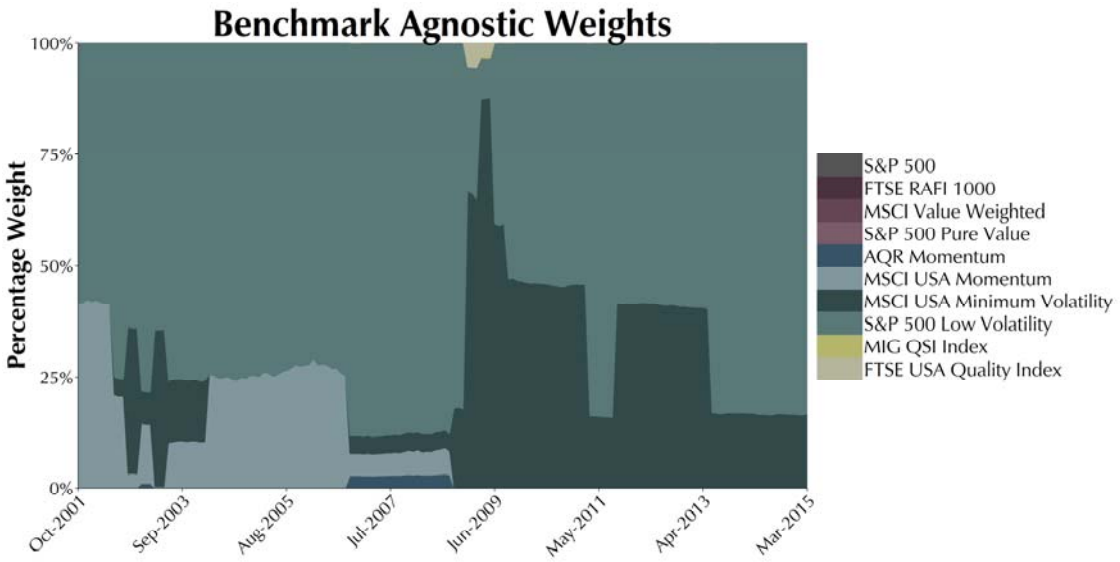
Looking at rolling 3 year periods, we can see consistent strong outperformance with only eight periods of underperformance. However, one rolling 3-year period underperformed by almost 4%.

Graph 54. Benchmark Agnostic Case - Portfolio Exposures



The benchmark agnostic case portfolio investment provides the most balanced exposure to factors of all three cases while still maintaining close to 75% market exposure. The factor exposure theme continues with reducing market exposure, the portfolio achieves better exposures to all factors: higher exposures to Value, Momentum, Low Volatility, and Quality, with lower exposures to Large Size.

Graph 55. Benchmark Agnostic Case - Portfolio Weights



By not being sensitive to tracking error and holding the market vehicle, outperformance is achieved without having exposure to the market vehicle, and allocating almost exclusively to a combination of Momentum and Low Volatility alternative beta indices.