Are Defensive Stocks Expensive? A Closer Look at Value Spreads

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For several years, many investors have been concerned about the apparent rich valuation of defensive stocks. We analyze the prices of these stocks using value spreads and find that they are not particularly expensive today.

Moreover, valuations may have limited efficacy in *predicting* strategy returns. This piece lends insight into possible reasons by focusing on the *contemporaneous* relation (i.e., how changes in value spreads are related to returns over the same period).

We highlight a puzzling case where a defensive long/short strategy performed well during a recent two-year period when its value spread normalized from abnormally rich levels. For most asset classes, cheapening valuations coincide with poor performance. However, this relationship turns out to be weaker for long/short factor portfolios where several mechanisms can loosen the presumed strong link between value spread changes and strategy returns. Such wedges include changing fundamentals, evolving positions, carry and beta mismatches. Overall, investors should be cognizant of the tenuous link between value spreads and returns.

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Introduction

Are defensive stocks expensive? Yes, mildly, taking a 20-year perspective. The bigger question is whether investors should be concerned about the valuations of defensive stocks when considering an allocation to the style.[1] Preliminary evidence suggests only a tenuous link between valuations and returns for style premia.[2] The predictive relation appears modest.[3] Here we document an even more basic failure: the contemporaneous relation between value spread changes and realized returns is weaker than many investors may expect (a contemporaneous relation doesn't ask if wide or narrow value spreads predict future returns but asks if the change in value spread over any period is related to the strategy return over the same period). For illustration, we highlight the following case: we observe that at the end of 2012 defensive stocks[4] were abnormally expensive relative to their riskier peers, yet a beta-neutral defensive long/short (L/S) strategy outperformed in 2013-14 even as defensive stocks became cheaper. We explore this puzzling result — buying a rich investment, seeing it cheapen, and yet making money — in more detail below. We leave the topic of predictive relations for future research.

We start by introducing the concept of value spreads. Value measures quantify the cheapness of a long-only single asset or portfolio relative to a fundamental anchor. For a style factor such as defensive, an equivalent measure of cheapness is the value spread which is the difference in value measures between the long and short sides of the factor portfolio.[5] The value spread of a style "widens" when the differential widens and the style grows relatively cheaper, and it "narrows" when the style becomes relatively richer. On standardizing these spreads, a positive value spread indicates the style is cheaper than its historical average, while a negative value spread indicates the style is expensive compared with its history.

Asset valuations are traditionally used in asset class timing or tactical asset allocation. If an asset is abnormally cheap relative to its history, one might expect it to ultimately revert to its mean, generating positive returns in the process. This rationale may be extended to timing styles — if value spreads for a style are wider than normal, they are more likely to converge to their normal range, implying that the long assets are likely to outperform. On the other hand, if spreads are narrower than their historical averages, it may indicate a crowded trade that is likely to underperform. Asness, Friedman, Krail and Liew (2000) and Cohen, Polk and Vuolteenaho (2003) find that over medium term horizons, the future return on value-minus-growth stock selection strategies is higher when the value spread is wider than normal.

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[1] For examples of thoughtful market observers advising caution on investing in the defensive style due to apparent overvaluation in 2012-13, see Knutzen (2013) and Swedroe (2013).

[2] Ilmanen, Israel and Moskowitz (2012) illustrate the existence of style premia across several asset classes and how to capture them. To recap:

- Value refers to the tendency for relatively cheap assets to outperform relative expensive ones.
- Momentum refers to the tendency for an asset's recent relative performance to continue in the near future.
- Carry refers to the tendency for higher-yielding assets to provide higher returns than lower-yielding assets.
- Defensive refers to the tendency for lower-risk-and higher-quality assets to generate higher risk-adjusted returns.

Hypothetical L/S style portfolios are formed by taking long positions in the assets with the strongest style attributes and short positions in the assets with the weakest style attributes. Further details are in **Appendix A**.

[3] For the U.S. low-beta style illustrated in this piece, correlations between the levels of value spreads and next-month returns are 0.1 for an industry-neutral L/S portfolio and -0.01 for a non-industry-neutral L/S portfolio, even when these use in-sample standardized value spreads that have the benefit of hindsight. Correlations may be higher over longer horizons.

[4] Specifically, defensive stocks are defined here as low-beta stocks, while risky stocks are defined as high-beta stocks, on a U.S. stock universe that is approximately the top 20th percentile ranked by market-cap and the top 15th percentile ranked by trading volume of U.S. stocks in MSCI Barra's GEM model universe. The portfolio is a hypothetical beta-neutral L/S portfolio that is long low-beta stocks and short high-beta stocks with stocks weighted proportionately to their betas and levered on the long side to be ex-ante beta-neutral. Returns are gross of fees and transaction costs, and excess of cash.

[5] This L/S value spread is applicable to both L/S and long-only factor portfolios. Alternatively, for long-only factors, one may define the value spread as the difference in value measures between the portfolio and the benchmark.

The efficacy of value spreads (and value measures) in predicting returns mainly relies on two assumptions.[6] One, value spreads will mean-revert, that is, valuations of the factor will converge to historical averages. Two, changes in valuations are primarily driven by prices, so that a richening asset or portfolio coincides with outperformance of that asset or portfolio.

Regarding the first assumption, it is not that easy to predict exactly when convergence will occur. As the Tech Bubble proved, mispricing can persist or intensify for a long time. As the saying goes, markets can stay irrational longer than you can remain solvent.

Moving to the second assumption, changes in value spreads and value measures alike can be caused not just by changes in prices but also by changes in fundamentals and portfolio composition. Many investors have a strong intuition that richening valuations should coincide with positive realized returns. This is true if rising asset prices are the cause of both richening valuations and high returns (e.g., a rising price leading to a lower B/P ratio). The strong intuition bears out in passive asset class portfolios whose constituents change infrequently, and we observe a typical contemporaneous correlation between monthly valuation changes and realized returns of **-0.9** (see **Exhibit 1**, with more detail in **Exhibit A1** in **Appendix A**). However, the correlation is weaker when mean-reverting prices are not the main driver of changes in value; which is more likely with factors whose portfolio composition changes more frequently.[7] For example, following a market crash, the constituents of an equity index portfolio are mostly the same with index weights affected only slightly. However, when a factor portfolio like momentum crashes, the "winner" stocks on the long side are no longer outperformers, resulting in a very different momentum portfolio the next period.

Exhibit 1: Contemporaneous Correlations Between Monthly Value (Spread) Changes and Realized Returns **(Summary of Empirical Evidence Over Multiple Decades in Exhibits A1-A3 in Appendix A)**

Typical (Median Correlation)	
Long-Only Assets	-0.9
Long/Short Factors	-0.3

Source: Refer to Exhibit A1-A3 in Appendix A for details. For Illlustrative purposes only.

Our empirical analysis focuses on a strategy that captures defensive stocks' relative performance most cleanly, without market-directional or industry exposures. In this case, we find value spreads between defensive and speculative stocks were unusually negative at the end of 2012 (indicating rich defensives) and subsequently reverted to cheaper levels in 2013-14. Oddly enough, during this period the beta-neutral low-minus-high-beta portfolio delivered strong positive performance. Given only mildly negative long-run correlations (**-0.1** to **-0.3**),[8] it is not unusual for normal random variation to cause the correlations to flip sign over a shorter window, and this is what happened with the low-beta style in 2013-14.

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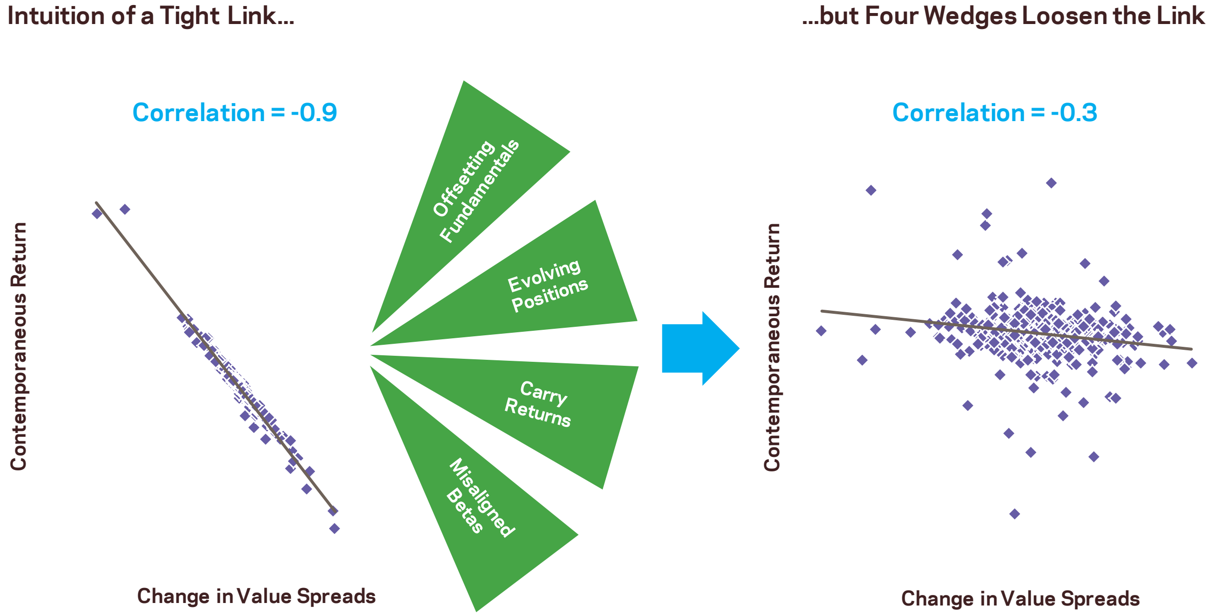
[6] Here, we ignore the effect of carry. Cheaper assets generally have higher yields, thus even if prices do not mean-revert, cheaper assets can be expected to outperform on a total-return basis through their higher yields. We analyze the impact of such carry advantage in our case study in **Exhibit 8.**

[7] As shown in **Exhibit A3** in **Appendix A**, we construct value spreads for Carry, Value, Momentum and Defensive L/S style portfolios in several macro asset classes and stock selection strategies across different regions. While the individual correlations between value spread changes and strategy returns vary between 0 and -0.7, the average correlation across asset classes is -0.47 for Carry, -0.38 for Value, -0.26 for Momentum and -0.25 for Defensive.

[8] Contemporaneous correlations between changes in value spreads and returns average -0.1 for the beta-neutral L/S (BAB) portfolio and -0.3 for the dollar-neutral L/S low-minus-high-beta portfolio. Refer to **Exhibit A2** in **Appendix A**.

Exhibit 2 – Wedges in the Tight Correlation Between Valuations and Realized Returns


Intuition of a Tight Link...
...but Four Wedges Loosen the Link
Correlation = -0.9
Contemporaneous Return
Change in Value Spreads
Offsetting Fundamentals
Evolving Positions
Carry Returns
Misaligned Betas
Correlation = -0.3
Contemporaneous Return
Change in Value Spreads

Source: AQR. A stylixed example, for Illlustrative purposes only.

We can reconcile this puzzle by examining several forces that drive a wedge into the expected relation between changing value spreads (or value measures for long-only assets) and returns. The net impact of these wedges varies, affecting style portfolios more than passive assets, and within styles, faster-moving Defensive and Momentum styles more than Value or Carry. For a stylized illustration, **Exhibit 2** visualizes the four wedges that we later address individually:

- *Fundamentals may be offsetting:* Value spread may change through changing fundamentals only (resulting from news or financial reporting), as opposed to through changing prices. For example, if earnings (E) go up only on expensive stocks, then the P/E of expensive stocks will go down, and the spread between cheap and expensive narrow, all with no need for a price change. If value spreads have some ability to predict relative earnings growth as well as future relative returns, changing fundamentals are more likely to offset than reinforce the return impact of value spread changes.
- *Evolving positions:* Portfolio holdings change over time (more so in faster-moving portfolios). Portfolio returns at a given time depend on the price appreciation and carry of initial (not current) holdings, but the value spread at a given time uses current portfolio positions. Thus, a portfolio may cheapen by trading out of richer stocks and into cheaper stocks when it is rebalanced, without any direct implications for portfolio returns.[9]
- *Carry returns:* Portfolio returns include carry (income or dividends) besides price changes, while the value spreads incorporate only changing prices.

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[9] We find that the contemporaneous correlation to returns is slightly higher in magnitude if calculating value spreads using the same portfolio holdings as the last period (i.e. the same portfolio on which returns are realized). Specifically, this correlation increases from -0.12 to -0.23 for the beta-neutral L/S (BAB) portfolio and from -0.31 to -0.37 for the dollar-neutral L/S low-minus-high-beta portfolio.

- *Misaligned betas:* The portfolio may target beta-neutrality. On the other hand, the value spread will generally have a net non-zero beta as, by construction, it is the difference between the value measures of a dollar each of the long and short assets. Thus the value spread could indicate cheapening or richening driven by its beta to the market, while the L/S portfolio returns would not fluctuate with the market. In the particular case of our study, this wedge has the biggest impact.

We stress that our empirical analysis is about contemporaneous relations and not about predictive relations. A future paper will attempt to provide direct evidence about the efficacy of value spreads in predicting future style returns, covering several styles and over multiple horizons. Another important topic not covered here is that if defensive stocks are expensive in a harmful way, certain portfolio construction techniques can mitigate the problem.[10]

We start by describing the methodology we use. For the subset of readers interested in more information about the construction, behavior and use of value spreads, we provide extensive further detail in **Appendices A-C**.

Methodology

Constructing Value Spreads

We define the value spread of a L/S factor portfolio as the difference between the weighted average valuations of the long and short sides of the portfolio.[11] We construct value spreads based on five equity value measures,[12] namely, forward-earnings-to-price (FEP), trailing earnings-to-price (EP), book-to-price (BP), operating-cash flow-to-enterprise value (CFOP) and sales-to-enterprise-value (SP). We standardize each series relative to its history by taking in-sample z-scores and then create a composite value spread that is an equal weighted average of the five standardized series. Finally we standardize the composite again using an in-sample Z-score.[13] The composite value spread thus created is a more holistic measure of value than any single measure.

The Betting-Against-Beta Factor

We construct value spreads for a L/S defensive style portfolio of U.S. stocks. For simplicity, the defensive style is represented by a single factor, the betting-against-beta (BAB) factor,[14] as described in Frazzini and Pedersen (2014). Stocks with low beta have been found to deliver high risk-adjusted returns (Baker, Bradley and Wurgler (2010)). Frazzini and Pedersen (2014) attribute this outperformance to leverage aversion — leverage constrained investors bid up the prices of high-beta assets, causing them to have lower required returns and leading to higher required returns for low-beta assets.

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[10] For example, L/S portfolios may combine defensive with other factors including value (disagreement between factor portfolios will reduce the net positions in expensive defensive stocks), and long-only defensive portfolios may be constrained to have minimal exposures to other factors including value (a binding constraint would make the portfolio tilt toward less expensive defensive stocks).

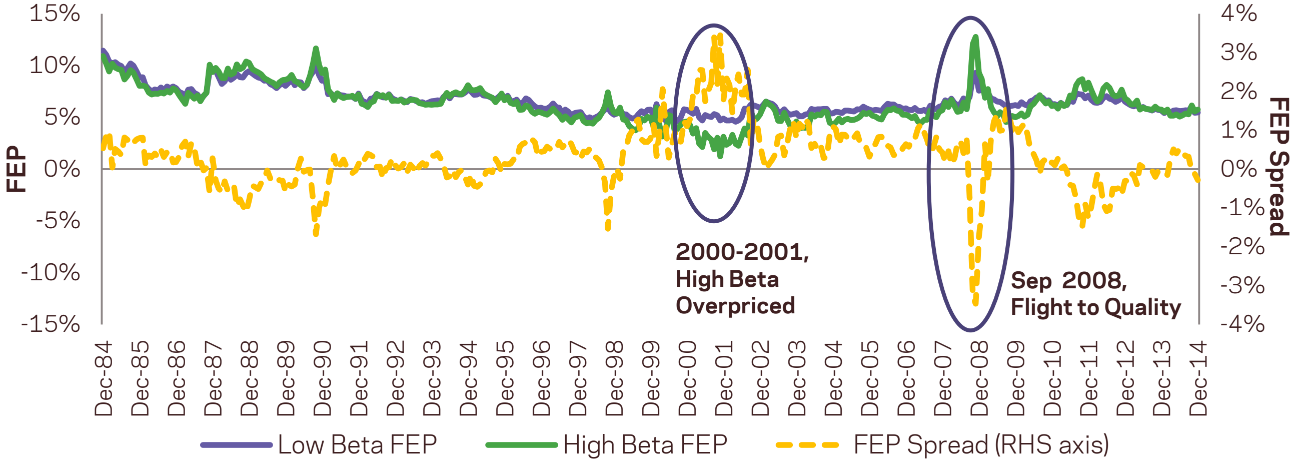
[11] Refer to **Appendix B** for details and variations in the methodology.

[12] Financial data is winsorized at 5% to trim outliers. However, negative values of value metrics like earnings and cash flow yields are included.

[13] As our analyses are limited to the contemporaneous relation between value spreads and returns, and not the predictive ability of value spreads, the use of in-sample Z-scores does not introduce look-ahead bias.

[14] Our specific proxy for defensive investing is a beta-neutral and industry-neutral L/S BAB portfolio. Other common proxies of defensiveness include fundamental high quality measures instead of statistical low-beta measures, or a combination of both. In this note, we use the terms 'defensive stocks' and 'low-beta stocks' synonymously, often for broader definitions than our particular specification. While we focus on industry-neutral positions, we find a similar pattern and levels of value spreads for a non-industry-neutral BAB portfolio that takes industry bets; a chart is available upon request.
Further, the term 'defensive' is commonly used for long-only low-beta portfolios and dollar-neutral low-minus-high-beta L/S portfolios but these are so market directional that market moves tend to trump any value considerations. Note especially that unlike BAB, the latter L/S portfolio holds $1 in both long and short legs, so it is has a net negative beta.

Exhibit 3 – FEP Value Measures and FEP Value Spread for Hypothetical U.S. Low-Beta vs. High-Beta Portfolios, 1985–2014



Source: AQR. FEP data is from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. Low-Beta and High-Beta portfolios refer to beta-weighted portfolios on a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Hypothetical data has inherent limitations, some of which are disclosed herein.

To capture the low-beta premium without betting on overall market direction, Frazzini and Pedersen (2014) construct a BAB factor which is a beta-neutral portfolio that goes long low-beta stocks and short high-beta stocks. Stocks are weighted on the long and short sides according to their betas. Then, to achieve beta-neutrality, the long side of low-beta stocks is levered up and the short side of high-beta stocks is de-levered so that each side has a beta of 1 at portfolio formation. On average, this BAB factor portfolio is long $1.5 worth of low-beta stocks and short $0.7 worth of high-beta stocks (i.e., the ratio of long leverage to short leverage is around 2, inversely proportional to the ratio of the respective betas). We study a BAB portfolio that is constructed similarly, but uses a narrower investable universe and is also industry neutral.[15]

Exhibit 3 plots the levels of value measures — in this case, the FEP measure (forward-looking equity yield) — for low-beta stocks and high-beta stocks over time, together with their difference, the value spread. The spread levels are inversely related to market performance: wide during the tech boom (low-beta relatively cheap) and narrow during the global financial crisis (low-beta relatively rich). The value spreads clearly exhibit reversion to the mean especially in the 2008-09 period — we see low-beta stocks getting expensive during flights to quality and market downturns, or cheapening during junk rallies but eventually reverting to their average range of valuation. Further, the movements in high-beta stock valuations are more pronounced, so the value spread was positive during the tech boom and negative during the global financial crisis.

So, are defensive stocks as expensive as many investors worry they are? **Exhibit 4** shows an in-sample standardized FEP spread as well as the five-indicator composite value spread of the industry-neutral U.S. BAB portfolio. We find that since mid-2007, the value spread between low-beta and high-beta stocks has been generally

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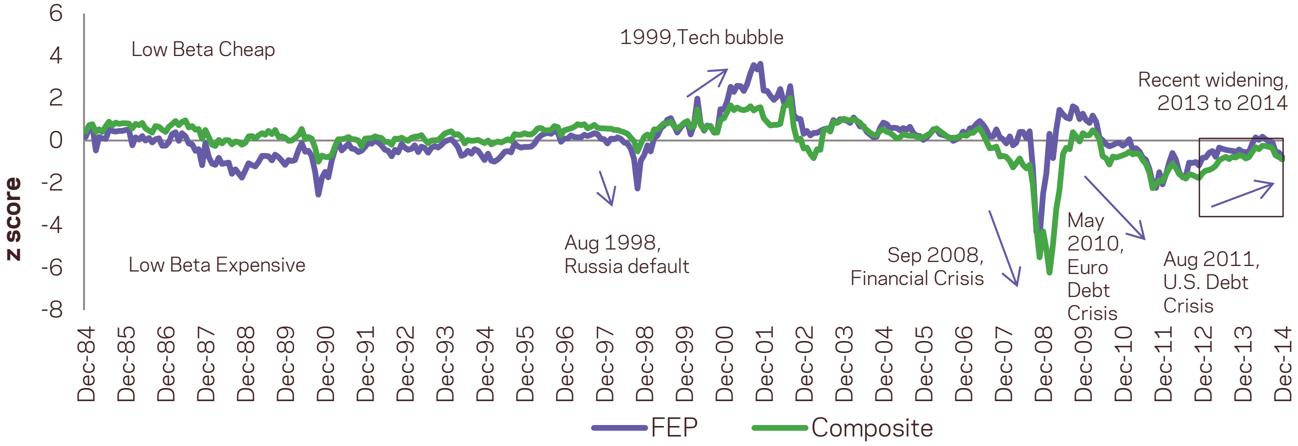
[15] Asness, Frazzini and Pedersen (2014) find that the low-beta anomaly persists within industries. We construct a similar industry-neutral BAB factor using a universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe, and betas from MSCI Barra's USE3L model. Stocks are weighted proportionately to their betas ranked within their own industry and the portfolio is rebalanced monthly. As beta differentials tend to be lower within industries, the long run weighted average betas of the long and short sides are 1.37 and 0.91 respectively. Thus, on average, the long side of the industry-neutral U.S. BAB portfolio is levered up 1.5 times more than the short side (1.37/0.91 ≈ 1.5).

Exhibit 4 – Standardized FEP and Composite Value Spread, Hypothetical U.S. Low-Minus-High-Beta Portfolio, 1985–2014



Source: FEP data is from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. This is for illustrative purposes only. Hypothetical data has inherent limitations, some of which are disclosed herein.

more negative than during the previous decade (i.e., low-beta stocks have grown relatively richer). We cannot conclusively say whether this indicates a regime shift reflecting higher demand for safer assets or whether this is the result of several flights-to-quality in the post-2007 period. After quite rich valuations (**-1.5 STD**) at the end of 2012, we see spreads reverted to less expensive levels during 2013-4. **Exhibit B4** in **Appendix B** reveals that as of the end of 2014, low beta stocks are not particularly expensive on any of the five value measures we consider. Further, we observe similarity in the pattern and current levels of value spreads for a non-industry-neutral U.S. BAB portfolio that takes industry bets.[16]

The Puzzle

Focusing on the recent experience, the steady widening of spreads from early 2013 up to mid-2014 may lead one to infer that low-beta stocks underperformed high-beta stocks. Yet, counterintuitively, the beta-neutral BAB long/short portfolio produced strong returns in the same period, as seen in **Exhibit 5**. Despite unusually rich initial valuations followed by the apparent relative cheapening of low-beta stocks, a beta-neutral L/S portfolio that was long defensive stocks and short speculative stocks outperformed during this 18-month period. (Our broad conclusions apply for the full 2013-14 period, despite spread reversal in the second half of 2014.)

How does one explain this unusual pattern? Value spreads have many moving parts, which drive a wedge into the negative correlation investors expect to see between changes in value spreads and contemporaneous returns.

1. Changing Fundamentals and Portfolio Positions

As we mentioned earlier, trading on value or value spreads alike involves two assumptions, the first that mean reversion will eventually occur, and the second that mean reversion is primarily driven by prices. **Exhibit 3** shows that value spreads for the low beta style tend to mean-revert. The question that follows is — how much of this is driven by changes in prices, versus changes in fundamentals or positions? **Appendix A** shows contemporaneous correlations between changes

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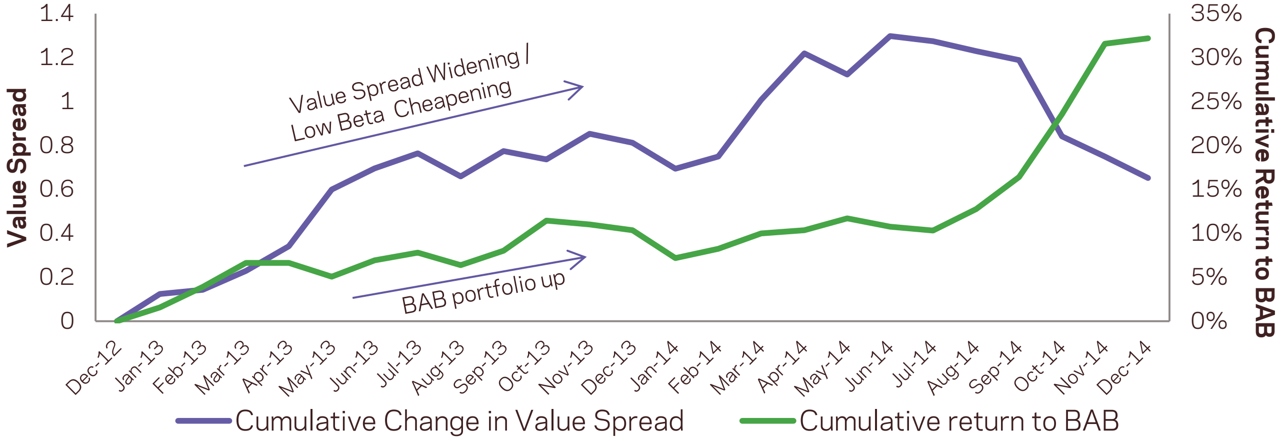
[16] As of December 2014, the composite value spread was at -0.9 standard deviations for industry-neutral U.S. BAB and at -1.2 standard deviations for non-industry-neutral U.S. BAB.
Looking at more recent numbers, the composite value spreads are at -1.2 standard deviations for both industry-neutral U.S. BAB and non-industry-neutral U.S. BAB as of September 30 2015.

Exhibit 5 – Composite Low-Minus-High-Beta Portfolio Value Spread and Returns of the Hypothetical U.S. BAB Portfolio, 2013–2014



Source: Financial data and prices are from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Returns are gross of fees and transaction costs and excess of cash. Hypothetical data has inherent limitations, some of which are disclosed herein.

in value spreads and returns across styles and asset classes — for the U.S. low-minus-high-beta portfolio this is **-0.1** to **-0.3**, indicating that much of the variation in spreads is not driven by prices.

While correlations vary with the style and asset class, on average they are weaker than those observed for lower-turnover long-only asset classes. Further, Value and Carry have higher negative correlations than Momentum, which has higher turnover, or Defensive, whose value spreads have misaligned betas (a point we will get to shortly, stay tuned). In faster-moving L/S portfolios, spread changes can be driven not by price performance of the portfolio at time *t* but by the new composition of the portfolio at time *t+1* (when the portfolio is rebalanced) compared with the portfolio at time *t*. Changing fundamentals too can drive value spreads when they are updated during quarterly financial reporting, or when consensus estimates are revised following news. We see the relation between value spreads and returns is weaker for faster-moving fundamental anchors. To measure the independent impacts[17] of evolving prices, fundamentals and positions, we decompose the change in spreads using an attribution methodology described in **Appendix C**. For example, the change in spreads from prices alone is estimated as the change in spreads assuming fundamentals and positions remained the same as in the previous month. **Exhibit 6** shows an attribution for one month for the change in FEP spreads of the U.S. low-minus-high-beta portfolio. The attribution for each month and the effect of changing prices on value spreads varies depending on the portfolio turnover for that month and news flow around fundamentals.

Exhibit 7 plots the cumulative estimated changes in the FEP value spread for each individual driver versus the total observed change in value spread. Up to mid-2014, we see that changing prices indeed contributed to spread widening (that is, relative low-beta cheapening). [18] However, improving fundamentals were almost as big a driver of the spread widening as changing prices were. In other words, earnings estimates for low-beta stocks improved relative to high-beta stocks,

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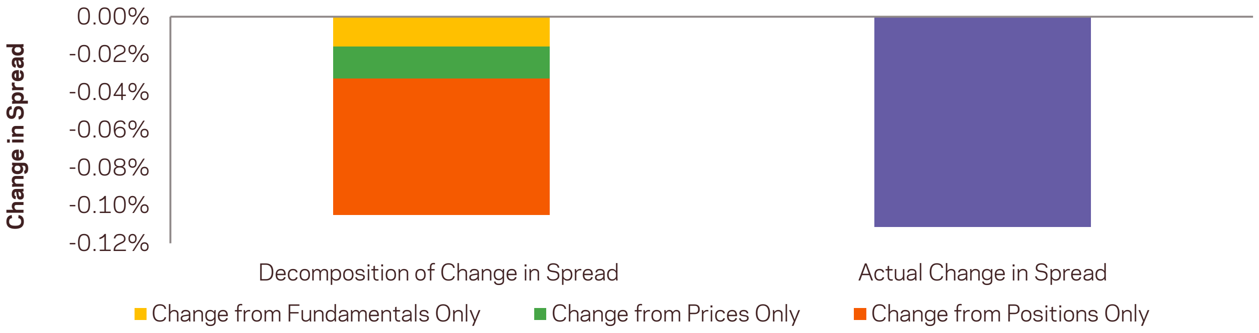
[17] This ignores interaction effects and to that end, is an approximation. However, as **Exhibits 6** and **7** show, the three components account for most of the variation in spread.

[18] As we discuss later, the beta differential between low-beta and high-beta stocks will cause value spreads to widen when markets trend up (assuming value spreads are driven by prices alone and that stock returns are purely systematic).

Exhibit 6 – Attribution of the Change in FEP Spreads for the Hypothetical U.S. Low-Minus-High-Beta Portfolio, for Dec 2014



Source: Financial data and prices are from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Methodology described in Appendix C. This is for illustrative purposes only. Hypothetical data has inherent limitations, some of which are disclosed herein.

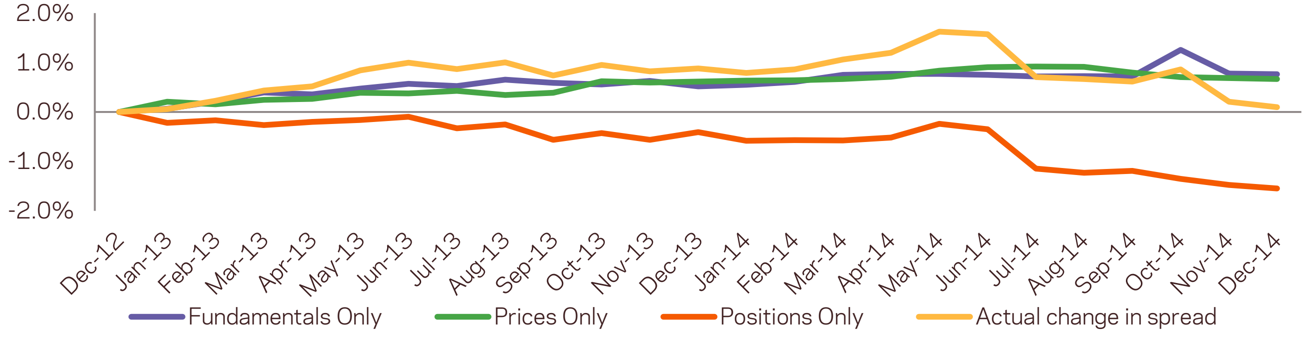
but their prices did not increase as much as high-beta stocks (as would normally happen in upwardly trending markets), leading to a relative cheapening of low beta. So in this case fundamentals did not offset, but rather reinforced, the impact of price changes, at least when the FEP measure is used. **Exhibit 7** also shows that improving fundamentals were offset by the changing positions, which had a consistent negative impact on value spreads over this period. This suggests that the high-beta portfolio reweighted to relatively cheaper stocks, or the low-beta portfolio reweighted to relatively expensive stocks, causing the spread to narrow.

To recap, offsetting fundamentals and evolving positions weaken the relation between value spread changes and the contemporaneous realized returns as they diminish the proportionate impact of changing prices on variation in value spreads. Presumably, they also make it harder to predict future returns using value spreads.

2. Carry: Higher Dividends of Low-Beta Stocks

Carry is a relatively predictable component of returns, but it weakens the link between changes in value spreads and contemporaneous returns because it is not a component of value spreads. On average, low-beta stocks have higher dividend yields than high-beta stocks, as seen in **Exhibit 8**. The differential in the exhibit is further amplified

Exhibit 7 – Cumulative Change to FEP Value Spreads of the Hypothetical U.S. Low-Minus-High-Beta Portfolio, 2013–2014



Source: FEP data is from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Methodology described in Appendix C. This is for illustrative purposes only. Hypothetical data has inherent limitations, some of which are disclosed herein.

as the BAB portfolio levers up the low-beta stocks to hold, on average, $1.50 of low-beta stocks for every $1 of high-beta. During 2013-14, the BAB portfolio was up 28% on price return alone, versus 34% on total return, indicating that dividends were a contributor, albeit not a major one, to the outperformance.

Exhibit 8 – Average Annualized Dividend Yields of U.S. Low-Beta and High-Beta Stocks

	1985 to 2014	2013 to 2014
Low Beta	3.50%	1.67%
High Beta	1.82%	1.14%

Source: Dividend yield data is from Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. This is for illustrative purposes only.

3. Misaligned Betas of Value Spreads and the BAB Portfolio

Finally, we address the wedge that has the biggest impact in this case, namely the co-movement of the low-minus-high-beta value spread with the market. (Recall that the value spread represents the difference in value measures between a portfolio that is long a dollar of low-beta and short a dollar of high-beta). When the aggregate market appreciates, assuming stock fundamentals remain the same and stock returns are entirely systematic (stock specific returns are zero), low-beta stocks become relatively cheaper, causing value spreads to widen. The opposite is true in down markets when low-beta stocks have less negative returns. Over the period 1985 to 2014, changes in the composite value spread had a correlation of +0.4 with returns to the Russell 1000.

This beta-driven directionality is, by construction,[19] specific to the low-beta style value spread because other styles like value and momentum do not have persistent beta biases.[20] On the other hand, the BAB portfolio is constructed to be non-directional because it is levered up on the long side to be beta-neutral at portfolio formation.[21] Thus, the BAB portfolio and the value spread for the low-minus-high-beta portfolio have misaligned betas.

Exhibit 9 shows that a dollar-neutral low-minus-high-beta portfolio experienced mostly steadily negative returns in 2013-14. Given that this dollar-neutral low-minus-high-beta portfolio will, by construction, have a beta well below zero,[22] it is not surprising to see it has negative returns in a period when markets trended upward (not shown here, but U.S. equity markets[23] were up every quarter in 2013-14, delivering double-digit returns in both years). To recap, for the dollar-neutral

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[19] This holds true even when using other common definitions of value spreads, e.g., the value spread between the top and bottom quintiles, using averages or medians instead of a weighted average or using the ratio instead of difference. In each case, by construction, there is a beta differential between the long side and short side.
Constructing value spreads for the low-minus-high-beta portfolio without this directionality is non-trivial. We do not use the leveraged weights of the beta-neutral BAB portfolio (in equation (1) in **Appendix B**) , because the long side of BAB is always levered relative to the short side and that would lead to scaling up the yields of the long low-beta stocks proportionately, thus making them appear cheaper than they truly are. Regression based approaches can be used to estimate changes in value spreads that are uncorrelated to market movements but these are somewhat brute-force methods not without limitations of their own. This is a topic we leave for further research.

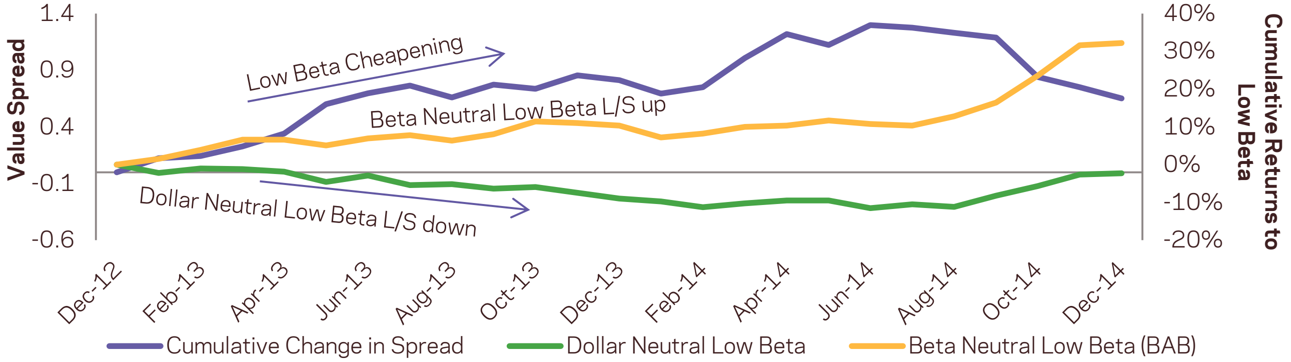
[20] There are several ways to construct L/S value and momentum portfolios that are both dollar-neutral and beta-neutral. These include simply optimizing value and momentum L/S portfolios to be beta-neutral or using value and momentum exposures after controlling for beta. But neither of these approaches is applicable to a low-minus-high-beta L/S portfolio.

[21] Asset volatilities and correlations vary over time, so that realized betas can be different from predicted betas. A portfolio that is *ex-ante* beta-neutral may not be *ex-post* beta-neutral, especially over shorter windows of time where it may deviate from the long term. Over the long run the BAB portfolio has a realized beta of 0.05 to the Russell 1000. However, over the shorter 2013-14 period, it has a beta of 0.24 to the Russell 1000. Since equity markets were up the past two years this was another contributor to BAB outperformance even as value spreads widened up to mid-2014.

[22] The BAB portfolio is not directional as it is constructed to be beta-neutral by levering up the low-beta stocks. However, as noted, the dollar-neutral L/S low-minus-high-beta style has a persistent beta below zero. Over the period 1985-2014 the dollar-neutral low-minus-high-beta portfolio has a highly significant realized beta of -0.51 to the Russell 1000, compared to a statistically insignificant realized beta of 0.05 for the beta-neutral low-beta portfolio. Thus, the dollar-neutral low-minus-high-beta portfolio is primarily a directional trade and not a relative value trade between low-beta and high-beta stocks.

[23] U.S. equity markets represented by the Russell 1000.

Exhibit 9 – Cumulative Change in Composite Value Spreads vs. Returns to Hypothetical U.S. Low-Minus-High-Beta Portfolios, 2013–2014



Source: Financial data and prices are from IBES and Xpressfeed. Betas are from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Returns are gross of fees and transaction costs and excess of cash. Hypothetical data has inherent limitations, some of which are disclosed herein.

low-minus-high-beta portfolio, the primary source of returns is its market directionality, not relative value between low beta and high beta, whereas the beta-neutral portfolio (BAB) allows one to make purer bets on the low-beta anomaly without betting on market directionality.

Exhibit A2 in **Appendix A** reaffirms our point about aligning spreads with returns — on average, value spreads have a correlation of **-0.3** with contemporaneous returns to the dollar-neutral low-minus-high-beta portfolio, as opposed to a correlation of **-0.1** with contemporaneous returns to the beta-neutral low-beta portfolio. As the exhibit shows, this pattern appears to be the case across most value measures.

Concluding Remarks

We document that despite the recent popularity of the low-beta anomaly, defensive stocks are not particularly expensive (compared to riskier stocks) from a historical perspective. Moreover, the last time the BAB portfolio was expensive (-1.5 standard deviations rich versus long-run norms), in December 2012, the signal proved unhelpful as BAB had strong subsequent performance. Contrarian timing is hard even for long-only asset classes, but when applied to L/S style investing, the wedges highlighted in this article can make the challenge even greater. Any investor who waited for low beta to cheapen missed out on the rally.

More generally, investors should be cognizant of the mechanics of value spreads and spread design choices. As we see with the low-beta style, value spreads are of limited efficacy in explaining contemporaneous returns. Whether they are useful in predicting returns is a topic to which we will return in future research.

Appendix A | Contemporaneous Correlations Between Value (Spread) Changes and Realized Returns

Here we compare how close the link between richening valuations and high realized returns is, for different investments. Contemporaneous correlations are near -1 for major long-only asset classes, as seen in **Exhibit A1**, indicating very tight relations. Intuitively, rising valuations, falling yields and narrowing credit spreads tend to coincide with strong market performance. We delay showing predictive relations until the next report, but note that even high contemporaneous correlations, as in the case of long-only equity indices, do not promise a strong predictive ability of value.

Exhibit A1 | Contemporaneous Correlations of Monthly Changes in Value Measures[24] With Asset Class Returns

Asset Class	Value Measure	Correlation with Excess Returns
U.S. Equities	Book-to-price	-0.90
U.S. Bonds	Real Bond Yield	-0.92
U.S. High Yield	Default Adjusted Credit Spread	-0.71
Currencies (G4)	Purchasing Power Parity	-0.92

Sources: Returns from Datastream, Bloomberg and Global Financial Database (GFD). U.S. Equities refer to the MSCI US from 1970 to 2014. U.S. Bonds refer to 10-year Treasuries from 1970 to 2014, returns are duration hedged to 7 years. 10-year Expected Inflation from the Survey of Professional Forecasters, Consensus Economics and the Federal Reserve as described in Ilmanen [2011]. High Yield refers to the Markit High Yield 5-year CDS Index from 2004 and the Barclays High Yield Corporate index minus 5 year Treasury swap returns, from 1990 to 2004, as a proxy. For Currencies we take the average correlation across three baskets that are long either of the yen, the euro (Deutschemark prior to 1999) or sterling and short the U.S. dollar. Purchasing Power Parity from Penn World tables, augmented with OECD data and goes back to 1970. This is for illustrative purposes only.

Exhibit A2 displays correlations between value spreads and contemporaneous returns to low-minus-high-beta portfolios.[25] In either case, we see more negative correlations (as one intuitively expects) when using slow moving fundamentals like book value and sales rather than earnings, whether trailing or forward estimates. We also notice a counter-intuitive positive correlation between EP spreads and returns. This is because EP is more likely to have negative values even after aggregation to the portfolio level, as opposed to value measures like BP and SP.[26]

Exhibit A2 | Contemporaneous Correlations of Changes in Value Spreads With Returns to Hypothetical U.S. Low-Minus-High-Beta Portfolios, 1985-2014

	Dollar Neutral	Beta Neutral
BP	-0.52	-0.18
CFOP	-0.44	-0.17
EP	0.19	0.05
FEP	-0.24	-0.11
SP	-0.54	-0.22
Average	**-0.31**	**-0.13**

Source: Financial data and prices are from Xpressfeed. Betas from MSCI Barra's USE3L model. The universe is U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Returns are gross of fees and transaction costs and excess of cash. Hypothetical data has inherent limitations, some of which are disclosed herein.

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[24] Real Bond yield is defined as Nominal Bond Yield – Expected Inflation. Default Adjusted Credit Spread is defined as Credit Spread – (1-Recovery Rate)*(Expected Default Probability Rate), and estimated on the Markit CDX North America High Yield 5 year index. Recovery Rate is assumed to be the rough historical average of 40%.

[25] As described earlier, we construct an industry-neutral low-beta L/S portfolio that is long low-beta stocks and short high-beta stocks. Stocks are weighted proportionate to their betas on the long and short sides respectively. The beta-neutral version of this portfolio is levered on the long side. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Financial data and prices for the stocks are obtained from Xpressfeed. (Financial data is winsorized at 5%. Negative values are included.) Stock betas are predicted betas from MSCI Barra's USE3L model. All data is monthly, except where indicated.

[26] An example of this is seen in **Exhibit B4** in **Appendix B** during the 2000 to 2002 period, EP spreads widened while spreads using all other measures narrowed. This was because high-beta stocks, on aggregate, reported negative earnings in that timeframe. So, even as their prices fell, their aggregate EP declined and they looked more expensive on EP while they grew relatively cheaper on other measures like BP and even FEP.

When correlations are as mild as this (as opposed to -0.7 to -0.9), it is not surprising that over shorter windows, such as the 2013-4 period that we highlight, the correlation can flip sign. We studied 12-month rolling correlations between changes to the composite value spread changes and the low-beta portfolio returns over 30 years. They were negative 85% (73%) of the 12-month periods for the dollar-neutral (beta-neutral) low-minus-high-beta portfolios, but flipped positive often around the turn of the century and again in 2014.

Using a similar value spread construction methodology and relevant value measures for each asset class, we construct composite value spreads for L/S Value, Momentum, Carry and Defensive style portfolios in several asset classes as described in Ilmanen, Israel and Moskowitz (2012). **Exhibit A3** reveals moderate contemporaneous correlations between changes in these value spreads and returns to the respective beta neutral L/S style portfolio. Further, we see stronger correlations on average for styles like Carry and Value that are slower-moving and whose value spreads do not systematically co-move with the market the way value spreads for the Defensive style do.

Exhibit A3 | Contemporaneous Correlations of Changes in Value Spreads With Returns to Hypothetical Multi-Asset Style L/S Portfolios, 1990*-2014

	Asset Class / Market	Value	Momentum	Carry	Defensive
Macro	Commodities	-0.70	-0.36	-0.35	
	Developed Equities	-0.34	-0.13		-0.17
	Emerging Equities	-0.04	-0.07		-0.22
	Government Bonds (Developed)	-0.58	-0.25	-0.47	-0.51
	Developed Currencies	-0.66	-0.42	-0.73	
	Emerging Currencies	-0.68	-0.43	-0.58	
	Interest Rate Futures (Developed)	-0.56	-0.34	-0.21	
Industry Selection	Japan Industry Selection	-0.22	-0.18		-0.36
	Europe ex U.K. Industry Selection	-0.29	-0.28		-0.25
	U.K. Industry Selection	-0.18	-0.17		-0.29
	U.S. Industry Selection	-0.14	-0.18		-0.27
Stock Selection	Japan Stock Selection	-0.26	-0.28		-0.20
	Europe ex U.K. Stock Selection	-0.40	-0.20		-0.05
	U.K. Stock Selection	-0.42	-0.23		-0.18
	U.S. Stock Selection	-0.25	-0.32		-0.22
	Average	**-0.38**	**-0.26**	**-0.47**	**-0.25**

Source: *Data for Emerging Equities from 1996 and for Emerging Currencies from 1997. Financial data and prices from IBES, Bloomberg, Datastream, Consensus Economics, Xpressfeed, MSCI Barra and Penn World tables. All data is monthly. Strategy returns are monthly returns, gross of fees and transaction costs and excess of cash. Hypothetical data has inherent limitations, some of which are disclosed herein.

Styles as defined in Ilmanen, Israel and Moskowitz (2012). These style premia are captured in numerous asset classes: stock selection, industry allocation, country allocation in equity, fixed income and currency markets, and commodities, by combining several indicators in each asset class and forming hypothetical long-short style portfolios that are rebalanced monthly while seeking to ensure the portfolio is market-neutral. The universes are as described: Stock and Industry Selection: approximately 2,000 stocks across Europe, Japan, U.K. and U.S. Country Equity Indices: Developed Markets: Australia, Canada, Eurozone, Hong Kong, Japan, Sweden, Switzerland, U.K., U.S. Within Europe: Italy, France, Germany, Netherlands, Spain. Emerging Markets: Brazil, China, India, Israel, Malaysia, Mexico, Poland, Singapore, South Africa, South Korea, Taiwan, Thailand, Turkey. Bond Futures: Developed Markets: Australia, Canada, Germany, Japan, U.K., U.S. Emerging Markets: Czech Republic, Hong Kong, Hungary, Mexico, Poland, Singapore, South Africa, South Korea Yield Curve: Australia Germany, United States. Interest Rate Futures: Australia, Canada, Europe (Euribor), U.K. and U.S. (Eurodollar). Currencies: Developed Markets: Australia, Canada, Euro, Japan, New Zealand, Norway, Sweden, Switzerland, U.K., U.S. Emerging Markets: Brazil, Hungary, India, Israel, Mexico, Poland, Singapore, South Africa, South Korea, Taiwan, Turkey. Commodity Selection: Silver, copper, gold, crude, Brent oil, natural gas, corn, soybeans.

Appendix B | Variations in Value Spread Construction Methodology

To recap, we define value spreads of a factor as the difference between the weighted average valuations of the long and short sides of the factor portfolio. For a L/S portfolio that amounts to

$$\text{Value spread at time } t = \sum_{i=1}^{n} w_{i,t}\, v_{i,t} \qquad (1)$$

where

$w_{i,t}$ = weight of stock i in the factor portfolio (negative for the shorts)

$v_{i,t}$ = value measure of stock i, e.g., forward-earnings-to-price (FEP)

To calculate weighted averages, we rescale weights of the long and short sides separately so that they add to 100% long and 100% short at each point in time. This prevents leverage from affecting the relative valuations of the long and short sides. Further, by preventing changes in spreads solely due to a change in leverage, it makes spreads comparable across time.[27]

Alternative definitions of value spreads are shown in **Exhibit B1**. They include using the ratio or logarithm of ratio, of value measures of the long and short sides, as opposed to the difference in value measures. The difference value spread, by construction, is sensitive to aggregate market valuations. For example, when overall market BP is high, BP spreads of the value style will increase in magnitude and denote increased cheapness of value[28] even if the ratio of BPs between the long and short sides remains the same. The ratio value spread is thus a purer measure of the "value" of the portfolio, while the difference value spread measures the "carry" of the portfolio as it measures the yield differential between the long and short sides. However, the limitation of using ratio spreads is that they cannot be used for value measures that can have negative or near-zero values even after aggregating to the portfolio level (e.g., equity earnings yields like EP and FEP and real bond yields). We choose to use the difference in value measures in our analyses as this definition of value spreads can be used across a broader range of value measures.

Exhibit B1 | Variations in Constructing Value Spreads

Dimension	Description
Universe	Only tails of the universe (e.g., quintile or decile spreads versus the entire universe/all holdings of the factor portfolio)
Weighting	Simple average or median of Longs and Shorts versus factor weighted
Spread measure	Difference / Ratio / Log Ratio of Longs vs. Shorts

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[27] Factor portfolios may have unequal leverage on the long and short sides. To prevent any difference in leverage between the long and short sides from affecting their relative valuations, weights are rescaled to add up to 100% each on the long and short side. Further, any factor portfolio that targets constant volatility has time-varying leverage as asset weights must change in accordance with changing asset volatilities and correlations. In a low volatility regime, asset weights must be scaled higher to achieve the same level of portfolio risk and vice versa. Referring to Equation (1), the higher magnitude weights would result in proportionally wider spreads even if actual valuations did not change. To prevent changes in spreads that arise solely from reweighting for risk targeting, we rescale weights to add up to 100% long, 100% short at each point in time. This is equivalent to a dollar-neutral L/S portfolio.

[28] When overall market BP is high, BP spreads for other styles will increase in magnitude too but depending on the whether the long side is cheaper than the short side, this could denote either cheapening or richening of the style.

Exhibit B2 illustrates how taking the natural log of the ratio has the added advantage of being symmetrical.

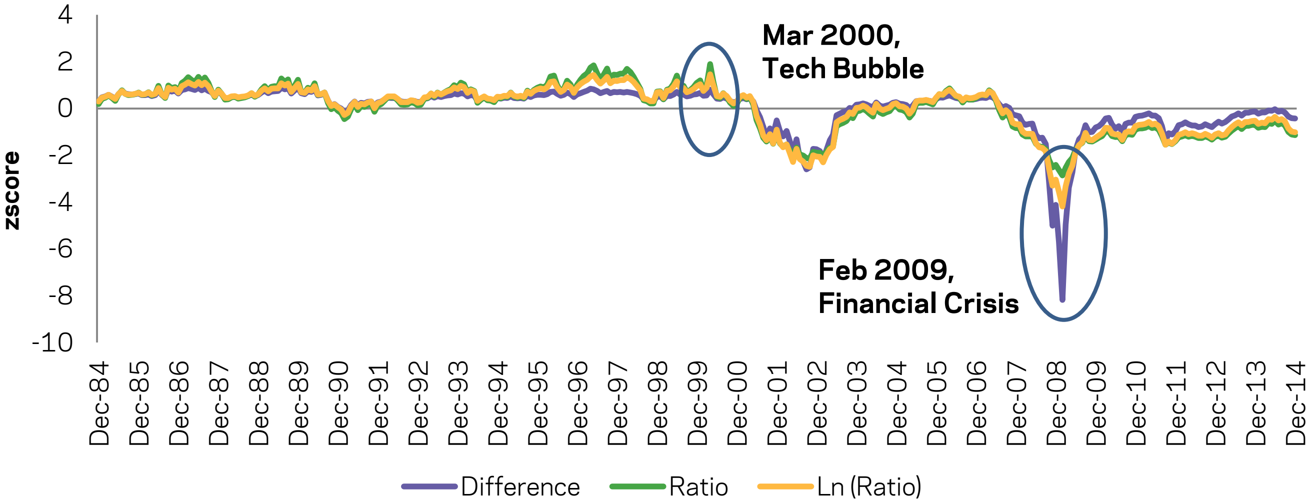
Exhibit B2 | Example of Using Ratio Value Spreads vs. Logarithm (Ratio) Value Spreads

	BP Long	BP short	Ratio Spread BP Long / BP Short	Ln (Ratio) Spread ln (BP Long / BP Short)
Low Beta Cheap	1	0.5	2	0.69
Low Beta Expensive	0.5	1	0.5	-0.69

Source: AQR. This is for illustrative purposes only.

Exhibit B3 shows that historical BP spreads have similar contours using the three approaches. While the three are highly correlated, they are different at market extremes. We see that during the Tech Bubble, normalized BP difference spreads were narrower than the corresponding BP ratio spreads as market aggregate BP was relatively low. During the Global Financial Crisis, however, difference spreads were wider than the corresponding ratio spreads as market aggregate BP was relatively high.

Exhibit B3 | Book-to-Price Spreads, Hypothetical U.S. Low-Minus-High-Beta Stock Portfolio, 1985–2014



Source: Book-to-price data is from Xpressfeed. Betas from MSCI Barra's USE3L model. The universe is U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe.. Book-to-price spreads constructed for the industry-neutral U.S. low-beta style. Hypothetical data has inherent limitations, some of which are disclosed herein.

Exhibit B4 displays the evolving value spreads for the long/short industry neutral BAB portfolio for each of the five value measures we use, as well as their composite. While details differ, overall patterns are similar across different value measures except for the 2000-2002 period, when the trailing earnings spread behaved very differently from other measures.[29] Over the 2013-2014 period which is the focus of this paper, all value spreads share the broad contours of the five-indicator BAB composite.

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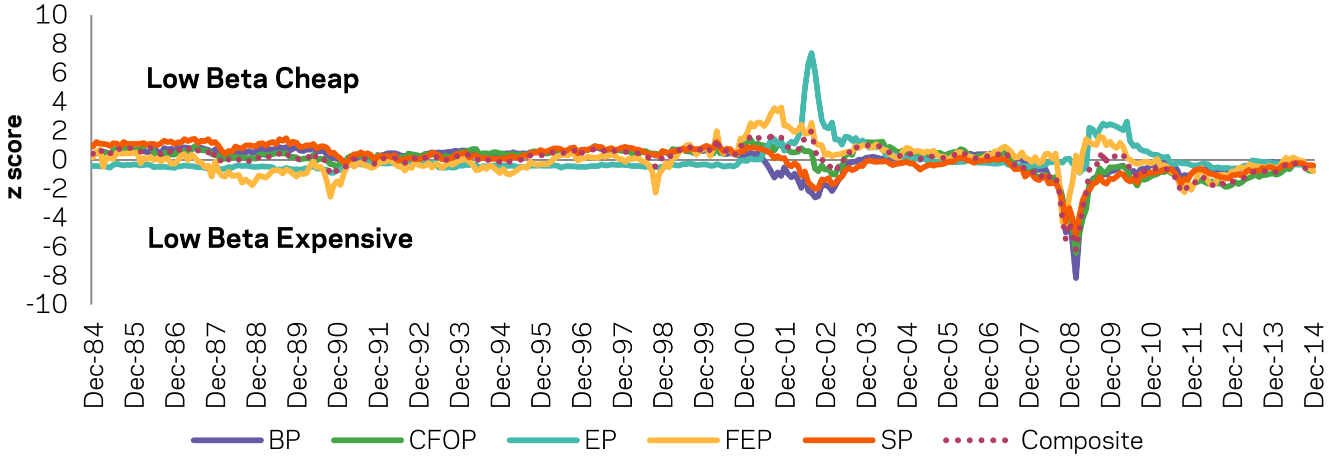
[29] We observe a widening in the trailing earning spread even as value spreads of all other measures narrowed, due to the fact that high-beta stocks had on aggregate, negative trailing earnings, so that even as their prices declined, their EP decreased while their BP and SP increased.

Exhibit B4 | Value Spreads, Hypothetical U.S. Low-Minus-High-Beta Stock Portfolio, 1985–2014



Source: Financial data and prices are from Xpressfeed. Betas from MSCI Barra's USE3L model. The universe is a U.S. stock universe that is approximately the top 20th percentile by market-cap and the top 15th percentile by trading volume of U.S. stocks in MSCI Barra's GEM model universe. Composite value epreads constructed for the industry-neutral U.S. low-beta style. Hypothetical data has inherent limitations, some of which are disclosed herein.

Appendix C | Methodology to Attribute Changes in Value Spreads

From Equation (1) in Appendix B, we see there are 3 drivers of changes in value spreads

1. Prices
2. Fundamentals (e.g., forward earnings)
3. Portfolio Positions

We attribute the change in value spreads that comes from each of these drivers independently of the other two. For example, to measure the impact of price changes on spreads, we estimate the next period's value spread assuming only prices changed to the values of the next period, while fundamentals and portfolio positions remain the same as the previous period. The difference between this and the actual value spread of the previous period is the change in spread that we attribute to price changes alone.[30]

Thus, each period we get a change in spread from prices alone which we can add up over time to see the cumulative impact of price changes on the change in value spreads. As we ignore interaction effects, this is an approximation. However, as **Exhibits 6** and **7** in the main text show, the sum of the independent changes from prices, fundamentals and positions, accounts for most of the actual change in value spread. We now explain each in detail, for FEP $\frac{FE_t}{P_t}$, so that

Value spread at time t: $s_t = \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t}}{P_{i,t}}$

Value spread at time $t+1$: $s_{t+1} = \sum_{i=1}^{n} w_{i,t+1} \frac{FE_{i,t+1}}{P_{i,t+1}}$

Change in Value spread, at time $t+1$: $ds_{t+1} = s_{t+1} - s_t$

1. Change in Value Spread From Changing Prices Alone

$$s_{t+1,\, prices\ only} = \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t}}{P_{i,t+1}}$$

Multiplying and dividing by P_t, we get

$$s_{t+1,\, prices\ only} = \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t}}{P_{i,t+1}} \frac{P_{i,t}}{P_{i,t}}$$

$$= \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t}}{P_{i,t}} \frac{1}{1+r_{i,t+1}}$$

where $r_{i,t+1} =$ price return of stock i from time t to $t+1$

$ds_{t+1,\, prices\ only} = s_{t+1,\, prices\ only} - s_t$

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[30] When decomposing changes in spreads we do not winsorize stock values. This is to ensure the same stock universe is used for the actual total change in spread and the spreads that would have results had prices, fundamentals or positions changed.

2. Change in Value Spread From Changing Fundamentals Alone

$$s_{t+1,\,fundamentals\ only} = \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t+1}}{P_{i,t}}$$

Multiplying and dividing by P_{t+1}, we get

$$s_{t+1,\,fundamentals\ only} = \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t+1}}{P_{i,t}} \frac{P_{i,t+1}}{P_{i,t+1}}$$

$$= \sum_{i=1}^{n} w_{i,t} \frac{FE_{i,t+1}}{P_{i,t+1}} (1 + r_{i,t+1})$$

where $r_{i,t+1} =$ price return of stock i from time t to $t+1$

$$ds_{t+1,\,fundamentals\ only} = s_{t+1,\,fundamentals\ only} - s_t$$

3. Change in Value Spread From Changing Positions Alone

$$s_{t+1,\,positions\ only} = \sum_{i=1}^{n} w_{i,t+1} \frac{FE_{i,t}}{P_{i,t}}$$

$$ds_{t+1,\,positions\ only} = s_{t+1,\,positions\ only} - s_t$$

At each point in time, we attribute changes in spreads and sum the changes over time to get the cumulative change in FEP spreads from each of these components.

References

Asness, C., A. Frazzini and L. Pedersen (2014). "Low Risk Investing without Industry Bets." *Financial Analysts Journal*, vol.70, no. 4, pp.24-41.

Asness, C., J. Friedman, R. Krail and J. Liew (2000). "Style Timing: Value versus Growth." *Journal of Portfolio Management*, 26, pp. 50-60.

Baker, M., B. Bradley and J. Wurgler (2011). "Benchmarks as Limits to Arbitrage: Understanding the Low-Volatility Anomaly." *Financial Analysts Journal*, vol. 67, no. 1 (January/February).

Cohen, R. B., C. Polk and T. Vuolteenaho (2003). "The Value Spread." Journal of Finance 58 (2), pp. 609-641.

Fama, E., and K. French (1993). "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics*, vol. 33,pp. 3–56.

Frazzini, A., and L. Pedersen (2014). "Betting against Beta." *Journal of Financial Economics*, vol. 111, no. 1 (January):1–25.

Ilmanen, A. (2011), *Expected Returns*, Wiley.

Ilmanen, A., R. Israel and T. Moskowitz (2012). "Investing with Style." AQR white paper.

Knutzen, E. (2013). "Pursuing the Low Volatility Equity anomaly: Strategic Allocation or Active Decision?" *Journal of Investing*, vol. 22, no. 3 (Fall 2013)

Swedroe, L., (2013)."Should You Pursue a Low-Volatility Strategy?" *CBS Moneywatch*, (September 12, 2013)

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Lars, a Principal at AQR, oversees research in the Global Stock Selection and Global Asset Allocation teams, and is a part of the portfolio management teams for a number of AQR's multi-strategy hedge funds as well as long-only equity portfolios. Prior to AQR, Lars was a visiting graduate student at Cornell University, where his research interests were finance and econometrics. Before that, he was a quantitative equity analyst at Danske Invest, the largest asset-management firm in Denmark. Lars earned a B.Sc. and an M.Sc. in economics from the University of Copenhagen.

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