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Risk Factors Are Not Generic

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ABSTRACT While academics and financial practitioners have subjected risk-factor investing to decades of study and have published countless articles, single and universally prescribed forms for individual factors do not yet exist. While illustrative of the broader concept, this paper focuses on two important but seemingly overlooked sources of differentiation across risk factors: factor definition and factor construction. Factor definition describes the observable asset characteristics (e.g., "book value" and "earnings yield") utilized to formulate a particular factor (e.g., equity value). Factor construction describes the design and implementation to compose a specific factor's definition. Even for a well-known and market-assimilated factor like equity value, seemingly subtle differences in the precise definition and construction of the factor can create meaningful divergences in factor performance.

According to the U.S. Food and Drug Administration, generic drugs offer "copies" of pharmaceutical treatments with "the same high quality, strength, purity and stability as brand-name drugs. The generic manufacturing, packaging, and testing sites must also pass the same quality standards as those of brand name drugs."[1] Since pharmaceutical firms typically publish the components and manufacturing recipes for their brand name drugs as part of their patent applications, generic drug manufacturers likely find this copying process relatively straightforward.

Despite common belief, risk factor investing (also sometimes called "smart beta" investing) does not offer the same degree of replicability as a brand-name drug. In fact, significant variations exist in the definition and construction of such factors. These discrepancies pose challenges for many asset allocators, who incorrectly assume that "canonical" risk factors should reflect nearly standardized strategies that operate more like passive investments. Instead, asset allocators should evaluate risk factor strategies through the same lens as they evaluate their other active managers.

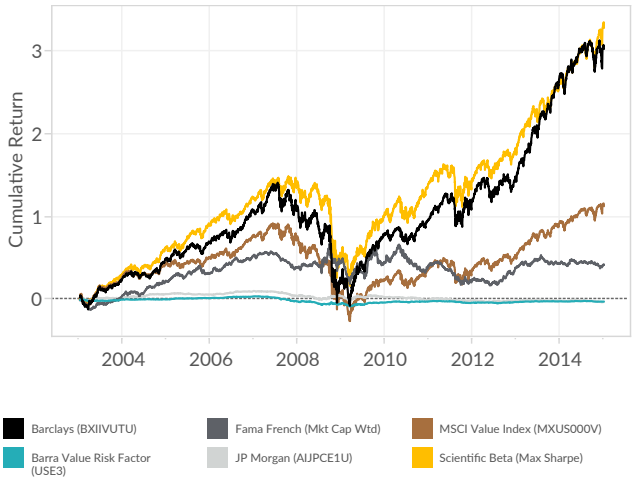
Consider the equity value factor. Academics have written about the excess returns of "high value" stocks (as compared to the broader equity market) for nearly a century (e.g., Graham and Dodd, 1934). One might expect that the financial market equivalent of a patent—i.e., the "secret sauce" embedded in an investment style—would have long since expired, but Figure 1 and the accompanying table contradict that notion.

Figure 1 plots the cumulative return of six different formulations of the equity value factor over the past decade: two from banks (Barclays and JP Morgan), two from academic lineages with published methodologies (Fama-French and Scientific Beta), one designed as a "pure" risk factor (Barra), and one designed as a more investable version of that risk factor (MSCI). All six formulations invest in the US equity market, yet the results exhibit wide dispersion across a number of metrics (e.g., annualized returns range from less than zero to more than twelve percent). Similar dispersion exists for other equity-based risk factors such as "quality," as well as for non-equity risk factors such as "commodity momentum" and "foreign exchange carry."

Many differences may underlie the dispersions within what is ostensibly a single risk factor. These differences, and their implications for portfolio construction, militate against simply picking the version with the highest historical returns. Some of the differences seem obvious. For example, variations in non-overlapping trading universes, the frequency at which the risk

1 See: http://www.fda.gov/Drugs/ResourcesForYou/Consumers/BuyingUsingMedicineSafely/UnderstandingGenericDrugs/ (accessed on October 18, 2015).

Figure 1 US Equity Value Premiums[2]



Factor Name	Annualized Return	US Equity Market Beta
Barclay's Value Factor	12.3 percent	0.92
Scientific Beta	12.4 percent	0.82
Fama French	3.0 percent	0.24
MSCI Value Index	6.4 percent	-0.15
Barra Value Risk Factor	-0.2 percent	0.04
JP Morgan	-0.2 percent	0.02

Source: Bloomberg, Ken French, Scientific Beta, Barra, Two Sigma Investments, LP.

factor is calculated or the portfolio optimized, and management fees may all lead to economically meaningful variation in factor performance. Other differences also require examination, including factor "purity" (i.e., the degree to which broader market changes influence results) and execution costs.

This paper focuses on two important but seemingly overlooked sources of differentiation across factors: factor definition and factor construction. In the parlance of a medical drug researcher, factor definition may best equate to the active ingredients, while factor construction resembles the manufacturing process used to combine the ingredients. Diagnosing these sources of differentiation can help risk-factor investors select the most appropriate applications for their overall asset allocation.

For the sake of simplicity, the remainder of this paper focuses primarily on the equity-value factor as a case example to illustrate these two overlooked sources of differentiation. On occasion, this paper also describes other risk factors—including non-equity risk factors—to emphasize the importance and generalizability of factor definition and construction as a general matter across factors.

I. Definition Matters: "Value" Lies in the Eye of the Beholder

While Graham and Dodd (1934) may have published the first academic text on value investing, seminal work by Fama and French (1991) often wins credit for statistically showing that a value-tilted portfolio can (statistically speaking) generate returns in excess of the broader equity market. Fama and French did so using a relatively simple, proof-of-concept construction of value they call "High Book-to-Market Minus Low Book-to-Market" (HML). According to their construction, the HML value factor equals the average equity returns of large and small firms in the top three deciles of a sorted list of high book-to-market equities (i.e., high-value firms) minus the average returns of large- and small-cap equities in the bottom three deciles (i.e., high-growth firms). In other words, companies with high tangible book value relative to the market value of their equity outperform those reliant on future profitability and asset appreciation.

The Fama-French (1991) results raise numerous questions among academics and practitioners. One such question is whether

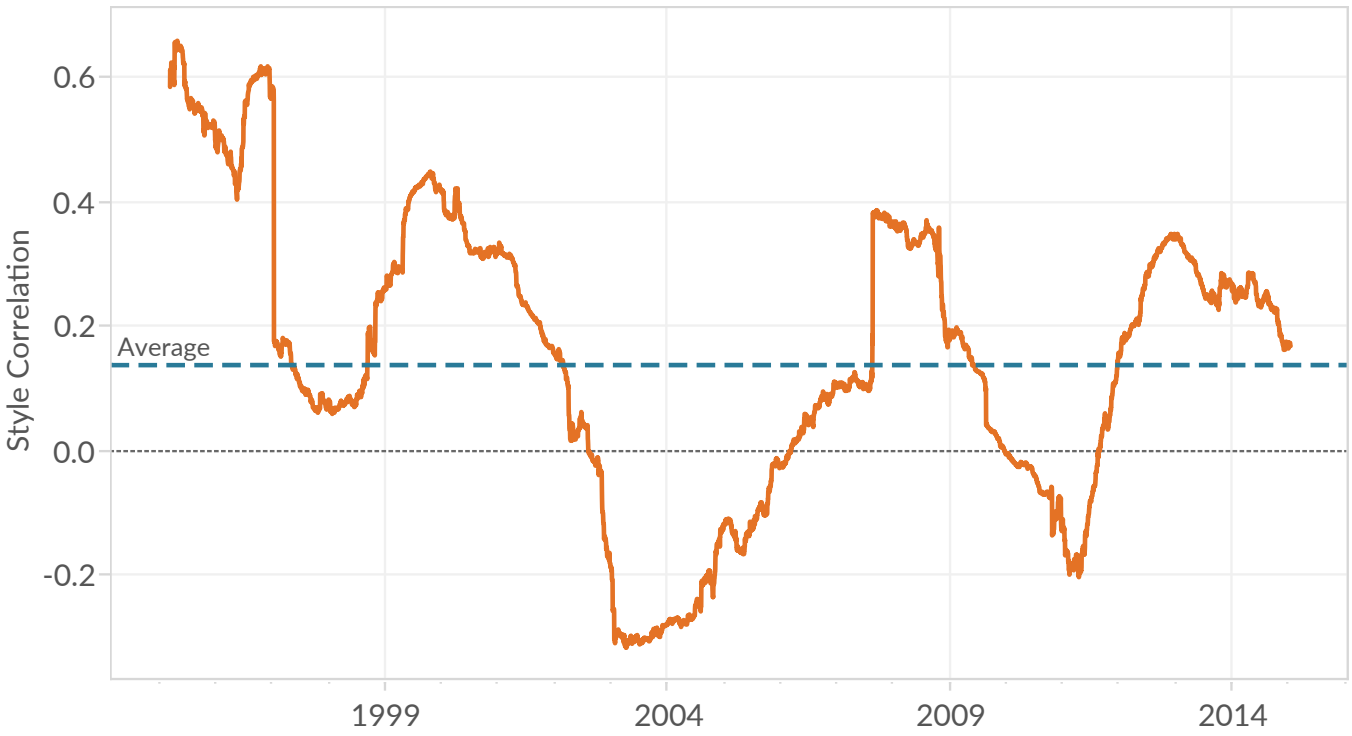
2 Returns are calculated based on daily returns of each index as described in Appendix A. The investable funds are net of fees.

the book-to-market ratio represents the most efficient way to garner exposure to the value risk factor. For example, why not sort firms by earnings yield or cash-flow yield instead?

These definitional differences can prove more than academic. Figure 2 plots the two-year rolling correlation of the expected returns of two definitions of value: book-to-market and earnings yield. For both definitions, a simple ordinary least squares regression strips away confounding effects like industry exposures. As the chart illustrates, between January 1995 and December 2014, the correlation between these competing definitions ranges from negative 0.3 to positive 0.65. The average across this period equaled 0.14.[3]

During periods of relative market stability, the two definitions usually track one another closely. During periods of market distress, the definitions tend to diverge. The Russian financial crisis offers one such example. In August and September of 1998, the Russian government defaulted on their domestic local currency bonds. The US equity markets fell by 18 percent (peak to trough) during August, and a flight to quality ensued. Market participants disproportionately favored firms with stronger book values. Two year correlation between the earnings yield and book-to-market fell from more than 60 percent in 1996 to 10 percent in 1998. Conversely, the correlation broke down again near the end of the financial crisis from 2009 through 2012, when serial mark-to-market write-downs debased the very concept of "book value". During that episode, correlation between the two measures troughed at negative 25 percent as investors seemed to favor firms exhibiting the ability to generate and grow earnings sustainably.

Figure 2 Rolling Correlation of Book to Market and Earnings Yield



Source: Two Sigma Investments, LP.

3 Shorter time horizons (e.g., one-year rolling correlations) exhibit similar patterns.

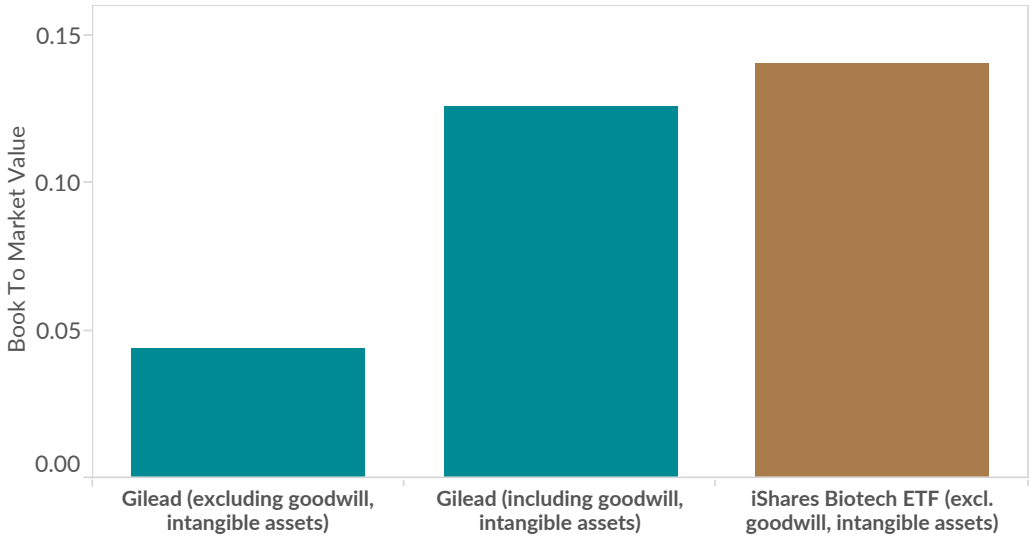
The ambiguity when defining a single risk factor extends beyond equity value, highlighting the challenges asset allocators face. For example, the commodity momentum factor depends on the reference time frame. Short-term and long-term momentum strategies can generate conflicting forecasts for the same instrument (Moskowitz, Ooi, and Pederson, 2012). Another example comes from the equity "quality" factor. Depending on the researcher, "quality" might mean high return on equity, earnings consistency, low financial leverage, or some combination of multiple definitions. Cochrane (2011) notes that researchers have sprouted a "zoo of factors" in the academic literature. Harvey et al. (2014) count more than 300. Eventually, this zoo may induce even more confusion—and more dispersion in definitions—than what already exists for just equity "value."

II. Construction Matters: Common Definitions Can Utilize Different Building Blocks

Factor construction proves as confounding as factor definition. Continuing the earlier analogy, utilizing different manufacturing processes to mix the same ingredients can cause inconsistency in the performance among generic pharmaceuticals, even if they all advertise the same active ingredient. The FDA seems to tolerate a 3.5 percent variation between the absorption rate of generic and brand name drugs despite the consistent "definition" or active ingredient.[4] For asset allocators, a similar level of variation should at least raise questions.

Consider again the definition of an equity value factor defined by the ratio of book value (i.e., assets minus liabilities) to market value. The seemingly simple numerator and denominator of this accounting ratio each mask ambiguity. "Book" can include or exclude goodwill. It must fairly value intangible assets and liabilities. Depreciation and amortization approaches vary across firms. Similarly, firms do not report book values at the same frequency as stock prices change, and the inter-quarter variance in book value can seem noisy. A risk-factor investor must settle on a policy rule to align book value and market value, whether to use year-end values, imputed or reported current values, or some sort of average. Even the semantically assimilated

Figure 3 Book to Market Value



Source: Gilead Sciences Q3 10-Q (September 30, 2015); www.ishares.com.

4 http://www.fda.gov/drugs/resourcesforyou/consumers/buyingusingmedicinesafely/understandinggenericdrugs/ucm167991.htm

"market value" warrants consideration. A risk-factor manager could choose current or year-end shares outstanding. Including or excluding preferred stocks may also generate different market values, and numerous other possible book-to-market constructions exist. The number of permutations when pairing the numerator with the denominator grows exponentially, illustrating the difficulty of defining what appears at first glance to be a relatively simple metric.

These construction differences matter empirically. Consider the example of Gilead Sciences, a large American biotechnology company. As with many companies in this sector, a large fraction of its balance sheet falls under the "intangible asset" category. The value of these assets depends on expected future cash flows from ongoing research and development efforts (i.e., intellectual property). As a result, Gilead's estimated book-to-market ratio is sensitive to the valuation approach applied to these assets. For example, including intangible assets would make Gilead's book-to-market ratio more than three times larger (0.10 versus 0.03) as of the second quarter 2015 (Figure 3). Since the biotech industry average for the period was 0.17, Gilead might appear less overvalued relative to other Nasdaq-listed biotech firms on a book-to-market scale when including intangibles.

Figure 4 further demonstrates the effect different constructions can have on a hypothetical equity portfolio's performance. This example shows expected performance for two classic equity value definitions—book value and earnings yield—after controlling for some potentially complicating factors, such as industry exposures and transaction costs. The box-and-whisker plot illustrates the extent of the dispersion over both a longer duration (2000 through 2008) and a shorter duration (2009, during the financial crisis).

Book value and earnings yield exhibit dispersions of approximately 1.8 percent and 4 percent, respectively, during the longer

Figure 4 Expected Performance of Book Value and Earnings Yield on a Portfolio of Equities

Source: Two Sigma Investments, LP.

NOTES
Expected performance is an annualized figure calculated after residualizing for risk factors including market, style and industry tilts and excluding all execution costs.

period. However, the right panels of both definitions paint a starker contrast. During a period of market disruption, the dispersions widen to 7 percent and 14 percent. That year marked the start of quantitative easing and the beginning of a "junk" rally in US equities. During this short time window, variations in construction could have generated either large expected returns or moderate losses, underscoring the differences that can arise from construction choices.

Multiple constructions also exist for macro risk factors. Once again, consider the commodity momentum factor as an example, while setting aside definitional differences such as the time horizon of the measurement. One might choose to utilize a simple rolling average or an exponentially weighted moving average, but both introduce their own set of challenges.

A moving average construction would mean that large outliers across the time horizon generate large swings in the momentum measurement. Once the moving average window passed one particular outlier, the momentum measurement might change significantly, even if the recent price history of the commodity exhibited minimal variation. Normalizing the data by some measure of recent realized volatility would eliminate some of the outlier effects, but the researcher would still need to select the time period for estimating recent volatility. Complicating matters further, different windows for volatility estimation generate different momentum signals.

Exponentially weighted moving averages address some of these challenges but introduce others. For example, a sudden and recent change in price would affect the momentum measurement more than in an equally weighted moving average. If such a large price change moves in the opposite direction of a longer-term trend, then the momentum measurement would drift closer to zero and away from the expected signal. No consensus in the published research asserts whether this would prove a welcome or counterproductive adjustment, leaving asset managers to decide for themselves which approach would best serve asset allocators.

III. Practical Implications for Risk Factor Investing

For better or worse, a single "correct" or optimal definition and construction of a given factor—equity value, commodity momentum, or another—does not exist. Researchers armed with historical data can only look to identify which formulation has performed better or more consistently along certain dimensions during particular periods. Rarely (if ever) will they find that one definition or one construction dominated along all dimensions during all periods. Instead, when determining how to incorporate risk factors into a broader portfolio, investors must pass judgment not only on definition and construction, but also—and more importantly—on the process of researching, and then selecting among or combining the options.

Passing judgment on a manager's process is not a challenge peculiar to risk factor investing. Thoughtful asset allocators recognize that evaluating strategies simply by their historical track records or (worse) their descriptions does not guarantee future performance.

The challenge peculiar to risk factor investing is that too many asset allocators and investment managers believe that risk factors are generic, and that asset allocators have the luxury of picking from a set of (nearly) identical formulations. Some of the alternative names for risk factor investing, such as "smart beta," reinforce this illusion. Unlike "beta," risk factor investing requires numerous, influential, active decisions by investment managers.[5] Thoughtful asset allocators will need to invest as much effort in assessing these active decisions as they do when evaluating all of their active managers.

5 One can similarly argue that a traditional "beta" index includes a number of variations and active decisions as well, but that topic remains beyond the scope of this paper.

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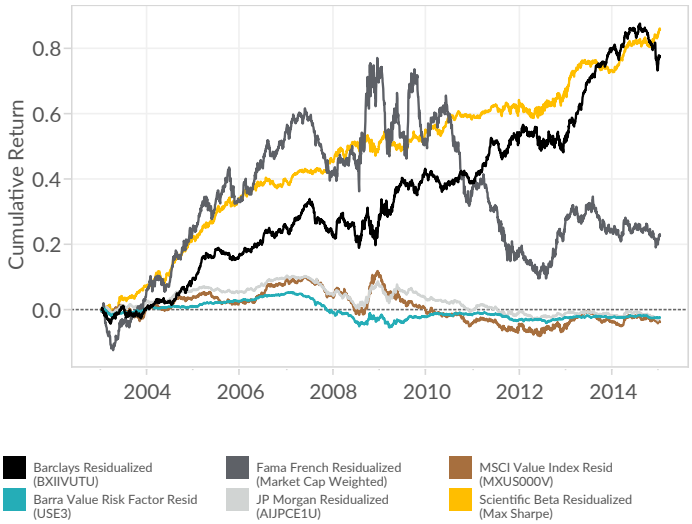
Appendix A: Factor Definitions

Factor Index	Description	Source
Barclay's Value Factor	The Barclays US Value Equity Index takes a long position in a basket of US stocks that look attractively priced based on the chosen value characteristics. This is the total return version of the index in USD.	Bloomberg: BXIIVUTU Index
Scientific Beta	The Scientific Beta Index is a Long Only index based on the top 50 percent stocks in a universe of 500 US stocks ranked by book-to-market value and weighted by max Sharpe.	http://www.edhec-risk.com/ERI_Scientific_Beta
Fama French	The Fama French index is a long-short index. The index takes a long position in the top 20 percent of US stocks and a short position in the bottom 20 percent of US stocks ranked by Book-to-Market value, weighted by market capitalization. The Fama French index is not investable.	http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
MSCI Value Index	The MSCI USA Value Index captures large- and mid-cap US securities exhibiting overall value style characteristics. The value investment style characteristics for index construction are defined using three variables: book value to price, 12-month forward earnings to price and dividend yield. With 316 constituents, the index targets 50 percent coverage of the free float-adjusted market capitalization of the MSCI USA Index.	Bloomberg: MXUS000V Index (https://www.msci.com/documents/10199/68100f32-80a9-499f-a0f9-5a2e0ba81c86)
Barra Value Risk Factor	The USE3 Value Factor captures book value of common equity as of the most recent fiscal year divided by the most recent value of the market capitalization of the equity. The Barra Value Risk Factor is not investable.	http://www.alacra.com/alacra/help/barra_handbook_US.pdf
JP Morgan	The Equity Value Carry strategy takes a long position in the MSCI Daily Value Total Return Gross World Index and a short position in the MSCI Daily Total Return Gross World Index.	Bloomberg: AIJPCE1U Index

Appendix B: Factor Definitions

Figure 5 US Equity Value Premiums Residualized to the Market[6]



Factor Name	Annualized Return	Annualized Std. Deviation
Barclay's Value Factor	4.9 percent	0.06
Scientific Beta	5.3 percent	0.04
Fama French	1.7 percent	0.10
MSCI Value Index	-0.3 percent	-0.04
Barra Value Risk Factor	-0.2 percent	0.02
JP Morgan	-0.2 percent	0.02

Source: Bloomberg, Ken French, Scientific Beta, Barra, Two Sigma Investments, LP.

6 Returns are calculated based on daily returns of each index as described in Appendix A. Returns are then residualized to the Russell 3000 Index of US stocks. The investable funds are net of fees.

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