LINE OF SIGHT

The Equity Imperative

ENGINEERED EQUITY

EVALUATING THE EFFICIENCY OF SMART BETA INDICES: A NEW METRIC

How well smart beta indices capture exposure to compensated risk factors and minimize unintended, uncompensated exposure can help explain the wide differences in performance results among these products. To more accurately measure intended risk-factor exposure, we created a new metric called the Factor Efficiency Ratio (FER) and use it to show that indices with higher FER metrics tend to have correspondingly higher risk-adjusted returns.

April 2015

The number of so-called "smart beta" equity indices have significantly increased over the last several years. While products now number in the hundreds, most seek to capture the excess returns of just a small handful of well-defined risk factors such as size, value, low volatility and dividend yield.[1] The popularity of these new indices is due, in part, to this relative simplicity.

Smart beta indices often produce markedly different performance results, even among those targeting the same factor.

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Despite similar objectives, smart beta indices often produce markedly different performance results, even among those targeting the same factor. For example, high-dividend indices produce a huge range of risk-adjusted returns despite their uniform intent of capturing higher yields. Over the last 10 years, the Dow Jones U.S. Select Dividend index achieved a Sharpe ratio (return per unit of risk) of just 0.37 while the S&P Dividend Aristocrats index yielded a Sharpe ratio of 0.67, more than 80% greater than the Dow Jones index. So, what explains this difference?

Although, these approaches seek excess returns from *compensated* factors such as yield, size and value, there are a number of widely recognized *uncompensated* factors that exist and may contribute meaningfully to risk but do not necessarily produce excess returns. These uncompensated factors include currency exposure and leverage, among others. Through their contribution to higher risk, uncontrolled exposure to these factors tends to lower risk-adjusted returns. Perhaps more importantly, by targeting a specific compensated factor it may be possible to gain undesirable exposure to other compensated factors. For example, while small-cap and value biases can produce positive excess returns, low-volatility indices tend to have a natural large-cap and negative value biases that may detract from returns. These biases stem from correlations that exist among factors, and low-volatility stocks tend to be larger in size and have higher valuations.

Strategies with higher FER metrics tend to have correspondingly higher risk-adjusted returns.

The performance of smart beta and alternative beta indices depends on more than just intentional targeting. How well they deal with unintended exposures to uncompensated and negatively compensated factors is key and can help explain performance differentials across products. In this paper we introduce a new metric for measuring the intended and unintended exposures of smart beta indices. We call this metric the Factor Efficiency Ratio (FER) and show that those with higher FER metrics tend to have correspondingly higher risk-adjusted returns.

The implications of these findings are twofold. First, they help explain the diversity of performance among indices that are highly similar, at least on first glance. Second, they suggest that the those specifically engineered to minimize unintended exposures achieve the highest risk-adjusted returns. In short: design matters.

THE FACTOR EFFICIENCY RATIO

The FER is conceptually very simple: It is the ratio of an index's *intended* factor exposures to its *unintended* exposures. Indices that are more "efficient" achieve more intended factor exposure per unit of unintended exposure.

FER = (Intended Factor Exposure)/(Unintended Factor Exposure)

To achieve a high FER, an index must have a strong tilt toward the compensated risk factor or factors (high numerator), minimize unintended factor exposure (low denominator), or a combination of the two. Factor exposures are calculated using established risk models such as Barra or Axioma. The full technical details of the FER ratio are given in the complementary paper by Hunstad and Dekhayser (2014)[3] published by the Social Sciences Resource Network.

In the next section, we will measure the FER of popular smart beta products that target small size, value, low volatility and dividend yield. We will relate these FER metrics to historical Sharpe ratios and show that high efficiency can lead to high risk-adjusted returns. In doing so, we also introduce the Northern Trust engineered equity strategies and demonstrate that conscientious design leads to both efficient factor exposure and stronger performance.

Small Size

On the whole, there are two approaches to capture excess returns from compensated factors. The first approach is known as "alternative weighting" and uses non-capitalization stock-weighting schemes based on fundamental measures such as sales, assets, etc. While the expressed intent of alternative weighting is simply to deviate from capitalization-weighting, the implied intent is to garner exposure to size and value factors as a source of excess returns.[4]

Alternatively weighted indices such as fundamental indexing approaches make no attempt to target a specific factor and have no mechanism to minimize unintended exposures. As a result, we might expect them to be less inefficient from a FER perspective. Exhibit 1 (page 4) shows this is, indeed, the case.

Despite the widely held belief that alternative weighting captures the small-cap premium, there is no way to ensure this outcome because factor exposures are not specifically targeted or controlled within construction. Indeed, as of December 31, 2014, the FTSE RAFI index actually had a slight *large-cap bias* leading to a negative FER. The unintended exposures are a result of a significant momentum, value and negative growth biases that are unusual for a small-cap index.

NORTHERN TRUST ENGINEERED EQUITY SOLUTIONS

Northern Trust Engineered Equity strategies are designed to target specific risk exposures (factors) intended to provide long-term outperformance while aligning portfolios with investment objectives and engineered to minimize exposure to uncompensated risk factors. The development of Engineered Equity strategies follows the gradual evolution of financial theory over the past several decades. These range from William Sharpe's Capital Asset Pricing Model, which popularized the notion that returns can be expected to increase as systematic market risk (beta) increases, to more-recent models that incorporate multiple factors. Our research suggests that several factors beyond systematic market risk drive equity returns, and a few can lead to improved risk-adjusted performance. These factors include:

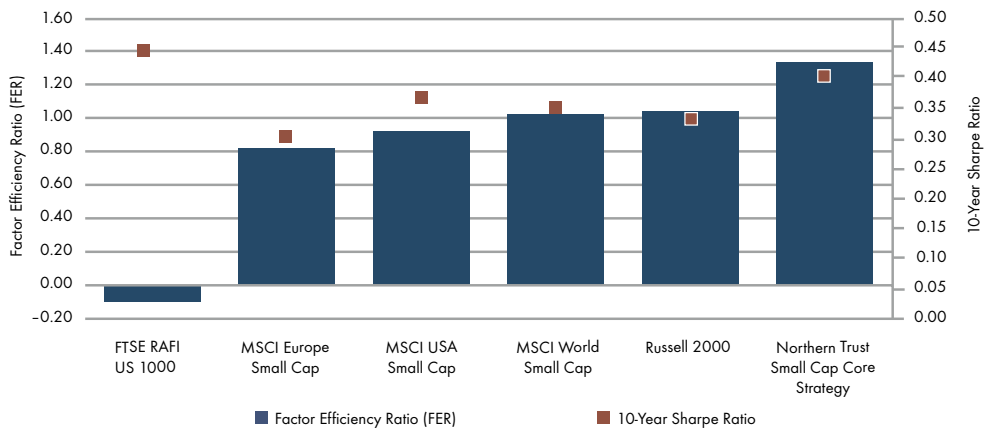
- High Quality
- High Dividend Yield
- High Value
- Small Size
- Low Volatility
- High Momentum

One common issue with strategies targeting single factors is that their performance relative to the market tends to fluctuate over shorter time periods. For many investors, such "factor cycles" give them pause because they may understand the long-term virtues of the exposure but have limited tolerance for long periods of poor performance. This can be mitigated by combining multiple uncorrelated factors. In particular, our research suggests that incorporating the quality factor improves risk-adjusted performance, and it also acts as a powerful complement to other factor exposures, both in terms of risk management and performance.

The second general approach targets a factor explicitly through the stock-selection process. For small-cap stocks, this is often as simple as defining the product universe based on capitalization. For example, the Russell 2000 index is simply the smallest two-thirds of the Russell 3000 index, based on market capitalization. However, note that targeting a factor in this manner does not allow for specific control of the intended factor – you simply get what you get.

The Northern Trust Small-Cap Core strategy actively concentrates holdings at the smaller end of the capitalization spectrum and achieves a significantly higher small-size exposure than most of the other indices shown in Exhibit 2. In doing so, it maintains unintended exposures at a level significantly below other targeted indices, thereby achieving a high degree of efficiency and a high FER. In fact, the Northern Trust Small Cap Core strategy is 28% more efficient than any small-cap index analyzed.

EXHIBIT 1: FER ANALYSIS – SMALL-SIZE FACTOR



Source: Northern Trust Quantitative Research and Barra Portfolio Manager, FTSE, MSCI and Russell

EXHIBIT 2: COMPARISON OF FER – SMALL-SIZE FACTOR

	FTSE RAFI US 1000	MSCI Europe Small Cap	MSCI USA Small Cap	MSCI World Small Cap	Russell 2000	Northern Trust Small Cap Core Strategy
Intended Exposure (Small Size)	–0.22	2.58	2.76	2.70	3.35	3.32
Unintended Exposure	2.18	3.16	2.98	2.65	3.21	2.49
Factor Efficiency Ratio (FER)	–0.10	0.82	0.92	1.02	1.04	1.33

Source: Northern Trust Quantitative Research and Barra Portfolio Manager. Data as of 12/31/2014 from the Barra GEM2 risk model. Exposure figures are risk-weighted and were multiplied by 100 to facilitate comparison.

Value

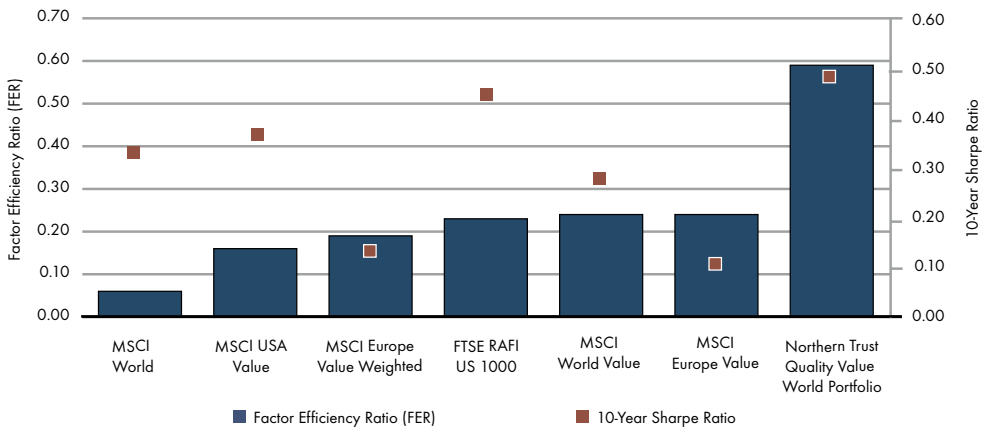
Despite their purported attempt to capture the value premium, few value-oriented smart beta indices have achieved higher risk-adjusted returns than their cap-weighted benchmarks over the last 10 years.

This is not because the value factor itself underperformed but is due in part to the poor performance of unintended exposures.[5] With targeted value exposure and focused management of unintended risks, the Northern Trust World Quality Value Portfolio has a FER more than double that of all other value products analyzed (Exhibit 3).

Few value-oriented smart beta indices have achieved higher risk-adjusted returns than their cap-weighted benchmarks.

Many of the other value indices analyzed had significant exposure to size, momentum and volatility factors. For example, the MSCI USA Value index had a larger absolute exposure to size than value, with a very significant volatility exposure. In this sense, the MSCI USA Value index looks and should behave more like a large-cap low-volatility index than a value index. Other indices likewise held a potpourri of significant unintended exposures.

EXHIBIT 3: FER ANALYSIS – VALUE FACTOR



Source: Northern Trust Quantitative Research and Barra Portfolio Manager, FTSE and MSCI

EXHIBIT 4: COMPARISON OF FER – VALUE FACTOR

	MSCI World	MSCI USA Value	MSCI Europe Value Weighted	FTSE RAFI US 1000	MSCI World Value	MSCI Europe Value	Northern Trust Quality Value World Portfolio
Intended Exposure (Value)	0.05	0.50	0.58	0.36	0.56	0.71	0.54
Unintended Exposure	0.94	3.17	3.04	1.60	2.36	2.93	0.92
Factor Efficiency Ratio (FER)	0.06	0.16	0.19	0.23	0.24	0.24	0.59

Source: Northern Trust Quantitative Research and Barra Portfolio Manager. Data as of 12/31/2014 from the Barra GEM2 risk model. Exposure figures are risk-weighted and were multiplied by 100 to facilitate comparison.

Low Volatility

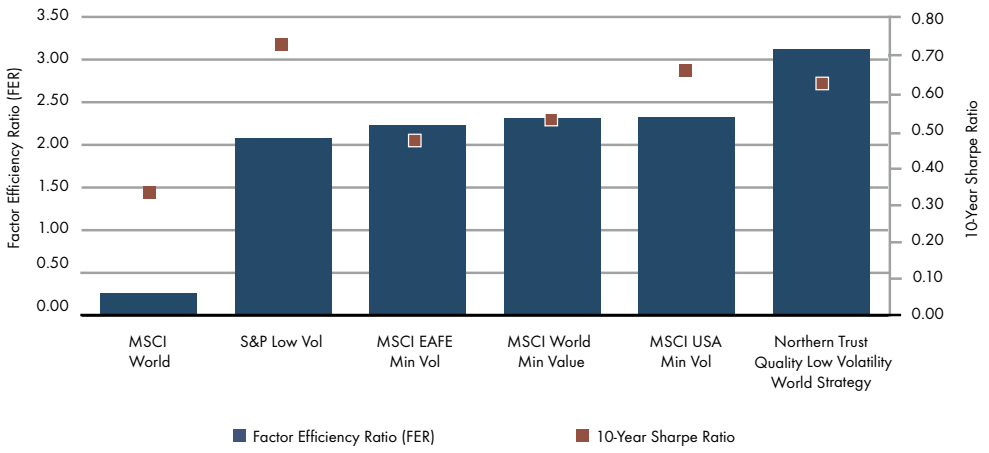
The degree of unintended exposure can speak volumes about product design. Although the S&P Minimum Volatility index maintains a volatility exposure consistent with products like the MSCI USA Minimum Volatility index, the S&P approach has almost 20% more unintended exposure than the MSCI index. In particular, the leverage, growth and size exposures were significantly higher.

We can think of FER as a measure of factor "purity."

While these unintended exposures did not necessarily detract from performance, they call into question the intent of the index – is it a true low-volatility index or is it intentionally trying to capture size and growth premia? In this sense, we can think of FER as a measure of factor "purity." These large, unintended exposures cause the S&P Minimum Volatility index to have a low FER.

The Northern Trust Quality Low Volatility World strategy has both the largest intended exposure and among the smallest unintended factor exposure of all low-volatility products, almost 34% higher than the second-place MSCI USA Minimum Volatility index. This is

EXHIBIT 5: FER ANALYSIS – LOW VOLATILITY FACTOR



Source: Northern Trust Quantitative Research and Barra Portfolio Manager, S&P Dow Jones and MSCI

EXHIBIT 6: COMPARISON OF FER – LOW-VOLATILITY FACTOR

	MSCI World	S&P Low Vol	MSCI EAFE Min Vol	MSCI World Min Vol	MSCI USA Min Vol	Northern Trust Quality Low Volatility World Strategy
Intended Exposure (Low Vol.)	0.21	3.17	2.53	3.14	3.00	3.94
Unintended Exposure	0.79	1.53	1.14	1.35	1.29	1.26
Factor Efficiency Ratio (FER)	0.26	2.08	2.23	2.32	2.33	3.12

Source: Northern Trust Quantitative Research and Barra Portfolio Manager. Data as of 12/31/2014 from the Barra GEM2 risk model. Exposure figures are risk-weighted and were multiplied by 100 to facilitate comparison.

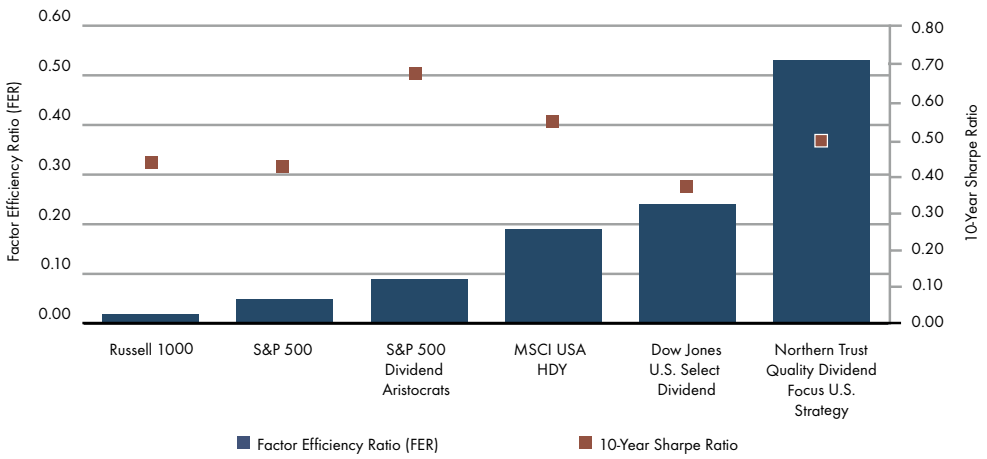
achieved through very tight controls on unintended risks, thus delivering a very "pure" and concentrated exposure to the low-volatility factor.

Dividend Yield

The FER can also be a meaningful measure of style drift. While the S&P 500 Dividend Aristocrats yielded the highest risk-adjusted returns of any dividend index analyzed, it actually had a very small exposure to dividend yield – less than half of the MSCI index exposure and less than a third of the Northern Trust Quality Dividend Focus strategy exposure.[6] In fact, the intended exposure of the S&P 500 Dividend Aristocrats was only slightly higher than the S&P 500 index itself.

What the S&P 500 Dividend Aristocrats index does have is a large low-volatility exposure that dwarfs the intended dividend exposure. In this sense, the S&P 500 Dividend Aristocrats may be more correctly classified as a low-volatility index, with a Sharpe ratio that is very similar to other S&P and MSCI low-volatility indices. This is partially the result of unintended exposure not being specifically controlled in the design of the Dividend Aristocrats index.

EXHIBIT 7: FER ANALYSIS – DIVIDEND YIELD FACTOR



Source: Northern Trust Quantitative Research and Barra Portfolio Manager, S&P Dow Jones and MSCI

EXHIBIT 8: COMPARISON OF FER – DIVIDEND YIELD FACTOR

	Russell 1000	S&P 500	S&P 500 Dividend Aristocrats	MSCI USA HDY	Dow Jones US Select Dividend	Northern Trust Quality Dividend Focus U.S. Strategy
Intended Exposure (Div. Yield)	0.03	0.11	0.38	0.96	1.18	1.27
Unintended Exposure	1.22	2.21	4.21	5.03	4.87	2.41
Factor Efficiency Ratio (FER)	0.02	0.05	0.09	0.19	0.24	0.53

Source: Northern Trust Quantitative Research and Barra Portfolio Manager. Data as of 12/31/2014 from the Barra USE3L risk model. Exposure figures are risk-weighted and were multiplied by 100 to facilitate comparison.

The MSCI USA High Dividend Yield index has a meaningful dividend exposure but a host of large unintended exposures, including volatility, momentum and size. Again, we can attribute at least part of the index's performance to these unintended exposures. Like the Dividend Aristocrats, the MSCI USA High Dividend Yield index makes no attempt to manage unintended risks.

The Northern Trust Quality Dividend Focus strategy is designed to deliver pure dividend exposure without style drift. This is evidenced by the strong relative intended exposures and unintended exposures that are about half those of other approaches. This leads to a significantly higher efficiency and a higher FER.

The Northern Trust Quality Dividend Focus strategy is designed to deliver pure dividend exposure without style drift.

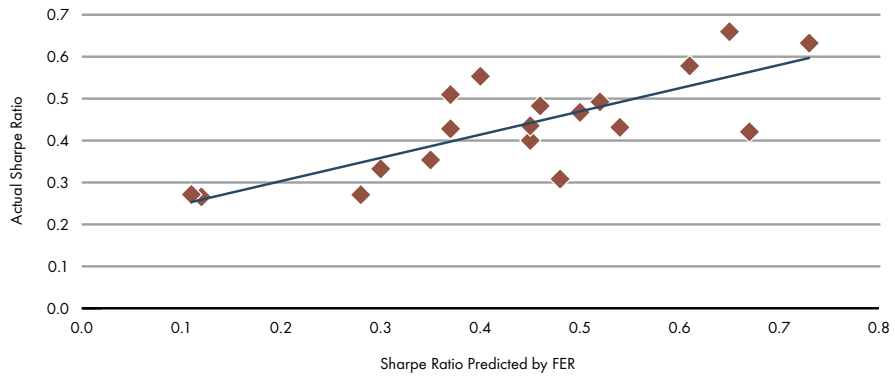
Design Matters!

Intuitively we expect indices with higher FER ratios to deliver higher risk-adjusted returns. The numerator of the FER is a measure of exposure to one or more *compensated* factors. As the numerator increases, we expect returns to increase proportionally. The denominator is a measure of all unintended exposures, including uncompensated and negatively compensated. By minimizing the denominator, we rid the index of excess risks that do not necessarily produce return. As a result, an efficient factor exposure and high FER ratio should lead to high risk-adjusted returns as measured by Sharpe ratios.[7]

Estimating the empirical relationship between FERs and Sharpe ratios is complicated by the markedly different performance of equity markets around the globe. It is not sufficient to simply regress FERs on Sharpe ratios, as these differences cause a violation of one of the basic assumptions of the linear regression model.[8] Instead, we utilize a random effects model which properly corrects for this violation, the details of which are fully explained in Hunstad and Dekhayser (2014).

Exhibit 9 shows the results of the random effects estimation. There is a strong relationship between the Sharpe ratio predicted from the FER and the actual Sharpe ratio. The R^2 of this model is approximately 0.54 suggesting a correlation between FER and Sharpe of

EXHIBIT 9: RANDOM EFFECTS ESTIMATION



Source: Bloomberg, MSCI, Barra and Northern Trust Quantitative Research

more than 0.73. The FER beta is positive and statistically significant at the 99% confidence level (see appendix for details). Thus, we conclude the relationship between FERs and Sharpe ratios is as-expected, positive and statistically valid.

Northern Trust equity strategies are engineered to deliver high FERs. The result is highly efficient exposure to intended factors, free of unnecessary style drift and unintended bets. This efficiency has translated into superior risk-adjusted returns across the strategy set.

For more information on the efficient use of compensated risk factors, see the Northern Trust paper, "Combining Risk Factors for Superior Returns".[9] The importance of targeting strategies with high risk-adjusted returns is discussed in our paper, "Improving Active Risk Budgeting".[10]

APPENDIX

Exhibit 10 details the factor efficiency ratios (FER) and 10-year Sharpe ratios for all smart beta indices analyzed in this paper. We note Sharpe ratios for European indices are markedly lower than similar indices in the United States or with World coverage. In fact, the average Sharpe ratio for European and EAFE indices is 0.25 while the average Sharpe ratio for U.S. indices is 0.50. This difference creates problems when attempting to relate FERs, which are not affected by differentials in market performance, to Sharpe ratios, which are clearly influenced by these differences. Simply correlating FERs and Sharpe ratios across the entire group of products would produce spurious results.

One approach to correct this problem is to utilize a random effects model described fully in Greene (2002). Similar in many ways to a classical linear regression, the random effects model appropriately corrects for regional biases, if present. To test for the applicability of the random effects model, we performed both the Lagrange multiplier test of Breusch and Pagan (1980) and the specification test of Hausman (1978). Data was divided in two groups by region, specifically U.S. indices formed group 1 and non-U.S. and global indices formed group 2.

The Breusch Pagan test statistic of 270.8778 far exceeds the 95% critical value for the chi-squared distribution with one degree of freedom, 3.8415. We therefore conclude that the classical regression model is inappropriate and reject this null in favor of the random effects model. The Hausman test statistic of 0.2636 is less than the critical value of 3.8415, thus we cannot reject the hypothesis that regional effects are uncorrelated with FERs. Based on the Breusch-Pagan test, which is decisive that regional effects exist, and the Hausman test, which suggests that these effects are uncorrelated with other variables in the model, we conclude that the random effects model is appropriate. See Greene (2002) or Davidson and MacKinnon (2003) for a full description of these tests.

EXHIBIT 10: 10-YEAR SHARPE RATIOS AND FER

	10-Year Sharpe Ratio	Factor Efficiency Ratio (FER)
FTSE RAFI (Size)	0.45	(0.10)
MSCI Europe Small Cap	0.30	0.82
MSCI USA Small Cap	0.37	0.92
MSCI World Small Cap	0.35	1.02
NT Small Cap Core	0.40	1.33
MSCI USA Value	0.37	0.16
MSCI Europe Value Weighted	0.12	0.19
FTSE RAFI (Value)	0.45	0.23
MSCI World Value	0.28	0.24
MSCI Europe Value	0.11	0.24
NT World Quality Value	0.48	0.59
S&P Low Vol	0.73	2.08
MSCI EAFE Min Vol	0.46	2.23
MSCI World Min Vol	0.52	2.32
MSCI USA Min Vol	0.65	2.33
NT World Quality Low Vol	0.61	3.12
S&P 500 Dividend Aristocrats	0.67	0.09
MSCI USA HDY	0.54	0.19
Dow Jones US Select Dividend	0.37	0.24
NT Quality Dividend Focus US	0.50	0.53

Source: Northern Trust Quantitative Research, S&P Dow Jones, MSCI, FTSE and Russell

The results of the random effects model with regional effects is shown in Exhibit 11. As discussed, the model is highly significant and the FER coefficient of 0.10656 has the expected sign. Further, the model explains more than 50% of the variation in Sharpe ratios across the dataset, suggesting the relationship between FERs and Sharpe ratios is robust. Note that metrics in Exhibit 11 are interpreted the same way as in ordinary least-squares regression.

EXHIBIT 11: RANDOM EFFECTS WITH REGIONAL EFFECTS

	Estimate	Standard Error	t-Stat	DF	p-Value
Intercept	0.32824	0.07228	4.5412	18	0.000252
FER	0.10656	0.02684	3.9694	18	0.000899
R^2	0.5369				
Adjusted R^2	0.5112				
AIC	–19.726				
BIC	–15.743				

Source: Northern Trust Quantitative Research

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ENDNOTES

1 For a thorough analysis of compensated risk factors, see "Understanding Factor Tilts," Northern Trust, June 2013

2 Figures as of 12/31/2014

3 Hunstad, Michael and Dekhayser, Jordan, "Evaluating the Efficiency of 'Smart Beta' Indexes," Northern Trust, October 2014

4 Research Affiliates, RAI Fundamental Index

5 For the 10 years ending 12/31/2014, the cheapest quintile of stocks in the MSCI World Index outperformed the most expensive quintile by more than 200 bps annually

6 Actual dividend yields as of 12/31/2013, were: S&P 500 1.96%, S&P 500 Dividend Aristocrats 2.27%, MSCI USA HDY 3.07% and NT Quality Dividend Focus 3.24%

7 A Sharpe ratio is defined as the annualized return of the product above the risk-free rate divided by the annualized standard deviation of excess returns

8 Specifically, the Gauss Markov theorem assumes error terms are uncorrelated with regressors. Regional differences in equity returns causes a marked violation of this assumption thereby invalidating the regression estimate

9 "The Equity Imperative: Combining Risk Factors for Superior Returns," Northern Trust, October 2014

10 "The Equity Imperative: Improving Active Risk Budgeting," Northern Trust, May 2014

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Important Information Regarding Hypothetical Returns – Where hypothetical portfolio data is presented, the portfolio analysis assumes the hypothetical portfolio maintained a consistent asset allocation (rebalanced monthly) for the entire time period shown. Hypothetical portfolio data is based on publicly available index information. Hypothetical portfolio data contained herein does not represent the results of an actual investment portfolio but reflects the historical index performance of the strategy described which were selected with the benefit of hindsight. Components of the hypothetical portfolio were selected primarily utilizing actual historic market risk and return data. If the hypothetical portfolio would have been actively managed, it would have been subject to market conditions that could have materially impacted performance and possibly resulted in a significant decline in portfolio value.

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