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NEUBERGER BERMAN

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# Improving Diversification by Adding Momentum

While all prudent investors consider the risk of capital loss when making investment decisions, the methods employed to manage that risk can vary widely. Positions in more "defensive" assets such as bonds or gold, market-timing strategies and investing in volatility products such as options are just a few of the approaches investors have taken in an attempt to protect their portfolios from a market drawdown. Each of these comes with pros and cons, of course, along with associated implicit or explicit costs that must be considered.

In this paper we offer momentum strategies as a potential option for investors looking to balance risk mitigation with cost considerations and return potential. We discuss the characteristics of momentum strategies, the role they may play in a diversified portfolio and their historical performance across market environments. We use the Neuberger Berman Breton Hill Velocity strategy as an illustration of how momentum strategies may be brought together in a single strategy that seeks to generate return in most market environments while also seeking to protect capital during periods of stress.

**What is Momentum?**

While for decades momentum has been one of the most common market phenomena harvested by investors, it was not formally documented until the 1993 publication of a seminal paper by Jegadeesh and Titman[1]. Subsequent research has delved into various explanations for the momentum effect, with much of it focusing on cognitive biases such as herd mentality (making investment decisions based on those of other investors), anchoring (using an initial set of data to make subsequent judgments) and other risk premia-based explanations. At its core, momentum—both positive and negative—reflects a feedback loop: The strong get stronger and the weak get weaker. A positive feedback loop may be more likely to develop at times when the future is uncertain and information asymmetry is high, as it is reasonable to think that others are acting on information unknown to the broader market; in fact, this is the basis of many of the behavioral explanations behind the momentum effect.

The "traditional" measure of momentum, as used by Jegadeesh and Titman and by academics and researchers since that time, is simply the 11-month return of an asset (equities, currencies, commodities and rates) from 12 months prior to one month prior. For example, on December 31, 2017, the momentum of a given return series would be measured as the return from December 31, 2016, through November 30, 2017, ignoring the most recent month of returns[2]. While this time-series approach remains a classic measure of momentum, countless other permutations and definitions have emerged over time as investors seek to profit from "trends." These range from simple alternate time-series definitions that adjust the measurement period (to three or six months, say) to more sophisticated machine-learning algorithms seeking to predict future price movements of an asset based on historical patterns.

An important distinction to make, however, is the difference between absolute momentum strategies and relative momentum strategies. The main difference between these two is that absolute momentum strategies bet on the persistence of directional trends (often referred to as "trend following"), while relative momentum strategies bet on winners continuing to outperform losers within a universe ("cross-sectional momentum"). Figure 1 below highlights additional differences between these two types of momentum strategies. As you can see, while the two approaches embrace a similar philosophy—buy winners and sell losers—their methodologies and risk profiles are quite different. It thus stands to reason that their performance and risk characteristics would be complementary.

**FIGURE 1. ABSOLUTE MOMENTUM VS. RELATIVE MOMENTUM STRATEGIES**

| | Absolute Momentum | Relative Momentum |
|---|---|---|
| Characteristic | Trend-following | Cross-sectional momentum |
| Intuition | Assets with positive (or negative) performance trends in the past will continue to experience positive (or negative) performance in the future | Winners will continue to outperform losers within a given universe (this can be applied at the asset class level or the security level) |
| Sample Methodology | Buy assets with attractive momentum, sell assets with unattractive momentum | Rank all assets within a given universe based on momentum; buy the high-ranked assets and short the low-ranked ones |
| Typical Instruments: Equities | Index-based instruments, such as futures on S&P 500, FTSE or TOPIX | Individual securities |
| Net Directional Exposure | Can vary between long or short | Typically managed to be close to zero |
| Performance Profile | Performs well during extreme market movements in either direction but exhibits particularly attractive performance relative to traditional asset classes during extreme bear markets | Generally can profit when there is high and persistent dispersion across securities independent of market conditions given low directional exposure |
| Risk | Performance tends to be flat in less-extreme market environments | Prone to deep corrections when there is a reversal in market leadership |
| Skew | Positive | Slightly positive to slightly negative |

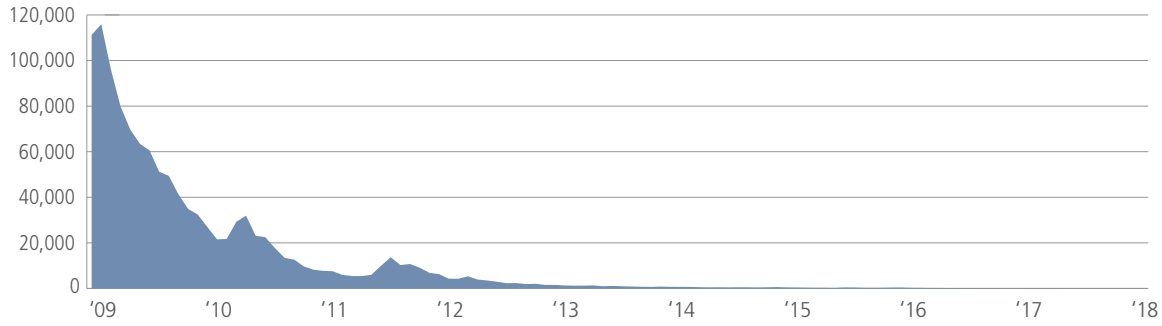
Source: Neuberger Berman. The above is intended only as an example. Methodologies can and do vary widely, as do the instruments typically employed in these strategies.

[1] "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," Narasimhan Jegadeesh and Sheridan Titman, *Journal of Finance*, March 1993.
[2] Most academics use this 2-12 momentum methodology and ignore the most recent month of returns due to avoid a short-term reversal effect.

Combining the above two programs efficiently in a fund has several benefits, namely providing diversification in the tails. Tail protection can be achieved using the above methodology that uses diversifying strategies or buying protection using options. However, since the financial crisis an investor would have lost close to 100% of capital by implementing the exposure solely through options. The chart below shows the performance of the S&P 500 Short-Term VIX Futures Total Return Index (VXX).

**FIGURE 2. LONG VOLATILITY HAS BEEN A LOSING POSITION OVER THE PAST 10 YEARS**

S&P 500 Short-Term VIX Futures Total Return Index (VXX)




Source: Bloomberg. Investing entails risks, including possible loss of principal. **Past performance is no guarantee of future results.** See Additional Disclosures at the end of this piece, which are important part of this presentation.

While some general observations about absolute and relative momentum strategies were provided in Figure 1, let's examine the empirical evidence of how these strategies have performed in different market scenarios. For the purposes of this analysis we use the SG Trend Index as a measure of absolute momentum and the Fama-French Global Momentum Factor data series as a proxy for relative momentum[3]. Figure 3 presents selected annual index returns for stocks, bonds, a 60/40 stock/bond portfolio and these two measures of momentum since 2007, as well as their correlations to one another. As you can see, down equity markets resulted in either one or both of the momentum strategies producing positive returns. Moreover, the correlation of the two momentum strategies relative to equities is zero to negative, while the correlation between the two momentum strategies is moderately positive but still low at 0.33.

**FIGURE 3. ANNUAL RETURNS AND CORRELATIONS**

| Annual Return | MSCI World Index (Net) | Barclays Global Aggregate Index | 60/40 Portfolio | Absolute Momentum (SG Trend) | Relative Momentum (Fama French Momentum) |
|---|---|---|---|---|---|
| 2007 | 9.04% | 9.48% | 9.36% | 8.58% | 18.62% |
| 2008 | -40.71% | 4.79% | -24.85% | 20.88% | 13.86% |
| 2009 | 29.99% | 6.93% | 20.71% | -4.80% | -39.27% |
| 2010 | 11.76% | 5.54% | 9.63% | 13.13% | 13.42% |
| 2011 | -5.54% | 5.64% | -0.94% | -7.93% | 7.60% |
| 2012 | 15.83% | 4.32% | 11.26% | -3.52% | 3.88% |
| 2013 | 26.68% | -2.60% | 14.18% | 2.67% | 17.87% |
| 2014 | 4.94% | 0.59% | 3.23% | 19.70% | 1.32% |
| 2015 | -0.87% | -3.15% | -1.57% | 0.04% | 16.26% |
| 2016 | 7.51% | 2.09% | 5.49% | -6.14% | -10.02% |
| 2017 | 22.40% | 7.39% | 16.20% | 2.20% | 8.36% |

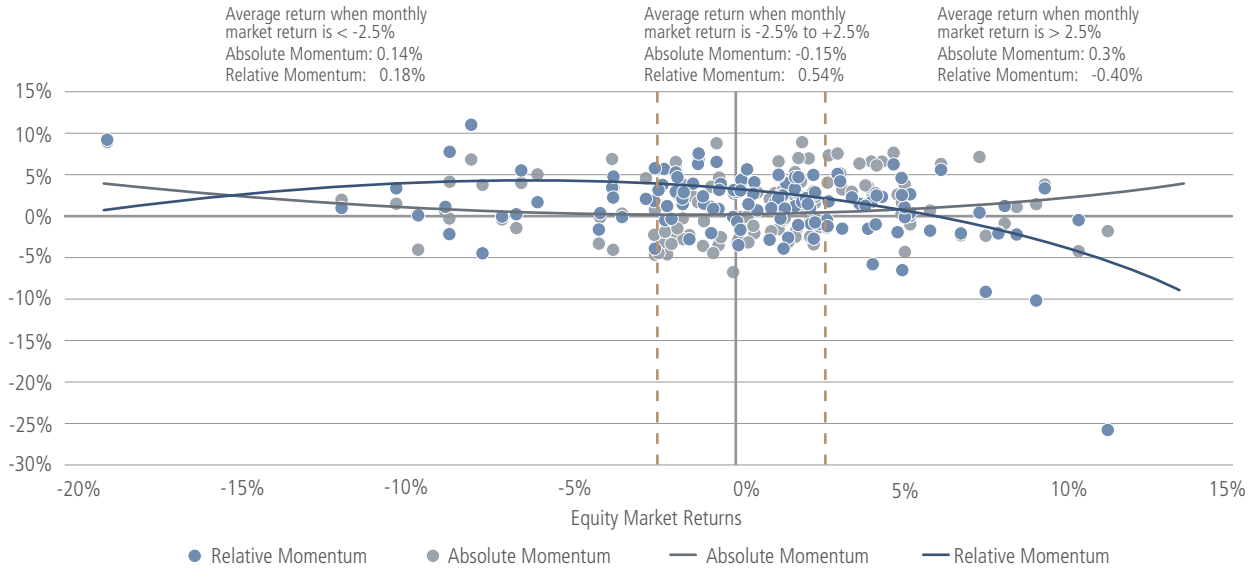
[3] The SG Trend Index is a cross-asset indicator and is an equal-weighted index track the largest CTA's. The Fama-French Global Momentum Factor is an equal weighted average of the returns of the winner's portfolio minus the average return of the loser's portfolio and is available from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

| Correlations | MSCI World Index (Net) | Barclays Global Aggregate Index | 60/40 Portfolio | Absolute Momentum (SG Trend) | Relative Momentum (Fama French Momentum) |
|---|---|---|---|---|---|
| MSCI World Index | 1.00 | | | | |
| Barclays Global Aggregate Index | 0.40 | 1.00 | | | |
| 60/40 Portfolio | 0.98 | 0.57 | 1.00 | | |
| Absolute Momentum (SG Trend) | 0.01 | 0.15 | 0.04 | 1.00 | |
| Relative Momentum (Fama French Momentum) | -0.37 | -0.17 | -0.37 | 0.33 | 1.00 |

Source: Bloomberg. All returns are gross of fees unless otherwise indicated. Investing entails risk, including possible loss of principal. Indexes are unmanaged and are not available for direct investment. **Past performance is no guarantee of future results.** 60/40 Portfolio consists of 60% MSCI World Index and 40% Bloomberg Barclays Global Aggregate Index and is rebalanced monthly.

In Figure 4 we look at the monthly returns for the MSCI World Index and the performance for the two momentum approaches during these periods. As seen from Figure 3, both relative and absolute momentum provide needed diversification when markets sell off. Perhaps more important, a combination of the two strategies would provide some level of diversification when markets are range-bound. Absolute and relative momentum historically have provided positive results during a market selloff, with absolute momentum doing better when there is a prolonged and deep drawdown.

**FIGURE 4. PERFORMANCE OF MOMENTUM STRATEGIES ACROSS EQUITY MARKET ENVIRONMENTS**
(Based on Monthly Returns from January 2007 to December 2017)

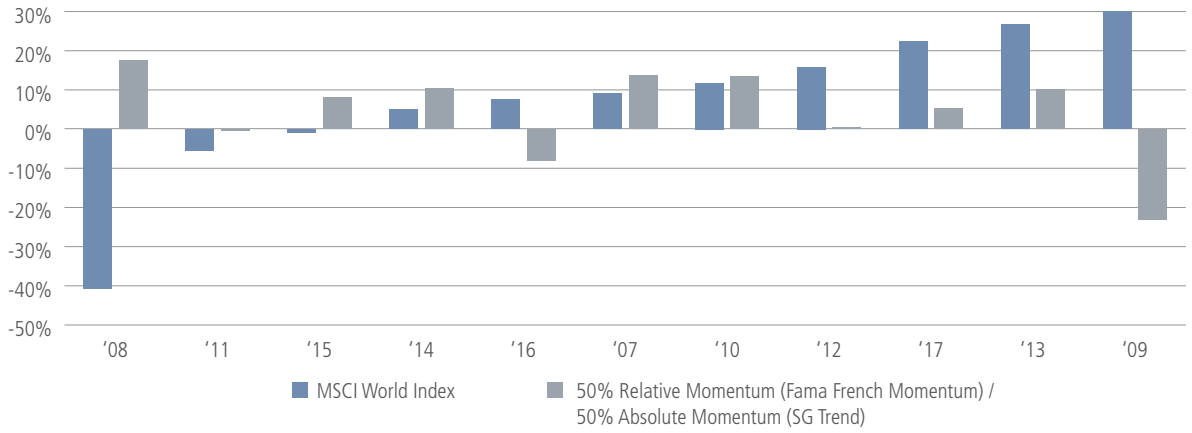



| | | Monthly MSCI World Index Returns | | |
|---|---|---|---|---|
| | | < -2.5% | -2.5% to 2.5% | > 2.5% |
| Distribution (%) | | 15 | 57 | 28 |
| Average monthly returns | Absolute (Trend) | 0.14% | -0.15% | 0.36% |
| | Relative (Cross-Sectional) | 0.19% | 0.54% | -0.40% |
| % of months positive | Absolute (Trend) | 55 | 47 | 65 |
| | Relative (Cross-Sectional) | 60 | 73 | 46 |

Source: Bloomberg and Dartmouth.

The chart below highlights the yearly performance of a 50/50 portfolio composed of absolute and relative momentum strategies, rebalanced monthly, arranged according to the performance of the MSCI World Index from worst to best. This combination has had a low to negative correlation to equities, particularly when the market sells off.

**FIGURE 5. MOMENTUM TYPICALLY DEMONSTRATES A LOW TO NEGATIVE CORRELATION TO EQUITIES**




Source: Bloomberg and Dartmouth.

**NB Breton Hill Velocity Strategy**

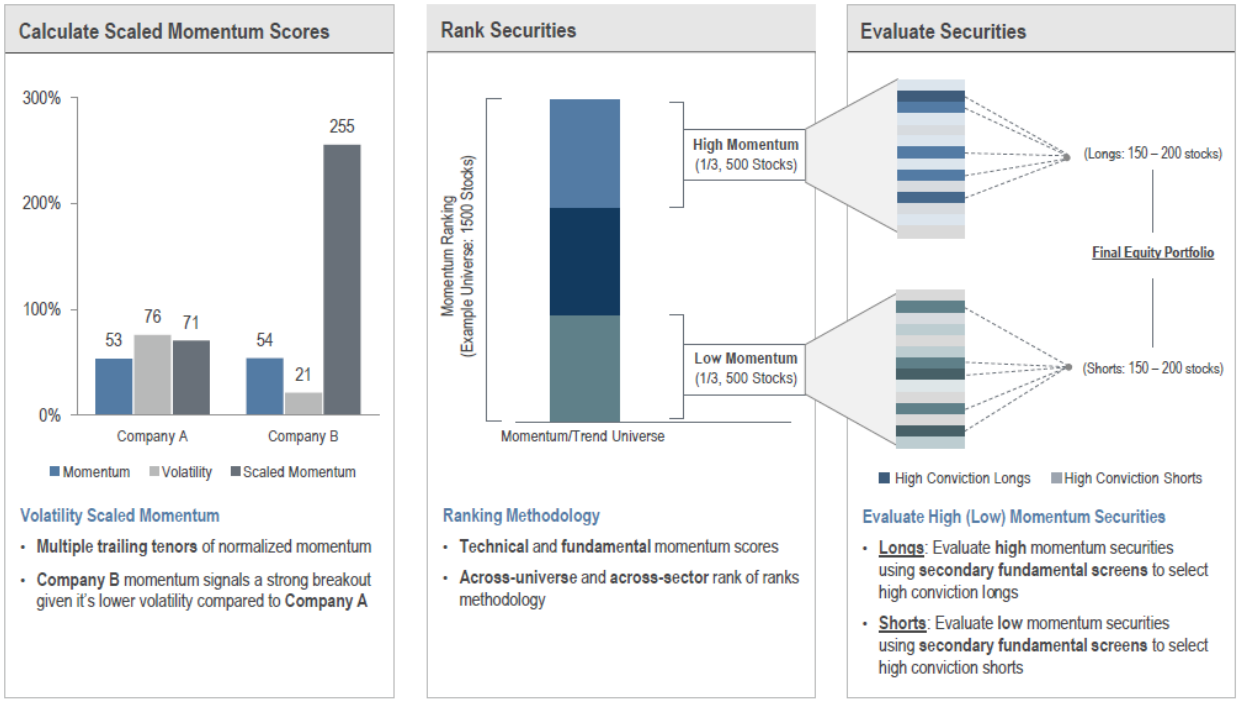
Our cursory analysis suggests that the inclusion of absolute and relative momentum strategies in a broad portfolio may offer diversification benefits and added return potential. This is precisely the objective of the NB Breton Hill Velocity strategy. Building upon the team's years of experience managing a variety of trend-following and cross-sectional momentum strategies, we believe a consolidated strategy that can benefit from the complementary hedging and diversification properties of each is the optimal approach to including them in a portfolio. From an implementation efficiency perspective, both strategies can be funded with a single allocation since futures trend-following is highly capital efficient. This also means that investors can minimize overhead costs and pay a single management fee rather than separate management and operational fees.

We employ a four-step process to assemble a diversified portfolio of securities that seeks to produce an attractive, positively convex payoff structure in both rising and declining equity markets:

1. Specify Signals
2. Rank Securities
3. Select Securities
4. Implement and Trade

To define the universe of our momentum signals, we use a multidimensional approach that seeks to include a diversified array of indicators, including fundamental and technical sources of momentum as well as absolute and relative measures of momentum. First, we calculate a scaled momentum score for every security in the investable universe and rank the securities based on this score. Whereas some momentum managers at this point might turn their attention to only the top and bottom thirds of the rankings—as potential buys and potential shorts, respectively—we drill down further within these tertiles, applying additional screens to identify securities that are experiencing fundamental changes and to weed out those whose prices may be driven by speculation. The systematic application of a second layer of fundamental analysis enables us to seek to avoid pitfalls with securities that may be prone to speculative price actions. Figure 6 provides an overview of our process.

**FIGURE 6: SELECTING SECURITIES USING "RANK OF RANKS" APPROACH**




For illustrative and discussion purposes only. This material is intended as a broad overview of the Portfolio Manager's style, philosophy and process, and is subject to change without notice. The use of tools cannot guarantee performance. Investing entails risks, including possible loss of principal. See Additional Disclosures at the end of this piece, which are an important part of this material.

### Neuberger Berman Breton Hill Velocity Strategy Profile

In Figure 7 we present the results for the hypothetical Neuberger Berman Breton Hill ("NB BH") Velocity Model Portfolio for the period January 2007 through December 2017. We compare this to various traditional asset classes and to the performance of the SG Trend Index.

**FIGURE 7. SUMMARY STATISTICS (HYPOTHETICAL BACKTESTED PERFORMANCE)[4]**
(Based on Monthly Returns from January 2007 to December 2017)

| | MSCI World Index (Net) | Barclays Global Aggregate Index | NB BH Velocity Model Portfolio[4] | SG Trend Index |
|---|---|---|---|---|
| Annualized Return | 5.39% | 3.66% | 7.90% | 3.63% |
| Annualized Volatility | 15.75% | 5.69% | 9.38% | 11.43% |
| Sharpe Ratio | 0.34 | 0.64 | 0.84 | 0.32 |
| Max Drawdown | -54.03% | -10.08% | -15.38% | -17.82% |
| Skewness | -0.82 | -0.16 | -0.08 | 0.13 |

Source: Bloomberg.
[4] Model portfolio returns are shown net of management fee (0.75% per annum) and estimated transaction costs.
All returns are gross of fees unless otherwise indicated.
PLEASE SEE "HYPOTHETICAL BACKTESTED PERFORMANCE DISCLOSURES" AT THE END OF THIS MATERIAL. These results are shown on a supplemental basis. Investing entails risks, including possible loss of principal. Indexes are unmanaged and are not available for direct investment. **Past performance is no guarantee of future results.**

In addition, this combined strategy historically has provided attractive diversification benefits to traditional asset classes and portfolios. For example, adding the hypothetical NB Breton Hill Velocity Model Portfolio to a traditional 60/40 portfolio of stocks and bonds (Figure 8) results in a higher risk-adjusted return as an enhancement in return is coupled with lower volatility.

**FIGURE 8. HYPOTHETICAL STATISTICS OF MODEL PORTFOLIOS (HYPOTHETICAL BACKTESTED PERFORMANCE)[5]**
(Based on Monthly Returns from January 2007 to December 2017)

| | 60/40 Portfolio | 80% 60/40 Portfolio + 20% NB BH Velocity Model[5] |
|---|---|---|
| Annualized Return | 4.97% | 5.71% |
| Annualized Volatility | 10.56% | 8.68% |
| Sharpe Ratio | 0.47 | 0.66 |

60/40 portfolio consists of 60% MSCI World Index and 40% Bloomberg Barclays Global Aggregate Index and is rebalanced monthly.

If we dig a bit deeper into the return profile of a traditional 60/40 portfolio as compared to Trend strategies and the NB Breton Hill Velocity Model Portfolio, we see that these strategies are attractive potential hedges against periods of significant equity declines.

**FIGURE 9. NB BRETON HILL VELOCITY STRATEGY PERFORMANCE ACROSS DIFFERENT EQUITY MARKET SCENARIOS (HYPOTHETICAL BACKTESTED PERFORMANCE)[5]**

(Based on Monthly Returns from January 2007 to December 2017)

| MSCI World Index Return | # of Months | MSCI World Index (Net) | Barclays Global Aggregate Index | 60/40 Portfolio | SG Trend Index | NB BH Velocity Model Portfolio[5] | 80% 60/40 Portfolio + 20% NB BH Velocity[5] |
|---|---|---|---|---|---|---|---|
| < -5% | 13 | -9.11% | -0.65% | -5.73% | 1.32% | **-0.19%** | -4.62% |
| -5% to 0% | 39 | -1.81% | 0.17% | -1.01% | -0.75% | **1.14%** | -0.58% |
| 0% to 5% | 61 | 2.08% | 0.33% | 1.38% | 1.08% | **0.73%** | 1.25% |
| > 5% | 19 | 7.05% | 1.20% | 4.71% | -0.37% | **0.10%** | 3.79% |

Finally, we examine some of the largest drawdowns in the equity markets since 2007. Figure 10 details the performance of traditional asset classes, traditional CTAs and the NB Breton Hill Velocity Model Portfolio during these periods, as well as various portfolio blends of these return series.

**FIGURE 10. STRATEGY PERFORMANCE DURING DRAWDOWNS (HYPOTHETICAL BACKTESTED PERFORMANCE)[6]**

| Start of MSCI World Index Drawdown | End of MSCI World Index Drawdown | MSCI World Index (Net) | Barclays Global Aggregate Index | NB BH Velocity Model Portfolio[6] | 60/40 Portfolio | 80% 60/40 Portfolio + 20% NB BH Velocity[6] | SG Trend Index |
|---|---|---|---|---|---|---|---|
| 5/31/2007 | 8/31/2007 | -3.04% | 2.83% | -4.66% | -0.71% | -1.51% | -9.42% |
| 10/31/2007 | 2/27/2009 | -54.03% | 0.69% | 8.37% | -36.40% | -28.97% | 21.58% |
| 8/29/2014 | 1/30/2015 | -3.51% | -3.95% | 24.12% | -3.68% | 1.46% | 21.38% |
| 5/29/2015 | 2/29/2016 | -11.96% | 2.28% | 17.17% | -6.19% | -1.80% | 3.71% |

Source: Bloomberg and Neuberger Berman.

[5] Model portfolio returns are shown net of management fee (0.75% per annum) and estimated transaction costs.
All returns are gross of fees unless otherwise indicated.
PLEASE SEE "HYPOTHETICAL BACKTESTED PERFORMANCE DISCLOSURES" AT THE END OF THIS MATERIAL. The results are shown on a supplemental basis. Investing entails risks, including possible loss of principal. Indexes are unmanaged and are not available for direct investment. **Past performance is no guarantee of future results.**

The average correlations (Figure 11) of the NB Breton Hill Velocity Strategy to traditional markets are low. Over the last 10 years, we've had a significant spike in the equity markets and bonds have rallied as interest rates moved lower. If an investor has a view that we are in a rising-rate environment in which bonds will not fare well on an absolute-return basis, using momentum strategies may mitigate some of the losses from increasing rates while providing broad diversification.

**FIGURE 11. LOW CORRELATIONS TO STOCKS AND BONDS (HYPOTHETICAL BACKTESTED PERFORMANCE)[6]**

| | MSCI World Index (Net) | Barclays Global Aggregate Index | NB BH Velocity Model Portfolio[6] | Fama French Global Momentum | SG Trend Index |
|---|---|---|---|---|---|
| MSCI World Index | 1.00 | | | | |
| Barclays Global Aggregate Index | 0.40 | 1.00 | | | |
| NB BH Velocity Model Portfolio | 0.02 | 0.00 | 1.00 | | |
| Fama French Global Momentum | -0.37 | -0.17 | 0.51 | 1.00 | |
| SG Trend Index | 0.01 | 0.15 | 0.54 | 0.33 | 1.00 |

Source: Bloomberg, Neuberger Berman and Dartmouth.

### Summary

Finally, we conclude by emphasizing that risk management is an important consideration, particularly in momentum strategies. Compared to other risk premia—such as value—that may be slower to shift directionally, momentum signals can reverse course in a relatively short period of time. Further, a manager's trading experience is critically important to translating a strategy from research to implementation; without the appropriate calibration of the research process to take into account trading costs, turnover and leverage, the potential alpha of a strategy can be quickly eroded in implementation.

Bringing this all together, we believe that a thoughtfully designed, diversified approach to capturing various expressions of momentum can help actively manage drawdowns while also participating in the upside during volatile markets.

[6] Model portfolio returns are shown net of management fee (0.75% per annum) and estimated transaction costs.
All returns are gross of fees unless otherwise indicated. PLEASE SEE "HYPOTHETICAL BACKTESTED PERFORMANCE DISCLOSURES" AT THE END OF THIS MATERIAL. The results are shown on a supplemental basis. Investing entails risks, including possible loss of principal. Indexes are unmanaged and are not available for direct investment.
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**Hypothetical Backtested Performance Disclosures**

The hypothetical performance results included in this material are of a backtested model portfolio that is shown for illustrative purposes only. The hypothetical results were calculated by running the model portfolio on a backtested basis using the stated methodologies and assumptions below. The results are shown on a supplemental basis and do not represent the performance of any Neuberger Berman managed account or product and do not reflect the fees and expenses associated with managing a portfolio. The results assume no withdrawals and reinvestment of any dividends and distributions. Standard fees applied are a management fee of 0.75% per annum and estimated transaction costs.

The following is a summary of the backtested methodology and assumptions for the NB BH Velocity Model Portfolio:

The NB BH Velocity Model Portfolio is constructed using the following approximate risk allocations: 40% Equities, 20% Commodities, 20% Currencies and 20% Multi-Asset Trend. Allocations in the current live NB BH Velocity strategy differ from the allocations represented in the NB BH Model Velocity Portfolio.

Hypothetical backtested returns have many inherent limitations. Unlike actual performance, they do not represent actual trading. Since trades have not actually been executed, results may have under- or over-compensated for the impact, if any, of certain market factors, such as lack of liquidity, and may not reflect the impact that certain economic or market factors may have had on the decision-making process. Hypothetical backtested performance also is developed with the benefit of hindsight. Other periods selected may have different results, including losses. There can be no assurance that Neuberger Berman will achieve profits or avoid incurring substantial losses. Neuberger Berman managed accounts in the manner reflected in the models during a portion of the backtested time periods shown.

Unless otherwise indicated, results shown reflect reinvestment of any dividends and distributions. The hypothetical performance figures are shown gross of fees, which do not reflect the deduction of investment advisory fees and other expenses. If such fees and expenses were reflected, returns referenced would be lower. Advisory fees are described in Part 2 of NB BH's Form ADV. A client's return will be reduced by the advisory fees and any other expenses it may incur in the management of its account. The deduction of fees has a compounding effect on performance results. For example, assume Neuberger Berman achieves a 10% annual return prior to the deduction of fees each year for a period of 10 years. If a fee of 1% of assets under management were charged and deducted from the returns, the resulting compounded annual return would be reduced to 8.91%. Please note that there is no comparable reduction from the indices for the fees.

**Additional Disclosures**

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The **CBOE S&P 500 Volatility Index® (VIX)** is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Since its introduction in 1993, VIX has been considered by many to be the world's premier barometer of investor sentiment and market volatility. Several investors expressed interest in trading instruments related to the market's expectation of future volatility, and so VIX futures were introduced in 2004, and VIX options were introduced in 2006.

The **MSCI World (Net) Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets. The MSCI World Index consists of the following 23 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Net total return indexes reinvest dividends after the deduction of withholding taxes, using (for international indexes) a tax rate applicable to non-resident institutional investors who do not benefit from double taxation treaties. Net total return indexes reinvest dividends after the deduction of withholding taxes, using (for international indexes) a tax rate applicable to non-resident institutional investors who do not benefit from double taxation treaties.

The **Bloomberg Barclays Global Aggregate Index** provides a broad-based measure of the global investment-grade fixed income markets. The three major components of this index are the Bloomberg Barclays U.S. Aggregate, the Bloomberg Barclays Pan-European Aggregate and the Bloomberg Barclays Asian-Pacific Aggregate Indices. The index also includes Eurodollar and Euro-Yen corporate bonds, Canadian government, agency and corporate securities, and USD investment grade 144A securities.

The **SG Trend Index** is equal-weighted and reconstituted annually by SG Prime Services. The index calculates the net daily rate of return for a pool of trend-following based hedge fund managers and is designed to track the largest trend-following CTAs and be representative of the trend followers in the managed futures space.

Client accounts are individually managed and may vary significantly from composite performance and representative portfolio information.

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Effective as of November 1, 2017, Breton Hill Capital Ltd. was acquired by Neuberger Berman and, in connection with the transaction, its name was changed to Neuberger Berman Breton Hill ULC.

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