MSCI

Research Insight

Introducing MSCI IndexMetrics

An Analytical Framework for Factor Investing

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Executive Summary

Factor investing aims to capture exposures to various equity risk premia. For that, investors need a standardized approach to assess whether a factor investment meets their objectives along the dimensions of performance, exposure, investability, and, for multi-factor investments, combination effects (diversification and turnover reduction). MSCI has created the "IndexMetrics" analytical framework to address this need and to help bring transparency to multi-factor allocations.

The rationale for IndexMetrics and the analysis of factor indexes it provides are presented in a series of three papers. In this, the third paper of the series, we describe IndexMetrics, which turns the concepts laid out in the first two papers into a set of actionable and concrete quantitative metrics along the dimensions of performance, exposure, investability, and combination effects. The process that this analytical framework follows is summarized in Exhibit 1 over the page.

The output of IndexMetrics is a standardized report which aims to answer the following questions:

1) ***Performance:***
   a) *How has the factor index performed in absolute, relative, and risk-adjusted terms?*
   b) *How does the whole factor index return distribution look in terms of shape and tails?*
2) ***Exposure:***
   a) *What are the active factor, sector and region exposures in the index?*
   b) *How does the index look now, and versus history, in terms of fundamental valuation?*
3) ***Investability:***
   a) *How liquid, on average, are the index constituents? How has that changed over time?*
   b) *What size of allocation can be efficiently allocated into a portfolio replicating the index?*
   c) *What turnover should an institutional investor expect when replicating the index?*
4) ***Combination Effects:***
   a) *How does a combination of factor indexes benefit from diversification?*
   b) *How does a combination of factor indexes benefit from natural crossing?*

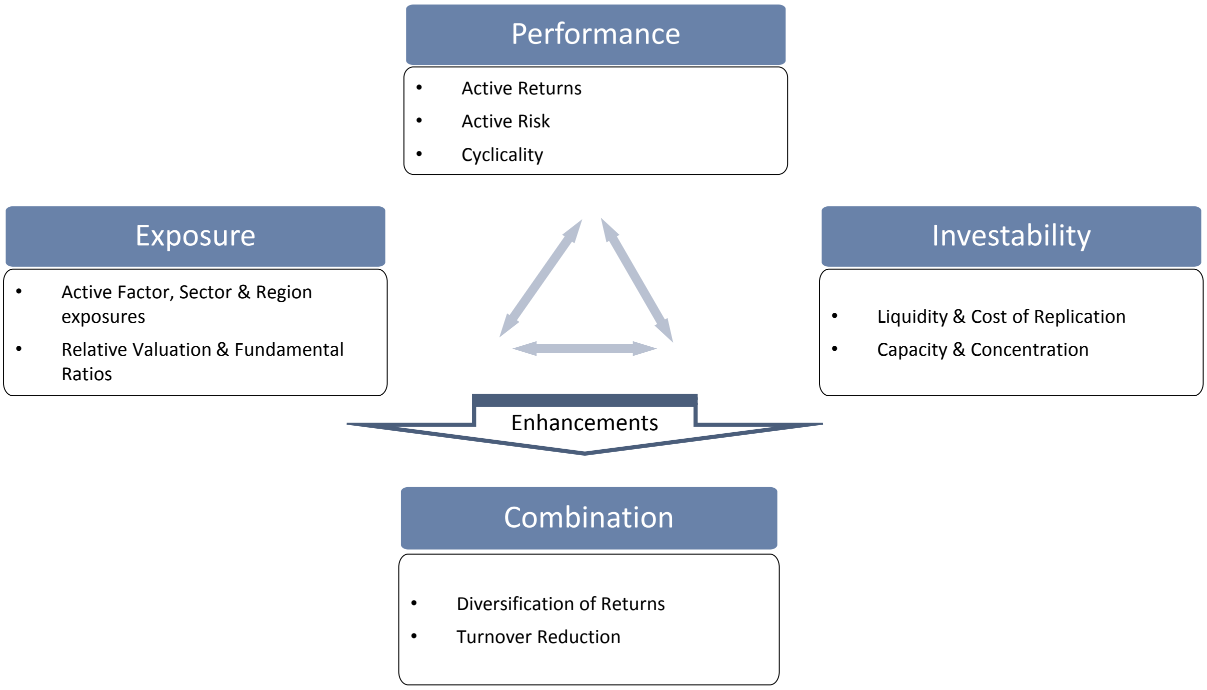
IndexMetrics provides a consistent, scalable, analytical framework to help investors answer these performance, exposure, investability and combination effect questions, and incorporate the results into index selection and combination. We believe IndexMetrics significantly enhances the current analytical framework for factor investing by not only giving a comprehensive risk/return view at the single factor level, but also adding an understanding of the sources of the underlying exposures driving the risks and returns.

At the same time, the IndexMetrics analytical framework adds an extra dimension which has very often been overlooked in such analyses to date: investability. We believe IndexMetrics is one of the first analytical frameworks to address investability in a structured way.

Finally, IndexMetrics also attempts to measure the diversification and turnover reduction effects of combining several factor indexes into a multi-factor index.

The rest of this paper proceeds as follows: The next two sections briefly introduce factor investing, the combinations of factor indexes, and the goal of the IndexMetrics analytical framework. We then define the scope and output of IndexMetrics by describing the output of the analysis on the MSCI ACWI Quality Mix Index, a multi-factor index. Finally, Appendices describe in more detail the calculation of our metrics and the Barra risk model we use to describe factor exposures.

Exhibit 1: The IndexMetrics Analytical Framework



I. Factor Investing

What Are We Measuring?

Before an investor can select and allocate among factor investments, it is important to understand what they are. As the first paper in this series, "Foundations of Factor Investing", shows, a factor can be thought of as any consistent characteristic that is important in explaining the returns and risk associated with a group of related securities. Researchers generally look for factors that can explain the performance of a broad range of stocks and are persistent.

From hundreds if not thousands of identifiable factors, we distinguish between generic factors and premium-earning factors (or "risk premia factors"), which earn persistent significant premia over long periods via increased return and/or reduced risk. In other words, these factors earn a *risk premium* relative to a capitalization-weighted market index. We currently identify six such risk premia factors: **Value, Low Size, Low Volatility, High Yield, Quality and Momentum**. They are grounded in academic research and have solid explanations as to why they have historically provided a premium.

Exhibit 2: MSCI Factor Indexes

Systematic Factors	MSCI Indexes
Value	➢ **MSCI Value Weighted Indexes:** Capture Value factor by weighting according to four fundamental variables (Sales, Earnings, Cash Flow, Book Value)
Low Size (Small Cap)	➢ **MSCI Equal Weighted Indexes:** Capture low size effect by equally weighting all stocks in a given parent index
Low Volatility	➢ **MSCI Minimum Volatility Indexes:** Reflect empirical portfolio with lowest forecast volatility using minimum variance optimization ➢ **MSCI Risk Weighted Indexes:** Capture low volatility stocks by weighting based on the inverse of historical variance
High Yield	➢ **MSCI High Dividend Yield Indexes**: Select high dividend stocks with screens for quality and potential yield traps
Quality	➢ **MSCI Quality Indexes:** Capture high quality stocks by weighting based on debt-to-equity, return-on-equity, and earnings variability
Momentum	➢ **MSCI Momentum Indexes:** Reflect the performance of high momentum stocks by weighting based on 6- and 12-month momentum scaled by volatility

However, persistent factors described by academics often entail assumptions that in practice are difficult to capture in real-life portfolios. They do not, nor are they meant to, consider systematically features that are key to actual implementation: transaction costs, liquidity, investability, capacity. Therefore, until recently, premium factor returns could only reasonably be captured by active managers.

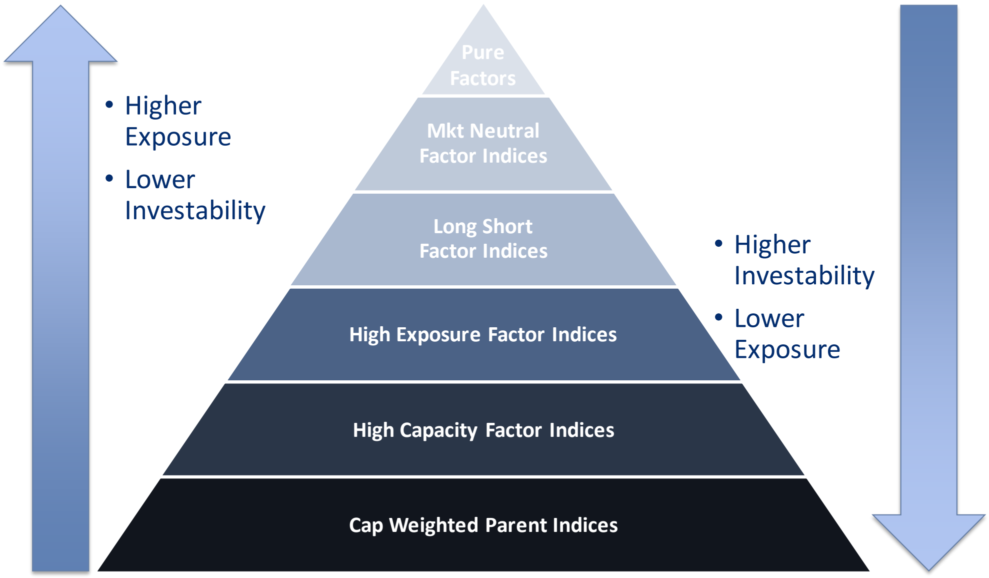
Over the last decade, index providers recognized that the performance of factor investments could be measured through indexes in transparent rules-based ways. They showed that historically, factor investments outperformed the market over long horizons with risk-adjusted performance related to their theoretical factor counterparts while also having strong liquidity and investability characteristics. MSCI developed an investable factor index family to reflect the premium factors identified above.

Exhibit 2 above summarizes MSCI's factor index family, which is applied to a full range of geographies—flagship global indexes like the MSCI ACWI, MSCI World, MSCI Emerging Markets, and MSCI EAFE Indexes, as well as many individual country indexes. The IndexMetrics framework analyzes the performance and exposure of these factor indexes and compares them to market capitalization weighted indexes. Investability is also addressed in a structured way, and in addition, IndexMetrics brings a new transparency to the combination effects of multi-factor indexes, both in terms of diversification and turnover reduction.

Key Characteristics of Factor Indexes

Critical decisions for constructing factor indexes include the choice of the security universe, the choice of the weighting scheme, and the rebalancing frequency. Exhibit 3 below visually displays a ***general framework*** in which these three decisions fit together, with purity of factor exposure increasing as we move up the pyramid and investability increasing as we move down. The closest to market capitalization weighted indexes are the High Capacity Factor Indexes. These are indexes that hold all the stocks in the parent index but use a different weighting scheme from market capitalization weighting. As we move up, High Exposure Factor Indexes target a subset of stocks and can employ various weighting schemes. Optimization or screening can be used for high exposure factor indexes to control or neutralize active country or industry weights or exposures to other style factors; or to control turnover, tracking error, or concentration. Next, Long Short Factor Indexes add leverage (e.g., 150/50, 130/30) and typically employ optimization, and lastly Market Neutral Factor Indexes are pure long/short indexes that have zero market exposure.[1]

Exhibit 3: Alternative Ways of Capturing Factors through Indexation



We stress that there is an unavoidable tradeoff as we move up and down the pyramid between purity of factor, and investability, complexity, and tracking error of the factor index. Some institutional investors will prefer higher capacity approaches for lower tracking error, investability, and simplicity, while others will prefer the higher exposure approaches for their stronger signal strength and potential return enhancement. Investors must make a self-assessment of where they

[1] Active country and sector weights will be zero and exposures to all other style factors will be zero.

desire to be on the pyramid, and IndexMetrics aims to provide this consistent, scalable, analytical framework needed to help institutional investors make this assessment, and incorporate the results into index selection and combination. IndexMetrics aims to give not only a comprehensive view of risk and return at the factor index level, but also to add an understanding of the sources of the underlying exposures driving the risks and returns while addressing investability and combination effects in a structured way.

Combining Factor Indexes

While the discussion so far has focused on single factor investments, the historical cyclicality of factor returns may provide a strong motivation for certain investors to combine multiple factor investments through multi-factor allocations. The second paper in our series, "Deploying Multi-Factor Index Allocations in Institutional Portfolios", addresses combination effects of multi-factor indexes.

Performance and Diversification. Although MSCI's individual factor indexes have outperformed their market capitalization-weighted counterparts since 1988, relative returns have been cyclical and some factor indexes have experienced long periods of underperformance. At the same time, periods of underperformance for the factor indexes have not been identical. Allocating to multiple factors can address some of these cyclicality issues, and thus has historically provided lower volatility and tracking errors, higher information ratios, and less regime dependency over the business cycle.

Notably, the active returns of the MSCI Value Weighted, MSCI Quality and MSCI Momentum Indexes have historically very low or negative correlation with most of our other factor indexes. As an illustration, in Exhibit 7, we show the Risk Profile of the MSCI ACWI Quality Mix Index, which is an equally weighted combination of the MSCI ACWI Quality Index, the MSCI ACWI Value Weighted Index and the MSCI ACWI Minimum Volatility Index, rebalanced semi-annually, together with the Risk Profile of its components. While the returns are effectively linear combinations of the individual indexes, the risk metrics are not. For example, over the period from the end of May 1999 to end-September 2013, the MSCI ACWI Quality Mix Index exhibited an information ratio of 0.59 (compared to 0.29, 0.42 and 0.39 for each of the underlying indexes respectively) by virtue of high active returns and low tracking error.

Turnover Efficiency. A second possible reason for combining multiple factors in a single index is the opportunity to reduce turnover in the index. This "natural crossing" leads to lower turnover and by implication, potentially lower transaction costs in index replicating portfolios. Take for example a stock whose price is falling over time. As the price falls, it may drop out of a momentum strategy but the lower price could push the stock into a value strategy. If a manager is managing both the momentum and value portfolios together, the manager would not have to sell or buy all the shares required of the individual portfolios but could "cross" the overlapping trades. The accompanying reduction in turnover translates directly into lower transaction costs.

One major innovation in the IndexMetrics analytical framework is an attempt to measure the effects of combining several factor indexes into a multi-factor index in a structured way, and as such, IndexMetrics can help investors quantify the potential effects of combining factor investments into multi-factor allocations in terms of diversification and turnover reduction.

In the following section, we describe the IndexMetrics report structure and walk through its sections in detail, giving the motivation behind displaying the metrics shown, using a real-world example.

In addition, Appendix A goes through the IndexMetrics calculations in more detail and Appendix B gives some details on the Barra risk model used to describe factor exposures.

II. MSCI IndexMetrics – An Analytical Framework for Factor Investing

The Aim of IndexMetrics

IndexMetrics is designed to provide investors with quantitative measures along four dimensions - performance, exposure, investability, and combination effects - that can inform their decisions regarding factor investments including multi-factor allocations.

IndexMetrics leverages MSCI's extensive and high quality historical data, while using the Barra analytical framework to generate factor exposure data. The metrics it provides collectively give a comprehensive view on the performance, exposure, and investability characteristics of a factor index, and, for a multi-factor index, diversification and turnover reduction effects as well.

IndexMetrics allows clients to analyze combinations of standard factor indexes. During the exploratory/design phase of a multi-factor index clients may iterate through several permutations, and compare these on a consistent basis, before selecting their final combination.

IndexMetrics – Scope and Output

The motivation for IndexMetrics comes from our many clients who have asked for scalable, standardized analytical tools to help them address the following questions when choosing between different single factor investment strategies and their combinations:

1) ***Performance:***
    a) *How has the factor index performed in absolute, relative, and risk-adjusted terms?*
    b) *How does the whole factor index return distribution look in terms of shape and tails?*
2) ***Exposure:***
    a) *What are the active factor, sector and region exposures in the index?*
    b) *How does the index look now, and versus history, in terms of fundamental valuation?*
3) ***Investability:***
    a) *How liquid, on average, are the index constituents? How has that changed over time?*
    b) *What size of allocation can be efficiently allocated into a portfolio replicating the index?*
    c) *What turnover should an institutional investor expect when replicating the index?*
4) ***Combination Effects:***
    a) *How does a combination of factor indexes benefit from diversification?*
    b) *How does a combination of factor indexes benefit from natural crossing?*

A summary and grouping of some sample metrics is given in Exhibit 4 below. Please note that when we mention 'active' risk, return or factor exposures, these are in relation to the parent index.

In the rest of this paper we highlight the sample metrics through an example IndexMetrics report on the MSCI ACWI Quality Mix Index with the MSCI ACWI Index as its parent index. A detailed definition of the metrics and their calculation methodology are given in Appendix A. Risk measures come from the Barra Global Equity Model (GEM2L), whose details are discussed in Appendix B.

Exhibit 4: Summary and Grouping of Sample Metrics.

Performance Metrics	
Key Metrics	Return (Total, Active) Risk (Total, Active) Beta Sharpe/Information Ratio Turnover Key Valuation Ratios
Risk Profile	Risk (Total, Active, Downside) Sortino Ratio 95/99 Percentile VaR Expected Shortfall @ 95%/99% Max Drawdown (Total, Active) Max Drawdown Period (in Months) Skewness and Kurtosis

Exposure Metrics	
Active Exposures	Active Factor/Sector/Region Exposures
Valuations	Price/Book Price/Cash Earnings Price Earnings Price/Sales Dividend Yield Long-Term Forward EPS Growth Sustainable Growth Rate Return on Equity

Investability Metrics	
Liquidity & Cost of Replication	Weighted Average AVTR (%) Days to Trade - Periodic Rebalancing and Relative to Parent Index/Cash Turnover Performance Drag
Capacity & Concentration	Average/Effective Number of Stocks Top 10 Security Weight Market Cap Coverage (%) Capacity Measures (% of Float/Full Market Cap) Active Share Average/Maximum Weight Multiplier
Top Constituents & Top Active Positions	Top Absolute/Active Weights

Combination Effects	
Diversification	Active Return Correlations
Turnover	Natural Crossing Benefits

III. Performance Metrics

Key Metrics

The key metrics, along with charts and tables of absolute and relative index performances are intended to provide a high level one-page summary of the characteristics and performance of the factor index relative to the parent index, and provide stepping off points for the more detailed analysis in later sections. The key metrics along with their definitions are detailed in Exhibit 5 below.

Exhibit 5: IndexMetrics - Key Metrics

Key Metrics	Definition
Total Return	Annualized Total Return is a measure of gain or loss on the index.
Total Risk	Total Risk (also called Volatility) is a measure of index return dispersion. Annualized volatility is computed as the standard deviation of monthly index Total Returns.
Return/Risk	Return/Risk is the index return per unit of index risk, computed as the ratio of Total Return to Total Risk.
Sharpe Ratio	The Sharpe Ratio is computed as the ratio of average index Excess Return to risk where Excess Return is the average monthly difference between the Index Total Return and the risk-free rate, annualized.
Active Return	Active return is the Total Return of a factor index relative to its parent.
Tracking Error	Tracking Error (also called Active Risk) measures the dispersion of Active Returns between a factor index and its parent, and is calculated as the annualized standard deviation of Active Returns.
Information Ratio	Information Ratio measures Return/Risk in Active space, calculated as the ratio of Active Return to Tracking Error.
Historical Beta	Beta is a measure of the level of co-movement between a factor index and its parent.
Turnover	Turnover measures the percentage change in the composition of an index at each index rebalancing.
Price to Book Value	Total free float adjusted market capitalization of the index divided by total free float weighted book value of its constituents.
Price to Earnings	Total free float adjusted market capitalization of the index divided by total free float weighted earnings of its constituents.
Dividend Yield	Total free float weighted annual dividends paid by index constituents divided by the total free float adjusted market capitalization of the index.

By way of illustration, Exhibit 6 below summarizes the historical performance of the MSCI ACWI Quality Mix Index relative to its parent index, the MSCI ACWI Index, via the Key Metrics report. We can quickly see from the graphs that the MSCI ACWI Quality Mix Index has outperformed the MSCI ACWI Index during the period of analysis, and the tables further show us that it has done so with lower absolute risk (and a beta less than 1), leading to a higher Sharpe ratio than its parent and a positive information ratio. Valuations of the two are broadly in line, but on the negative side turnover for the Quality Mix factor index is higher at 20.9% compared to the parent index's 3.4%.

Exhibit 6: MSCI ACWI Quality Mix Index – Key Metrics

Key Metrics

	MSCI ACWI Index	MSCI ACWI Quality Mix Index
Total Return* (%)	4.5	6.6
Total Risk* (%)	16.7	13.9
Return/Risk	0.27	0.47
Sharpe Ratio	0.20	0.35
Active Return* (%)	0.0	2.1
Tracking Error* (%)	0.0	3.6
Information Ratio	NaN	0.59
Historical Beta	1.00	0.82
Turnover** (%)	3.4	20.9
Price to Book***	2.2	2.4
Price to Earnings***	18.0	17.2
Div. Yield*** (%)	2.3	2.5

* Annualized in USD for the 05/31/1999 to 09/30/2013 period

** Annualized one-way index turnover for the 05/31/1999 to 09/30/2013 period

*** Monthly averages for the 05/31/1999 to 09/30/2013 period

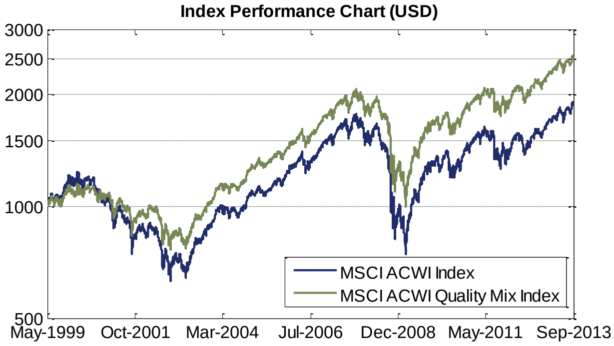
The definitions of all statistical parameters are available in the Appendix

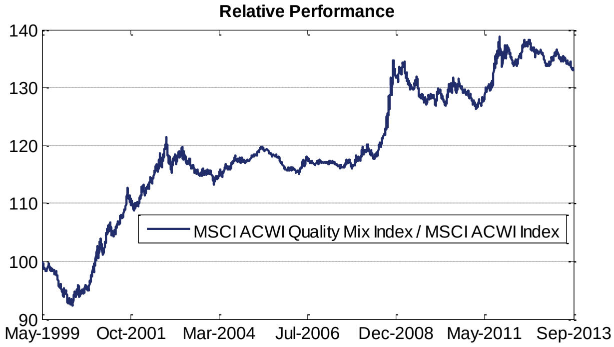
Performance (%)

	MSCI ACWI Index	MSCI ACWI Quality Mix Index
YTD	14.9	14.1
1 Yr	18.3	15.5
3 Yr	10.8	11.8
5 Yr	8.3	9.7
10 Yr	8.4	9.9

Gross Total Returns in USD for the period ending 09/30/2013

Returns are annualized for periods longer than one year





Since the MSCI ACWI Quality Mix Index is an equal-weighted combination of the MSCI ACWI Quality Index, the MSCI ACWI Value Weighted Index and the MSCI ACWI Minimum Volatility (USD) Index (at each semi-annual index rebalancing) we can view the key metrics of its component factor indexes to try to understand what the underlying drivers might be for its risk/return profile. These are shown in both tabular and graphical form in IndexMetrics, as per Exhibits 7 and 8 below:

Exhibit 7: MSCI ACWI Quality Mix Index – Key Metrics Analysis by Factor Index

Key Metrics

	MSCI ACWI Index	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
Total Return* (%)	4.5	6.6	5.7	5.9	7.7
Total Risk* (%)	16.7	13.9	14.9	17.5	10.9
Return/Risk	0.27	0.47	0.38	0.34	0.71
Sharpe Ratio	0.20	0.35	0.28	0.27	0.51
Active Return* (%)	0.0	2.1	1.2	1.4	3.3
Tracking Error* (%)	0.0	3.6	4.2	3.4	8.4
Information Ratio	NaN	0.59	0.29	0.42	0.39
Historical Beta	1.00	0.82	0.87	1.03	0.58
Turnover** (%)	3.4	20.9	22.9	19.1	25.3
Price to Book***	2.2	2.4	4.2	1.6	2.4
Price to Earnings***	18.0	17.2	16.2	17.2	18.2
Div. Yield*** (%)	2.3	2.5	2.1	2.7	2.7

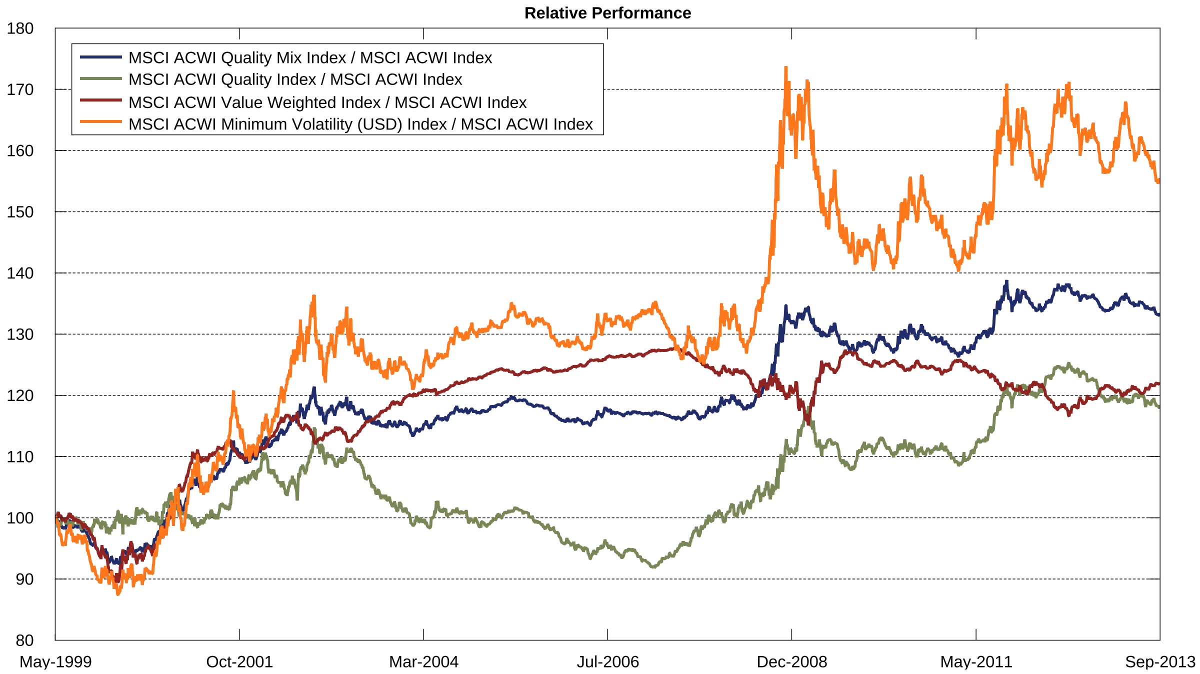
* Annualized in USD for the 05/31/1999 to 09/30/2013 period

** Annualized one-way index turnover for the 05/31/1999 to 09/30/2013 period

*** Monthly averages for the 05/31/1999 to 09/30/2013 period

The definitions of all statistical parameters are available in the Appendix

Exhibit 8: MSCI ACWI Quality Mix Index – Relative Performance Analysis by Factor Index



The breakdown of the absolute and relative returns and risks into component factor indexes, allows us to better appreciate the diversification effects of the factor combination, as well as the separate return drivers.

Risk Profile

The Risk Profile report describes the total, relative and tail risk properties of the factor index. Institutional investors have varying focuses on absolute risk, tracking error and drawdowns, and the Risk Profile report aims to show a broad selection of these measures. The various statistics used to assess risk are described in Exhibit 11 below. Risk metrics are shown in both tabular (by factor index) and graphical form in Exhibits 9 and 10 below.

Exhibit 9: MSCI ACWI Quality Mix Index – Risk Profile (a) Analysis by Factor Index

Key Risk Metrics

	MSCI ACWI Index	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
Absolute Risk Metrics					
Total Risk* (%)	16.7	13.9	14.9	17.5	10.9
Downside Risk* (%)	11.9	9.6	10.3	12.2	7.5
Sortino Ratio*	0.49	0.77	0.65	0.60	1.08
95 Percentile VaR (%)	-8.5	-7.3	-7.3	-9.8	-5.5
99 Percentile VaR (%)	-12.1	-9.9	-11.4	-12.1	-8.5
Expected Shortfall (CVaR) @ 95%	-10.9	-9.3	-9.6	-11.8	-7.3
Expected Shortfall (CVaR) @ 99%	-16.1	-13.5	-14.3	-16.4	-11.6
Max Drawdown (%)	54.6	47.8	46.4	57.6	38.6
Max Drawdown Period (in Months)	16	16	16	16	16
Skewness	-0.66	-0.75	-0.62	-0.58	-1.04
Kurtosis	4.34	4.73	4.05	4.76	5.44
Relative Risk Metrics					
Tracking Error* (%)	0.0	3.6	4.2	3.4	8.4
Max Drawdown of Active Returns (%)	0.0	7.7	18.4	10.3	19.3
Max Drawdown of Active Returns Period (in Months)	NaN	10	52	7	24

* Annualized in USD

Monthly averages for the 05/31/1999 to 09/30/2013 period

The definitions of all statistical parameters are available in the Appendix

Exhibit 10: MSCI ACWI Quality Mix Index – Return and Risk Profile (b) in Comparison with Parent Index

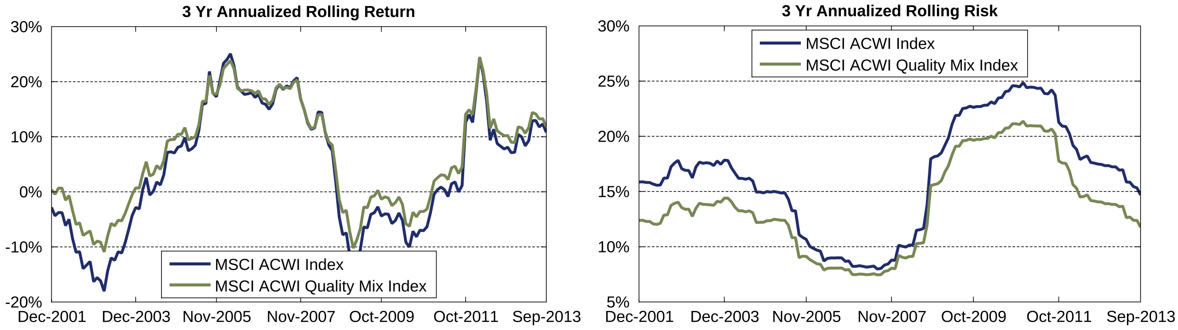


Exhibit 11: IndexMetrics - Risk Metrics

Absolute Risk	**Definition**
Total Risk	Total Risk (also called Volatility) is a measure of index return dispersion. Annualized volatility is computed as the standard deviation of monthly index Total Returns.
Annualized Downside Deviation	Downside Deviation is computed as the annualized standard deviation of negative monthly Total Returns.
Sortino ratio	The Sortino Ratio is computed as the average Excess Return (above a specified Minimum Acceptable Return, MAR) per unit of Total Downside Risk.
95 Percentile VaR	The *highest* index left tail return with 95% confidence over the next month. Historical VaR computes this left tail return measure using historical observations.
99 Percentile VaR	The *highest* index left tail return with 99% confidence over the next month.
Expected Shortfall @ 95%	Measures the *expected* index left tail return with 95% confidence over the next 1 month. Historical Expected Shortfall computes this left tail return measure using historical observations.
Expected Shortfall @ 99%	Measures the *expected* index left tail return with 99% confidence over the next 1 month.
Maximum Drawdown	Maximum Drawdown is the maximum percentage drop in Total Return over the period of analysis.
Maximum Drawdown Period	The number of months over which the Maximum Drawdown occurred.
Skewness	Skewness is the third central moment of the Index's gross monthly Total Return distribution and measures the degree of asymmetry of this return distribution.
Kurtosis	Kurtosis is the fourth central moment of the Index's Total Return distribution and measures the peakedness of the return distribution.
Relative Risk	**Definition**
Tracking Error	Tracking Error (also called Active Risk) measures the dispersion of Active Returns between a factor index and its parent, and is calculated as the annualized standard deviation of Active Returns.
Maximum Drawdown of Active Returns	Measures the Maximum Drawdown of *Active* Returns.
Maximum Drawdown of Active Returns Period	The number of months over which the Maximum Drawdown of Active Returns occurred.

The graph on the right in Exhibit 10 above shows that during the observed period the MSCI ACWI Quality Mix Index tended to have a lower volatility than its parent index. The table in Exhibit 9 above further shows us that during the observed period the major driver of absolute risk was the Value Weighted factor index, but the Minimum Volatility factor index had the highest tracking error.

We can also see that the Expected Shortfall or CVaR (see Appendix A for a definition) of the multi-factor index was lower than the average of its component factor indexes, further reflecting the left tail risk-reduction effects during this period of the combined multi-factor allocation over separate factor investments.

Finally, the effect of combining the factor indexes into a multi-factor index is apparent in the reduction in maximum drawdown of active returns, which was only 7.7% for the MSCI ACWI Quality Mix Index, compared to a range of 19.3% (Minimum Volatility) to 10.3% (Value Weighted) for its factor index components during this period.

IV. Exposure Metrics

Active Exposure

Given the historical risk and return profiles seen in the Key Metrics and Risk Profile reports, investors may well ask what active exposures the MSCI ACWI Quality Mix Index is taking relative to the parent index. This analysis is given next in the three “Active Exposure” reports from IndexMetrics, which focus respectively on active factor, sector, and region exposures, as shown in Exhibits 12 to 14 below.

For active factor and sector exposures the chart shows the current, average (red square), maximum, and minimum (indicated by the ‘candlestick’ ends) active exposures of the MSCI ACWI Quality Mix Index and its component factor indexes relative to the parent index. Region exposures are shown as active weights over time. In all cases, measurements are only taken on index rebalancing dates.

For the factors, active exposures represent index factor characteristics expressed in terms of standard deviations from those of the parent Index. As a rule of thumb, an active exposure above 0.2 or below -0.2 standard deviation units (z-scores) can be viewed as significant. What stands out immediately during this period is the MSCI ACWI Quality Mix Index’s negative exposure to the Volatility factor, driven by the large negative active exposure from its Minimum Volatility component. Active exposures to Liquidity and Leverage are also negative during this period, driven by the Quality component, as well as Minimum Volatility, and the Growth factor also has a negative active exposure, due mostly to the Value Weighted index component.

Looking at Active Sector Exposures, we see these are mostly driven by the Quality component during this period, with large negative active exposure to Financials and positive active exposure to Consumer Staples and Health Care. The large positive active exposure of the MSCI ACWI Quality Index to the Information Technology sector is balanced out by negative active exposures in Value Weighted and Minimum Volatility during this period.

Finally, in terms of active region exposures, these also tend to get balanced out between components during this period, with the large negative active exposure of Minimum Volatility to EMEA netting off to some extent with the Value Weighted factor index, which also balances out the large positive active region exposure of the Quality factor index to North America with its own underweight to the region.

Exhibit 12: MSCI ACWI Quality Mix Index – Active Factor Exposures

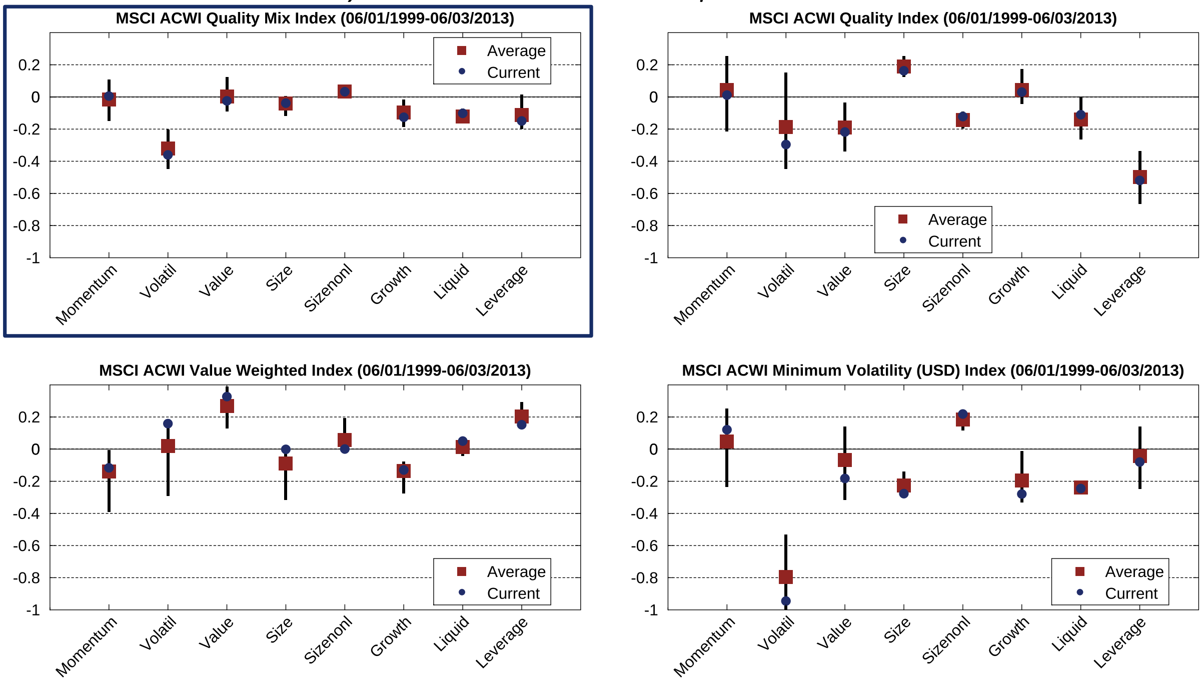


Exhibit 13: MSCI ACWI Quality Mix Index – Active Sector Exposures

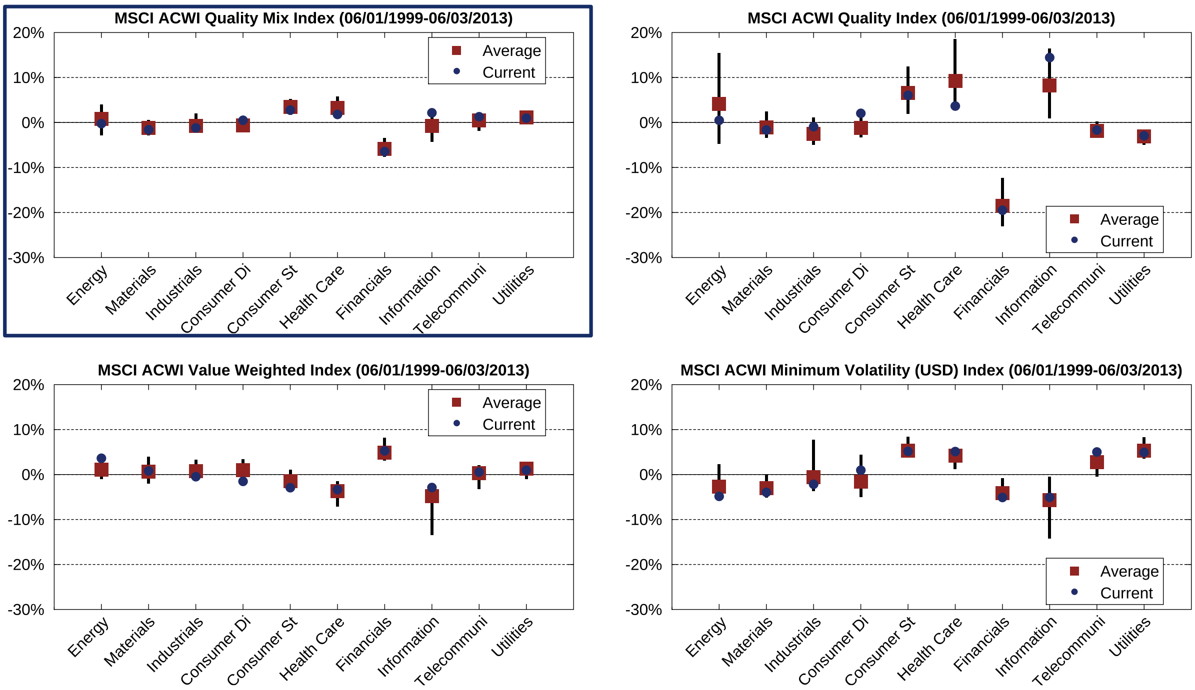
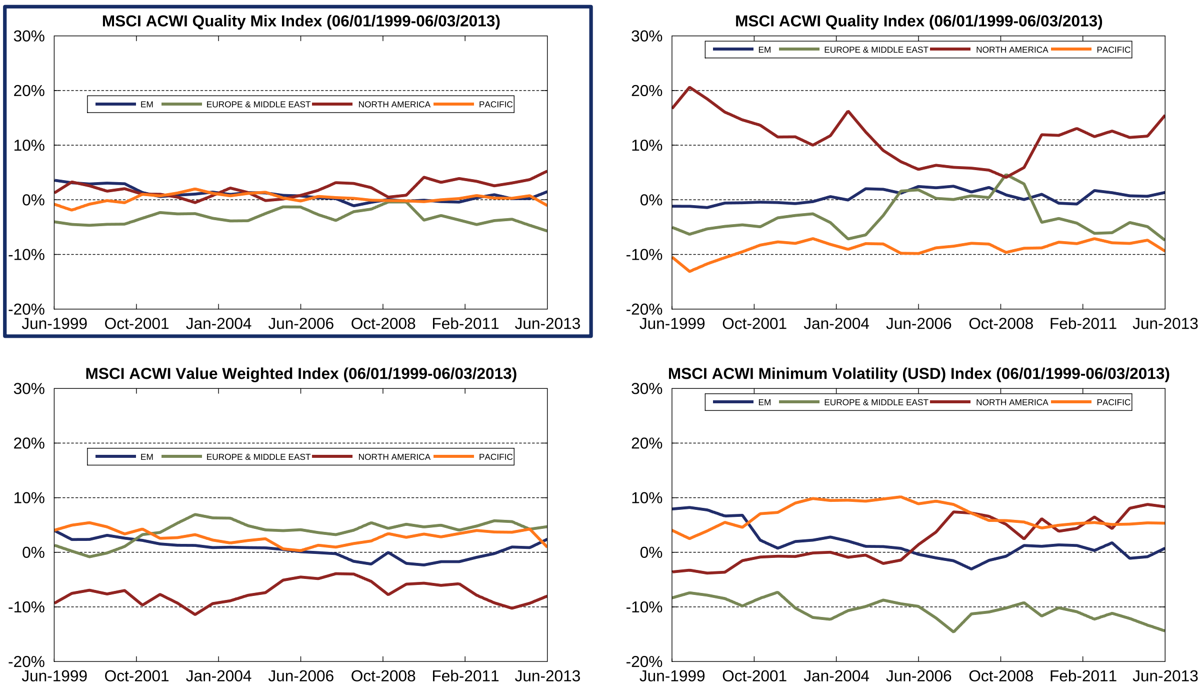


Exhibit 14: MSCI ACWI Quality Mix Index – Active Region Exposures



Valuations

Exhibit 15: IndexMetrics – Fundamental Ratios and Valuation Metrics

Fundamental Ratios and Valuation Metrics	Definition
Price to Book Value	At an index level P/BV is calculated using shareholders' equity available at the latest period end date for each constituent, weighted by the constituent's free float market capitalization.
Price to Earnings	At an index level P/E is calculated using net income from the continuing operations available to all equity shareholders for each constituent, weighted by the constituent's free float market capitalization.
Price to Cash Earnings	At an index level P/CE is calculated using earnings, as stated above, adding back depreciation and amortization as reported by the company. This is then free float market capitalization weighted.
Price to Sales	At an index level P/S is calculated using 12-month trailing sales (defined as net operating revenues from all on-going lines of business of the company). This is then free float market capitalization weighted.
Dividend Yield	At an index level, Dividend Yield is the annualised (last 12 months) gross regular cash dividend per share of each constituent, divided by its latest price, weighted by its free float market capitalization.
Long Term Forward EPS Growth Rate	At an index level, the Long Term Forward EPS Growth Rate is the free float market capitalization weighted average of the consensus of analysts' earnings growth rate estimates for each constituent, typically for the next 3-5 years.
Leverage	Leverage is the sum of the most recent book value of common equity plus preferred equity plus long-term debt, divided by book value of common equity. This is then free float market capitalization weighted across constituents.
Return on Equity	Return on Equity, which attempts to show the average return on equity for an index, is calculated using the index earnings divided by the index book value.

Once again, the Valuations section of the IndexMetrics report has a tabular (by factor index) and graphical (resulting multi-factor index) component. The goal of these components is to see how the valuation of the resultant multi-factor index is broken down into the valuation of its factor index components, and also how the resultant valuation metrics have changed over time. The ratios and metrics used in these reports are defined in Exhibit 15 above.[2]

Exhibit 16 below looks at the overall valuation of the MSCI ACWI Quality Mix Index relative to its parent Index, the MSCI ACWI Index, during this period and also relative to its three component factor indexes. We can see that the MSCI ACWI Quality Mix Index is similar in many valuation respects to its parent during this period, although it notably has a lower Long-Term Forward EPS Growth Rate (driven by its Value Weighted and Minimum Volatility factor index components) and a higher Return on Equity, driven principally by the Quality factor index.

Exhibit 16: MSCI ACWI Quality Mix Index –Valuations (a) Analysis by Factor Index

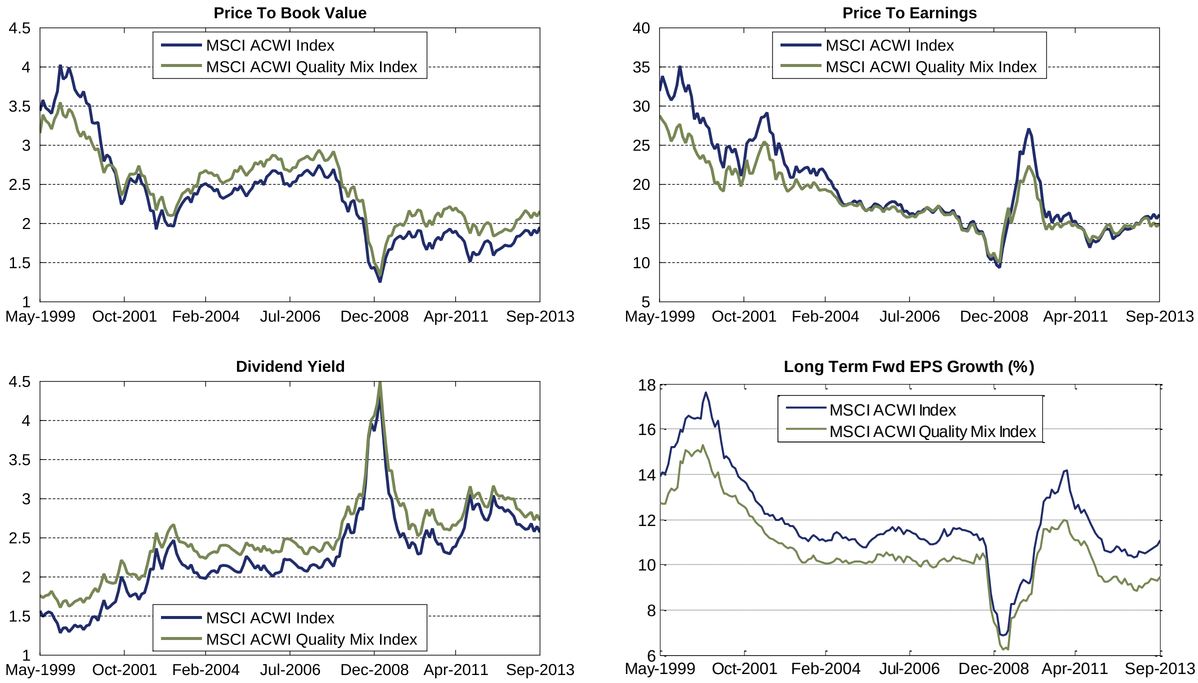
Key Ratios

	MSCI ACWI Index	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
Price to Book	2.2	2.4	4.2	1.6	2.4
Price to Cash Earnings	10.0	9.6	11.9	7.7	10.4
Price to Earnings	18.0	17.2	16.2	17.2	18.2
Price to Sales	1.2	1.1	1.9	0.7	1.5
Div Yield (%)	2.3	2.5	2.1	2.7	2.7
LT Fwd EPS G (%)	11.0	10.7	11.7	10.5	10.0
Sustainable Growth Rate (%)	7.6	7.9	16.9	5.4	6.7
Leverage	1.2	1.0	0.5	1.4	1.0
ROE (%)	12.7	13.9	25.8	9.9	13.3

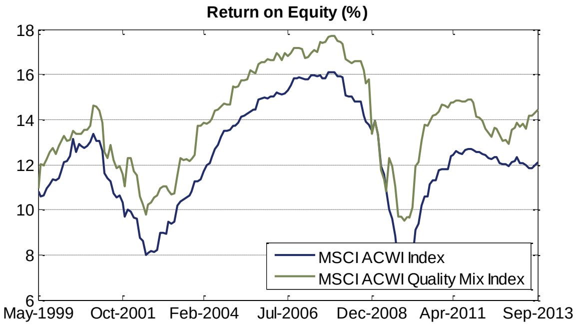
Monthly averages for the 05/31/1999 to 09/30/2013 period

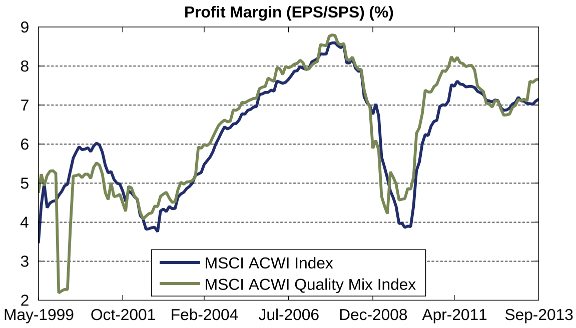
The definitions of all statistical parameters are available in the Appendix

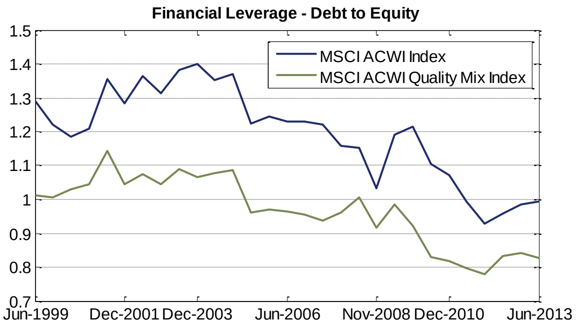
Exhibit 17: MSCI ACWI Quality Mix Index – Valuations (b) in Comparison with Parent Index



[2] For more details on the definition of the metrics, please refer to the MSCI Fundamental Data Methodology.







The time-series graphs shown in Exhibit 17 above paint a very consistent story about the valuation of the MSCI ACWI Quality Mix Index relative to its parent during this period: The MSCI ACWI Quality Mix Index tended to trade at a higher Price/Book, with an in-line Trailing Price/Earnings and slightly higher Dividend Yield. Overall, analyst consensus Long-Term Forward EPS Growth was lower, but Return on Equity was consistently higher, with generally higher Profit Margin.

V. Investability Metrics

Capacity and Concentration

As described above, factor indexes tilt away from market capitalization weights in order to target specific factors. We have also talked about the unavoidable tradeoff between purity of factor signal and investability, complexity, and tracking error, where factor purity can usually only be increased by taking on higher amounts of illiquidity/trading costs, active risk, and complexity. We further divided our factor index universe into High Capacity Factor Indexes, with generally low tracking error, and high investability and simplicity, and High Exposure Factor Indexes which tend to reverse these characteristics in return for stronger signal strength and higher potential return enhancement.

Exhibit 18: IndexMetrics – Concentration and (over page) Capacity/Active Tilt Metrics

Concentration Metrics	Definition
Average Number of Stocks	Average of number of stocks in the index over each rebalancing date.
Effective Number of Stocks	Effective number of stocks (EN) is a measure of index concentration and ranges between 1 (for a single stock) and the number of stocks in the index (for an equal-weighted index). Generally, the lower the EN, the more concentrated an index.
Market Capitalization Coverage	Market Cap Coverage measures the total Free Float Market Capitalization, in the parent index, of stocks which are constituents of the factor index.
Top 10 Security Weight	Top 10 Security Weight is a measure of portfolio concentration and calculated as the cumulative weight of the 10 highest weight securities in the index.

Capacity Metrics	**Definition**
Capacity/Stock Ownership	The proportion of the Free-Float/Full Market Capitalization of a stock held in a fund perfectly replicating an index, relative to the Free-Float/Full Market Capitalization of the stock, assuming USD 10bn AUM.
Average	Average Capacity of a stock in the index.
Tail Average @ 95%	Average Capacity of all stocks that have Capacity greater than the 95th percentile.
Maximum	Highest Capacity measure of any stock in the index.
Active Tilt Metrics	**Definition**
Active Share	Active Share measures the degree of Active tilt of the factor index. Mathematically, it is the one-way turnover that will be incurred in shifting from the parent to the factor index.
Average Weight Multiplier	At an index level the average Weight Multiplier (WM) is the ratio of the weight of each constituent of the factor index to its weight in the parent, weighted across constituents by free float market capitalization.
Maximum Weight multiplier	Maximum of the WM across all stocks in the index.
Maximum Strategy Weight	Maximum stock weight in the index.

The Capacity & Concentration reports in IndexMetrics, in concert with the Liquidity & Cost of Replication reports described in the next section, aim to give a snapshot and historical overview of the investability of the factor index, and how it has changed over time. In particular, the Capacity and Concentration reports in IndexMetrics define the “Capacity” of a factor index as the percentage of a stock’s free float or full market capitalization that a fund replicating the index would own for a given fund size. Combined with a limit on percentage ownership, the capacity of the fund (i.e., the total amount that could be invested into the factor index given these limits) can also be calculated.

IndexMetrics uses measures like Active Share and Maximum Strategy Weight to capture the degree to which a factor index is “active” relative to its parent index. We define IndexMetrics measures that capture concentration and capacity of a factor index in Exhibit 18 above, and follow this in Exhibits 19 and 20 below, which give tabular (split by component) and graphical (over time and relative to the parent) representations of concentration and capacity.

Exhibit 19: MSCI ACWI Quality Mix Index – Capacity & Concentration (a) Analysis by Factor Index

Capacity & Concentration Metrics

	MSCI ACWI Index	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
Concentration Metrics					
Avg No of Stocks	2415	2415	500	2415	355
Effective No of Stocks	362	252	75	397	186
Market Cap Coverage (%)	100.0	100.0	32.2	100.0	32.4
Top 10 Sec Wt (%)	10.8	13.6	28.3	9.6	12.7
Capacity of the Strategy*					
Stock Ownership (% of Float Market Cap)					
Average	0.03	0.03	0.11	0.04	0.38
Tail Average @95%	0.03	0.22	0.15	0.12	0.65
Maximum	0.03	0.27	0.17	0.53	0.65
Stock Ownership (% of Full Market Cap)					
Average	0.02	0.02	0.08	0.03	0.27
Tail Average @95%	0.03	0.17	0.14	0.10	0.64
Maximum	0.03	0.26	0.16	0.35	0.65
Degree of Index Tilt**					
Active Share (%)	0.0	38.7	69.8	22.9	81.6
Avg Weight Multiplier	1	1	1	1	1
Max Weight Multiplier	1	22	5	59	20
Max Strategy Weight (%)	1.8	2.4	4.8	1.4	1.5

* Assuming a fund size of USD 10 bn as of the index review on 06/03/2013

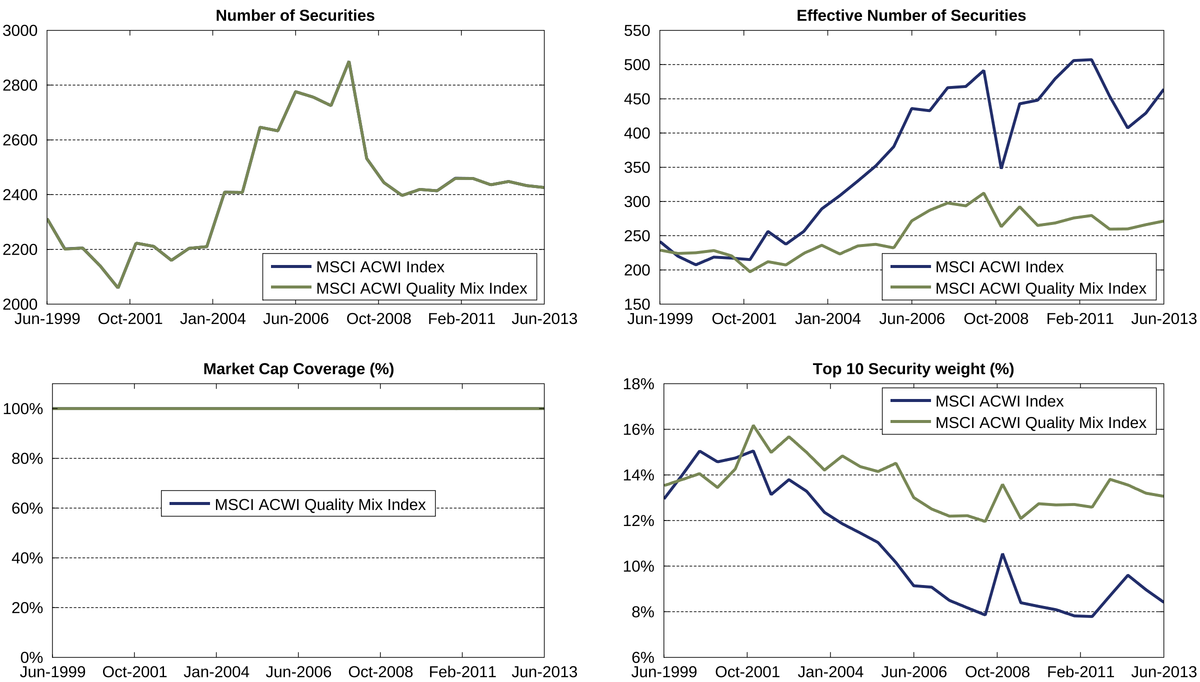
** Average values from 05/31/1999 to 09/30/2013

Exhibit 19 above shows the Concentration and Capacity metrics for the MSCI ACWI Quality Mix Index and its factor index components, compared to the parent index. Capacity has been calculated for USD 10bn, where the capacity metrics are all assumed linearly proportional to the fund size. As one component of the Quality Mix factor index is the “High Capacity” Value Weighted factor index, the resultant multi-factor index has the same average number of stocks and 100% of the market capitalization coverage of its parent index. However, the average Capacity for the combined MSCI ACWI Quality Mix Index is better than any of its components, and indeed of the same order of magnitude as its parent.

As one would expect, the resultant degree of index tilt for the multi-factor index is somewhere between its High Exposure (Quality and Minimum Volatility) and High Capacity (Value Weighted) factor index components.

Finally, the graphical output in Exhibit 20 below highlights that the differences between the MSCI ACWI Quality Mix Index and its parent were fairly consistent in terms of effective number of securities and top 10 security weight over the period observed.

Exhibit 20: MSCI ACWI Quality Mix Index – Concentration & Capacity (b) in Comparison with Parent Index



Liquidity and Turnover

The Liquidity and Cost of Replication reports in IndexMetrics aim to give a fuller picture of the liquidity and tradability of the constituents of the factor index compared to its parent, to help investors quantify the tradeoff between any potential risk-adjusted return benefits of factor investments versus their increased implementation and replication costs.

Liquidity metrics attempt to quantify how liquid individual stocks are in the factor index and how tradable the constituents of the index are as a whole. We start at the stock level by looking at the Average Traded Value Ratio (ATVR[3]), which shows how much of a stock’s free float market

[3] For more details, please refer to the MSCI Global Investable Market Indexes Methodology

capitalization on average trades in a given day. This is then weighted across all the components of the factor index.

"Days to Trade" measures how many days on average it would take to set up a USD 10bn position in the factor index, given a constraint not to trade more than 20% of the daily liquidity of any security (once again all these effects are assumed linear in size of allocation). These measures are shown on an average as well as tail basis. Finally, replication costs give an indication of the costs of replicating the index. The higher the turnover, the higher the cost of trading and higher the performance drag. Performance drag is calculated from Turnover as described in Appendix A, by taking the one-way Turnover, doubling it to calculate the two-way Turnover (to account for the sale of a current constituent and the purchase of a new constituent), and multiplying by the assumed transaction costs (again, all assumed linear with fixed trading costs) to arrive at the cost of implementing the index turnover. Importantly, these metrics are not an estimate of the actual market impact, which would require the use of more sophisticated (usually non-linear) trading cost models.

Exhibit 21 below defines the Liquidity and Turnover metrics used in IndexMetrics, Exhibit 22 shows these metrics for the MSCI ACWI Quality Mix Index and its factor index components, and Exhibit 23 shows how some of these selected metrics have changed over time for the MSCI ACWI Quality Mix Index versus its parent.

Exhibit 21: IndexMetrics – Liquidity and Cost of Replication Metrics

Liquidity Metrics	Definition
Weighted Average ATVR	ATVR (Annual Traded Value Ratio) provides a measure of trading volume in a security as a proportion of market capitalization. The weighted average ATVR then measures this liquidity at the index level.
Days to Trade	Days to Trade is the number of days required to trade a change in a stock position given its average trading volume. Calculated for the changes required for regular rebalancing, for initial set-up starting from the parent index and for initial set-up starting from cash. We assume USD10bn size and 10% ATV limit.
Weighted Average	Summation of stock weight in index times the days to trade changes in stock position.
Tail Average @ 95%	Average Days to Trade of all stocks that have Days to Trade greater than the 95th percentile.
Maximum	Maximum Days to Trade of any stock in the index.
Days to Complete 95% Trading	Number of days required in order to complete 95% of the changes in stock positions.
Cost of Replication Metrics	**Definition**
Turnover	Annualized average of one-way index turnover over all rebalancings.
Performance Drag	Performance Drag is computed as the total transaction cost incurred as a result of tracking the index assuming linear, proportional, transaction costs. Calculated for 25/50/75 bps transaction costs.

The table in Exhibit 22 below shows the (expected) difference in replicability between the High Capacity Value Weighted factor index component and the other two High Exposure members during the observed period.

Exhibit 22: MSCI ACWI Quality Mix Index – Liquidity & Cost of Replication (a) Analysis by Factor Index

Liquidity Metrics & Cost of Replication

	MSCI ACWI Index	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
Liquidity Metrics					
Weighted Average ATVR (%)	69.6	61.6	51.6	80.7	52.4
Days to Trade - Periodic Index Review*					
Weighted Average	0.0	0.3	0.3	0.1	1.2
Tail Average @ 95%	0.2	1.8	1.5	0.5	4.7
Days to complete 95% trading	1.0	1.0	1.8	1.0	4.8
Maximum	0.6	13.7	6.5	1.9	41.1
Days to Trade - Relative to Parent Index*					
Weighted Average	0.0	1.3	2.2	0.3	7.6
Tail Average @ 95%	0.0	4.0	2.6	1.0	11.9
Days to complete 95% trading	0.0	3.0	3.0	1.0	12.0
Maximum	0.0	10.4	5.6	2.0	33.6
Days to Trade - Relative to Cash*					
Weighted Average	0.8	1.9	3.1	0.9	8.4
Tail Average @ 95%	1.4	4.8	3.7	1.8	12.7
Days to complete 95% trading	2.0	4.0	5.0	2.0	13.0
Maximum	3.0	12.1	7.3	3.6	35.3
Cost of Replication					
Turnover** (%)	3.4	20.9	22.9	19.1	25.3
Performance Drag in bps (at 25 bps)***	1.7	10.4	11.4	9.5	12.6
Performance Drag in bps (at 50 bps)***	3.4	20.9	22.9	19.1	25.3
Performance Drag in bps (at 75 bps)***	5.1	31.3	34.3	28.6	37.9

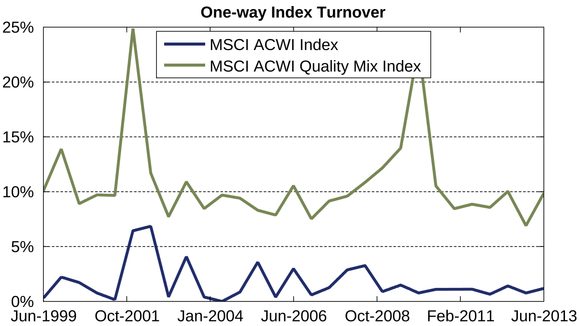
* Average of last four index reviews ending 09/30/2013. Assuming a fund size of USD 10 bn and a maximuming daily trading limit of 20%

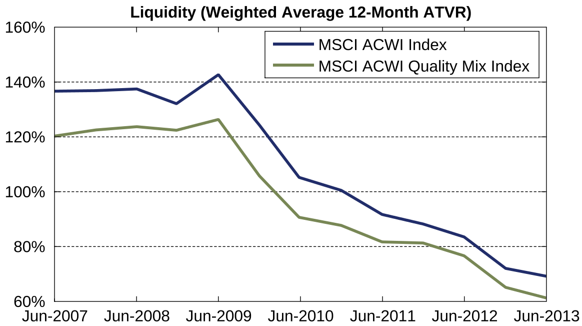
** Annualized one-way index turnover for the 05/31/1999 to 09/30/2013 period

*** Performance drag aims to represent the total two-way annualized index level transaction cost assuming various levels of security level transaction cost

Weighted Average ATVR for the MSCI ACWI Quality Mix Index is between the High Capacity and the High Exposure factor indexes. Weighted average Days to Trade is lower than the average of the index components, which when combined with the improvements in Capacity seen for the multi-factor index in Exhibit 22, illustrates one of the tradability effects during this period of combining single factor indexes into multi-factor ones.

Exhibit 23: MSCI ACWI Quality Mix Index – Turnover & Liquidity in Comparison with Parent





Top Constituents and Top Active Positions

So far most of the metrics we have examined have looked at the properties of the factor index as a whole, and those that have measured characteristics at the stock level have not named any constituents. In this final section of the IndexMetrics output we display the largest absolute stock weights in the index both in absolute and relative terms. We show this in IndexMetrics by looking at the top 25 consituents of the factor index by weight as well as the top and bottom 10 constituents of the factor index by active weight.

All three tables are shown together in Exhibit 24 below for simplicity.

Exhibit 24: MSCI ACWI Quality Mix Index – Top Constituents and Top Active Positions

Top 25 Constituents by Index Weight

	Country	Sector	Weight (%)	Active Weight (%)
Exxon Mobil Corp	US	Energy	2.1	1.0
Apple	US	Information Technology	2.1	0.7
Microsoft Corp	US	Information Technology	1.4	0.6
Johnson & Johnson	US	Health Care	1.4	0.6
Chevron Corp	US	Energy	1.1	0.3
Procter & Gamble Co	US	Consumer Staples	1.0	0.4
IBM Corp	US	Information Technology	1.0	0.4
McDonald's Corp	US	Consumer Discretionary	0.9	0.6
Roche Holding Genuss	CH	Health Care	0.9	0.3
Google A	US	Information Technology	0.8	0.1
Wal-Mart Stores	US	Consumer Staples	0.8	0.4
China Mobile	CN	Telecommunication Services	0.7	0.5
Pepsico	US	Consumer Staples	0.7	0.3
Coca-Cola Co	US	Consumer Staples	0.7	0.2
Bristol-Myers Squibb Co	US	Health Care	0.7	0.4
Automatic Data Process	US	Information Technology	0.7	0.5
Samsung Electronics Co	KR	Information Technology	0.6	0.2
Taiwan Semiconductor Mfg	TW	Information Technology	0.6	0.3
Lilly (Eli) & Co	US	Health Care	0.6	0.4
General Mills	US	Consumer Staples	0.6	0.5
Novartis	CH	Health Care	0.5	0.0
TJX Cos	US	Consumer Discretionary	0.5	0.4
Nestle	CH	Consumer Staples	0.5	-0.2
Colgate-Palmolive	US	Consumer Staples	0.5	0.3
Oracle Corp	US	Information Technology	0.5	0.1

As of 09/30/2013

Top Active Weights in MSCI ACWI Quality Mix Index

	Country	Sector	Weight (%)	Active Weight (%)
Exxon Mobil Corp	US	Energy	2.1	1.0
Apple	US	Information Technology	2.1	0.7
Johnson & Johnson	US	Health Care	1.4	0.6
McDonald's Corp	US	Consumer Discretionary	0.9	0.6
Microsoft Corp	US	Information Technology	1.4	0.6
Automatic Data Process	US	Information Technology	0.7	0.5
China Mobile	CN	Telecommunication Services	0.7	0.5
General Mills	US	Consumer Staples	0.6	0.5
Bristol-Myers Squibb Co	US	Health Care	0.7	0.4
Lilly (Eli) & Co	US	Health Care	0.6	0.4

As of 09/30/2013

Bottom Active Weights in MSCI ACWI Quality Mix Index

	Country	Sector	Weight (%)	Active Weight (%)
General Electric Co	US	Industrials	0.2	-0.5
Pfizer	US	Health Care	0.1	-0.4
Toyota Motor Corp	JP	Consumer Discretionary	0.1	-0.4
Wells Fargo & Co	US	Financials	0.3	-0.4
Philip Morris Int	US	Consumer Staples	0.1	-0.4
Merck & Co	US	Health Care	0.1	-0.3
HSBC Holdings (GB)	GB	Financials	0.3	-0.3
Amazon.Com	US	Consumer Discretionary	0.0	-0.3
JPMorgan Chase & Co	US	Financials	0.3	-0.3
Cisco Systems	US	Information Technology	0.1	-0.3

As of 09/30/2013

VI. Combination Effects

Active Return Correlations

As described in the introduction, the cyclicality of factor returns provides a potential motivation for allocating to multiple factor investments *in combination* to create a multi-factor allocation, potentially creating diversification and investability effects over independent factor allocations. One of the major innovations of the IndexMetrics analytical framework is its consistent and transparent method for displaying these diversification and turnover effects. The aim of the Diversification report in IndexMetrics is then to reflect these effects for factor indexes in terms of their non-zero correlation and the reduction in turnover due to natural crossing between components. These are shown below in the matrix in Exhibit 25 and the table in Exhibit 26.

Exhibit 25: MSCI ACWI Quality Mix Index – Active Return Correlations

Active Return Correlations

	MSCI ACWI Quality Mix Index	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index
MSCI ACWI Quality Mix Index	1.00			
MSCI ACWI Quality Index	0.54	1.00		
MSCI ACWI Value Weighted Index	0.09	-0.53	1.00	
MSCI ACWI Minimum Volatility (USD) Index	0.95	0.40	-0.02	1.00

Based on monthly returns for the 05/31/1999 - 09/30/2013 period

What is very clear from Exhibit 25 above is that the Value Weighted factor index has negative correlations to the Quality and Minimum Volatility components over the period. This reflects the fact that the risk premia which the factor indexes reflect have historically tended to outperform the market capitalization weighted parent over several business cycles, but can also underperform at different points in the cycle. Choosing a diversified set of factor investments may help to ensure that these performances are “smoothed out”, leading to lower active risk, but with returns which are the average of component factors.

The combination of single-factor indexes with low, or even negative, correlation to each other may create diversification effects that potentially may offset the higher risk of any particular factor index, leading to improved risk-adjusted returns. For example, if we look back to the Key Metrics and Risk Profile reports in Exhibits 7 to 9, we can see that the tracking error of the combined Quality Mix multi-factor index is lower than the average of its component factor indexes, resulting in an information ratio for the combined index that is higher than its single-factor index average.

Natural Crossing Benefits

As also described in the introduction, a second potential effect of combining multiple factors is the opportunity to cross trades for the individual factors in the portfolio. This “natural crossing” leads to lower turnover and by implication, potentially lower transaction costs. Take for example a stock whose price is falling over time. As the price falls, it may drop out of a momentum strategy but the lower price could push the stock into a value strategy. If a manager is managing both the momentum and value portfolios together, the manager would not have to sell or buy all the shares required of the individual portfolios but could “cross” the overlapping trades. The accompanying reduction in turnover translates directly into lower transaction costs.

Exhibit 26: MSCI ACWI Quality Mix Index – Potential Cost Effectiveness of Combined Indexes

Natural Crossing Benefits

	MSCI ACWI Quality Index	MSCI ACWI Value Weighted Index	MSCI ACWI Minimum Volatility (USD) Index	Separate Mandates (A)	Combined Mandates (B)	Reduction (A) - (B)
Turnover(%)	22.90	19.09	25.28	23.74	20.89	2.85
Performance Drag in bps (at 25 bps)*	11.45	9.54	12.64	11.87	10.44	1.42
Performance Drag in bps (at 50 bps)*	22.90	19.09	25.28	23.74	20.89	2.85
Performance Drag in bps (at 75 bps)*	34.35	28.63	37.92	35.60	31.33	4.27

Annualized for the 05/31/1999 to 09/30/2013 period

* Performance drag aims to represent the total two-way annualized index level transaction cost assuming various levels of security level transaction cost

Exhibit 26 above shows that the MSCI ACWI Quality Mix Index displays a reduction of 2.85% in turnover for a combined mandate over the period, as opposed to separate mandates. As described in Appendix A, the separate mandate turnover includes not only the costs of additions, deletions, and reweights in a given index at regular rebalances, but also the reweighting of single-factor indexes back to their target multi-factor index weights at each regular rebalancing. This additional rebalancing cost can mean that in some cases, as in Exhibit 26 above, the separate mandate turnover can actually be higher than the average of component turnovers.

Appendix A: Definitions of Metrics in Report

Total Return

Total Return (r) is a measure of gain or loss on the index. Annualized total return is calculated as:

$$r = \left(\frac{P_{\text{end}}}{P_{\text{start}}}\right)^{\left(\frac{365}{T}\right)} - 1$$

where P_{end}= price at end date, P_{start}= price at start date, and T = number of calendar days between the end date and start date.

Total Risk

Total Risk (σ, also called Volatility) is a measure of index return dispersion. Annualized volatility is computed as the standard deviation (*stdev*) of monthly index Total Returns:

$$\sigma = stdev(r_{1,}r_{2,} \dots, r_t) \times \sqrt{12}$$

where $(r_1, r_2, .., r_t)$ is the set of observed monthly Index Total Returns.

Return/Risk

Return/Risk is the index return per unit of index risk and computed as the ratio of Total Return to Total Risk:

$$\text{Return\_to\_Risk} = \frac{r}{\sigma}$$

Sharpe Ratio

The Sharpe Ratio is computed as the average index Excess Return per unit of index risk where Excess Return is the average monthly difference between the Index Total Return and the risk-free rate, *annualized over the period*:

$$\text{Excess\_Return}_i = \left(\frac{P_{i+1}}{P_i} - 1\right) - r_{\text{risk-free}}$$

$$\text{Mean\_Excess\_Return} = \frac{1}{T}\sum_{i=1}^{T} \text{Excess\_Return}_i \times 12$$

$$\text{Sharpe\_Ratio} = \frac{\text{Mean\_Excess\_Return}}{\sigma_{\text{Excess\_Return}}}$$

and $r_{\text{risk-free}}$ is the 1-month LIBOR rate at the start of the period in the Factor index's currency of calculation.

Active Return

Active return is the Total Return of a factor index relative to its parent:

$$ra = r_{\text{Factor\_Index}} - r_{\text{Parent}}$$

Tracking Error:

Tracking Error (TE, also called Active Risk) measures the dispersion of Active Returns between a factor index and its parent.

TE is calculated as the annualized standard deviation of Active Returns:

$$TE = stdev(ra_{1,} ra_{2,} \dots, ra_t) \times$$

Where $(ra_{1,} ra_{2,} \dots, ra_t)$ are monthly active returns (i.e., factor index return minus parent Index return)

Information Ratio

Information Ratio (IR) measures Return/Risk in Active space. It is calculated as the ratio of Active Return to Tracking Error (Active Risk):

$$IR = \text{Active Return/Tracking Error}$$

Correlation

Correlation (ρ) is a measure of the degree of co-movement between a factor index its parent:

$$\rho = \frac{\text{Covariance(Factor Index, Parent)}}{\sigma_{Factor\_Index} \times \sigma_{Parent}}$$

Historical Beta

Beta (β) is a measure of the level of co-movement between a factor index and its parent:

$$\beta = \rho * \frac{\sigma_{\text{Factor\_Index}}}{\sigma_{\text{Parent}}}$$

Turnover

Turnover measures the percentage change in the composition of an index at each index rebalancing. Two-way turnover aggregates both buy/weight increases and sell/weight decreases. One-way turnover is one half of two-way turnover:

$$\text{One} - \text{way\_turnover} = \frac{1}{2}\sum_{i=1}^{N}\left|w_{\text{proforma},i} - w_{\text{current},i}\right|$$

$w_{\text{proforma},i}$ = weight of security i in the proforma Index

$w_{\text{current},i}$ = weight of security i in the current Index

Downside Deviation

Downside Deviation is computed as the annualized standard deviation of negative monthly Total Returns. It is a measure of the risk of losses. Annualized Downside Deviation is calculated as:

$$\sigma_{\text{Downside}} = stdev(r_{1,} r_{2,} \dots, r_t) \times \sqrt{12}, \forall r_i < 0,$$

For all monthly Total Returns which are less than zero.

Sortino Ratio

In a similar fashion to the Sharpe Ratio, the Sortino Ratio is computed as the average Excess Return (above a specified Minimum Acceptable Return, MAR) per unit of Total Downside Risk:

$$\text{Excess\_Return}_i = \left(\frac{P_{i+1}}{P_i} - 1\right) - \text{MAR}$$

$$\text{Mean\_Excess\_Return} = \frac{1}{t}\sum_{i=1}^{t} \text{Excess\_Return}_i \times 12$$

$$\text{Sortino\_Ratio} = \frac{\text{Mean\_Excess\_Return}}{\sigma_{\text{Downside}}}$$

and MAR is 0.

Value at Risk (VaR)

For a given time horizon and confidence interval, Value at Risk (VaR) measures the *highest* index left tail return with that confidence and over that time horizon. Historical VaR computes this left tail return measure using historical observations.

Thus, if the historical VaR of an Index is 1% at a one month, 95% confidence level, historically the Index has fallen 1% or more over a given month on more than 5% of occasions.

Expected Shortfall

For a given time horizon and confidence interval, Expected Shortfall (also called Conditional Value at Risk or CVaR) measures the *expected* index left tail return with that confidence and over that time horizon. Historical CVaR computes this left tail return measure using historical observations.

Thus, if the historical CVaR of an Index is 2.5% at a one month, 95% confidence level, then historically the Index has averaged losses of 2.5% in the 5% of its lowest return months.

Maximum Drawdown

Maximum drawdown (MD) is the maximum percentage drop in Total Return over the period of analysis.

Maximum Drawdown period

Maximum Drawdown period is the number of months over which the Maximum Drawdown occurred.

Skewness

Skewness is the third central moment of the index's gross monthly Total Return distribution and measures the degree of asymmetry of this Return distribution: A negative number means that the left tail of returns (relative to the Mean) is longer than the right tail of returns.

Kurtosis

Kurtosis is the fourth central moment of the index's Total Return distribution and measures the peakedness of the return distribution: A positive number means that the tails of the distribution are fatter than a normal distribution's.

Effective Number of Stocks

Effective number of stocks (EN) is a measure of index concentration and ranges between 1 (for a single stock) and the number of stocks in the index (for an equal-weighted index). Generally, the lower the EN, the more concentrated an index:

$$EN = \frac{1}{\sum_{i=1}^{N} w_i^2}$$

Where the w_i are the weights of the N stocks in the Index.

Market Cap Coverage

Market Cap Coverage measures the total Free Float Market Capitalization, in the parent index, of stocks which are constituents of the factor index:

$$\text{Market\_Cap\_Coverage} = \frac{\sum_{i \in \text{factor\_index}} \text{FF\_Market\_Cap}_\text{i}}{\text{Parent\_FF\_Market\_Cap}}$$

Where the $\text{FF\_Market\_Cap}_\text{i}$ are summed over all the parent index constituents which are members of the factor index, and $\text{Parent\_FF\_Market\_Cap}$ is the total Free Float Market Capitalization of the parent index.

Top 10 Security Weight

Top 10 Security Weight is a measure of portfolio concentration and calculated as the cumulative weight of the 10 highest weight securities in the index:

$$\text{Top\_10\_Security\_Weight} = \sum_{i=1}^{10} w_i$$

where w_i = security weight in the index, ordered from highest weight (w_1) to lowest.

Capacity/Stock ownership

Capacity measures the proportion of the Free Float/Full Market Capitalization of a stock held in a fund perfectly replicating an index, relative to the Free Float/Full Market Capitalization of the stock in the index, assuming a certain Fund size (AUM):

$$\text{Capacity}_\text{i} = \frac{w_i \times \text{AUM}}{\text{Market\_Cap}_\text{i}}$$

Active Share

Active Share measures the degree of Active tilt of the factor index. Mathematically, it is the one-way turnover that will be incurred in shifting from the parent to the factor index:

$$\text{Active\_Share}=\frac{1}{2}\sum_{i=1}^{N}\left|w_{\text{Factor\_Index}_i}-w_{\text{Parent\_Index}_i}\right|$$

Where the $\boldsymbol{i}$ run over the N stocks in the Factor index and $w_{\text{Factor\_Index}_i}$ is the weight of stock $\boldsymbol{i}$ in the Factor index and $w_{\text{Parent\_Index}_i}$ is the weight of the same stock in the parent Index.

Weight Multiplier

Weight Multiplier (WM) is the ratio of the weight of a security in the factor index to its weight in the parent:

$$WM_i=\frac{w_{\text{Factor\_Index}_i}}{w_{\text{Parent\_Index}_i}}$$

Where $w_{\text{Factor\_Index}_i}$ is the weight of stock $\boldsymbol{i}$ in the factor index and $w_{\text{Parent\_Index}_i}$ is the weight of the same stock in the parent Index.

Weighted Average ATVR

ATVR (Annual Traded Value Ratio) provides a measure of trading volume in a security as a proportion of market capitalization (for more details, please refer to the MSCI Global Investable Market Indexes Methodology). The weighted average ATVR then measures this liquidity at the Index level:

$$\text{Weighted\_Average\_ATVR}=\sum_{i} w_{\text{Factor\_Index}_i}\times \text{ATVR}_\text{i}$$

Where $w_{\text{Factor\_Index}_i}$ is the weight of stock i in the Factor index and ATVR_i is its ATVR.

Days to Trade

Days to Trade is the number of days required to trade a change in a stock position given its average trading volume:

$$\text{Days\_to\_Trade}_i=\frac{w_{\text{Factor\_Index}_i}\times \text{AUM}}{ATV_i\times \text{Limit}}$$

Where $w_{\text{Factor\_Index}_i}$ is the weight of stock i in the Factor index and ATV_i is its Average Traded Value, AUM is the size of the position (e.g. US$ 10bn) and Limit is a cap on the percentage of Average Traded Value (here 20%) that can be traded in a given day.

Performance drag

Performance Drag is computed as the total transaction cost incurred as a result of tracking the index assuming linear, proportional, transaction costs:

$$\text{Performance\_Drag}=2\times\text{One-way\_Turnover}\times\text{Assumed\_Transaction\_Cost}$$

Where $\text{Assumed\_Transaction\_Cost}$ is expressed as a constant (assumed linear in trade size) proportion of the size of the trade.

<u>**Separate Factor Index vs. Multi-Factor Index Turnover**</u>

In the 'Combination Effects' section of the IndexMetrics output we highlight the potential cost-effectiveness in terms of turnover reduction of combining multiple factor indexes into a single multi-factor index. For this calculation, the Turnover of separate mandates is calculated as:

$$\sum_i \omega_{current,i} \times turnover_i + \frac{\sum_i |\omega_{current,i} - \omega_{proforma,i}|}{2}$$

Where the sum is taken over component strategy weights.

Appendix B: The Barra Global Equity Model (GEM2)[4]

The Barra multi-factor model framework yields valuable insight into the underlying sources of portfolio return by separating systematic effects from the purely stock-specific component that can be diversified away. In the model, excess returns are driven by a relatively small number, K_E, of global equity factors, plus an idiosyncratic component unique to the particular stock,

$$r_n = \sum_{k=1}^{K_E} X_{nk} f_k + u_n . \tag{2.1}$$

Here, X_{nk} $(k \le K_E)$ is the exposure of stock n to equity factor k, f_k is the factor return, and u_n is the specific return of the stock. The specific returns u_n are assumed to be uncorrelated with the factor returns. The factor exposures are known at the start of each period, and the factor returns are estimated via cross-sectional regression.

The coverage universe is the set of all securities for which the model provides risk forecasts. The estimation universe, by contrast, is the subset of stocks that is used to estimate the model. Judicious selection of the estimation universe is a critical component to building a sound risk model. *Representation, liquidity* and *stability* are the three primary goals that must be attained when selecting a risk model estimation universe. The GEM2 estimation universe utilizes the MSCI *ACWI Investable Market Index* (IMI), part of the MSCI Global Investable Market Indexes family which represents the latest in MSCI index-construction methodology. MSCI ACWI IMI aims to reflect the full breadth of global investment opportunities by targeting 99 percent of the float-adjusted market capitalization in 44 developed and emerging markets. The index-construction methodology applies innovative rules designed to achieve index stability, while reflecting the evolving equity markets in a timely fashion. Moreover, liquidity screening rules are applied to ensure that only investable stocks with reliable pricing are included for index membership.

The equity factor set in GEM2 includes a World factor (w), countries (c), industries (i), and styles (s). Every stock is assigned an exposure of 1 to the World factor. Hence, the local excess returns in Equation 2.5 can be rewritten as

$$r_n = f_w + \sum_c X_{nc} f_c + \sum_i X_{ni} f_i + \sum_s X_{ns} f_s + u_n . \tag{2.2}$$

Mathematically, the World factor represents the intercept term in the cross-sectional regression. Economically, it describes the aggregate up-and-down movement of the global equity market. Typically, the World factor is the dominant source of total risk for a diversified long-only portfolio.

Country factors play a critical role in global equity risk modeling. One reason is that they are powerful indicator variables for explaining the cross section of global equity returns. A second, related, reason is that the country allocation decision is central to many global investment strategies, and portfolio managers often must carefully monitor their exposures to these factors.

Exhibit 27 shows a list of the 55 countries covered by GEM2, together with their corresponding currencies. The country exposures X_{nc} in GEM2 are set equal to 1 if stock n is in country c, and set equal to 0 otherwise. We assign country exposures based on country membership within the MSCI ACWI IMI, MSCI China A Index and MSCI GCC Countries Index. Note that depository receipts and cross-listed assets are assigned factor exposures for the underlying or primary asset, as defined by the MSCI Equity Indexes.

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[4] See The Barra Global Equity Model (GEM2) Research Notes for more information

Exhibit 27: GEM2 Country Factors and Currencies

Code	Country	Name	Avg. Weight	Jan-08 Weight
ARG	Argentina	Argentine Peso	0.09	0.08
AUS	Australia	Australian Dollar	1.58	2.27
AUT	Austria	Euro	0.16	0.34
BHR	Bahrain	Bahraini Dinar	0.01	0.02
BEL	Belgium	Euro	0.62	0.63
BRA	Brazil	Brazilian Real	0.64	1.69
CAN	Canada	Canadian Dollar	2.53	3.14
CHL	Chile	Chilean Peso	0.17	0.24
CHN	China Domestic	Chinese Yuan	1.86	7.97
CHX	China International	Hong Kong Dollar	0.66	2.74
COL	Colombia	Colombian Peso	0.03	0.06
CZE	Czech Republic	Czech Koruna	0.06	0.14
DNK	Denmark	Danish Krone	0.38	0.42
EGY	Egypt	Egyptian Pound	0.05	0.15
FIN	Finland	Euro	0.58	0.64
FRA	France	Euro	4.08	4.8
DEU	Germany	Euro	3.23	3.41
GRC	Greece	Euro	0.27	0.41
HKG	Hong Kong	Hong Kong Dollar	1.05	1.47
HUN	Hungary	Hungarian Forint	0.06	0.08
IND	India	Indian Rupee	0.53	2.22
IDN	Indonesia	Indonesian Rupiah	0.13	0.31
IRE	Ireland	Euro	0.25	0.25
ISR	Israel	Israeli Shekel	0.19	0.29
ITA	Italy	Euro	2	1.91
JPN	Japan	Japanese Yen	11.24	8.23
JOR	Jordan	Jordanian Dinar	0.03	0.04
KOR	Korea	Korean Won	1	1.89
KWT	Kuwait	Kuwaiti Dinar	0.13	0.31
MYS	Malaysia	Malaysian Ringgit	0.42	0.48
MEX	Mexico	Mexican Peso	0.42	0.54
MAR	Morocco	Moroccan Dirham	0.03	0.08
NLD	Netherland	Euro	1.44	1
NZL	New Zealand	New Zealand Dollar	0.09	0.06
NOR	Norway	Norwegian Krone	0.33	0.65
OMN	Oman	Omani Rial	0.01	0.03
PAK	Pakistan	Pakistan Rupee	0.03	0.06
PER	Peru	Peruvian Sol	0.04	0.1
PHL	Philippines	Philippine Peso	0.06	0.13
POL	Poland	Polish Zloty	0.1	0.3
PRT	Portugal	Euro	0.19	0.22
QAT	Qatar	Qatari Rial	0.05	0.16
RUS	Russia	Russian Ruble	0.48	1.6

SAU	Saudi Arabia	Saudi Rial	0.31	0.82
SGP	Singapore	Singapore Dollar	0.47	0.66
ZAF	South Africa	South African Rand	0.62	0.79
ESP	Spain	Euro	1.38	1.76
SWE	Sweden	Swedish Krone	1.03	0.96
CHE	Switzerland	Swiss Franc	2.48	2.21
TWN	Taiwan	Taiwan Dollar	1.22	1.23
THA	Thailand	Thailand Bhat	0.18	0.33
TUR	Turkey	New Turkish Lira	0.17	0.41
GBR	UK	U.K. Pound	8.44	6.98
ARE	UAE	Emirati Dirham	0.06	0.28
USA	US	US Dollar	46.37	31.99

Note: Weights are computed within the GEM2 estimation universe using total market capitalization. Average is taken over the period from January 1997 to January 2008.

Industries are also important variables in explaining the sources of global equity return co-movement. One of the major strengths of GEM2 is to employ the Global Industry Classification Standard (GICS®) for the industry factor structure. The GICS scheme is hierarchical, with 10 top-level sectors, which are then divided into 24 industry groups, 68 industries, and 154 sub-industries. GICS applies a consistent global methodology to classify stocks based on careful evaluation of the firm's business model and economic operating environment. The GICS structure is reviewed annually by MSCI and Standard & Poor's to ensure it remains timely and accurate.

In GEM2, selection of the industry factor structure begins at the second level of the GICS hierarchy, with each of the 24 industry groups automatically qualifying as a factor. This provides a reasonable level of granularity, without introducing an excessive number of factors. We then analyze each industry group, carefully examining the industries and sub-industries contained therein to determine if a more granular factor structure is warranted. The result of this process is the set of 34 GEM2 industry factors, presented in Exhibit 28.

Exhibit 28: GEM2 Industry Factors

GICS Sector	GEM2 Code	GEM2 Industry Factor Name	Average Weight	Jan-08 Weight
Energy	1	Energy Equipment & Services	0.75	1.29
	2	Oil, Gas & Consumable Fuels	4.88	9.32
	3	Oil & Gas Exploration & Production	1.00	1.72
Materials	4	Chemicals	2.36	2.84
	5	Construction, Containers, Paper	1.38	1.24
	6	Aluminum, Diversified Metals	1.05	2.41
	7	Gold, Precious Metals	0.37	0.58
	8	Steel	0.79	1.83
Industrials	9	Capital Goods	7.33	8.60
	10	Commercial & Professional Services	1.43	0.77
	11	Transportation Non-Airline	1.82	2.32
	12	Airlines	0.37	0.45
Consumer Discretionary	13	Automobiles & Components	2.52	2.29
	14	Consumer Durables & Apparel	2.33	1.93
	15	Consumer Services	1.35	1.39
	16	Media	3.24	2.11
	17	Retailing	3.42	2.08
Consumer Staples	18	Food & Staples Retailing	1.82	1.76
	19	Food, Beverage & Tobacco	4.56	4.37
	20	Household & Personal Products	1.43	1.20
Health Care	21	Health Care Equipment & Services	2.13	1.93
	22	Biotechnology	0.78	0.68
	23	Pharmaceuticals, Life Sciences	6.17	3.82
Financials	24	Banks	10.52	10.83
	25	Diversified Financials	5.63	5.06
	26	Insurance	4.61	4.14
	27	Real Estate	2.08	3.07
Information Technology	28	Internet Software & Services	0.62	0.74
	29	IT Services, Software	3.24	2.56
	30	Communications Equipment	2.46	1.41
	31	Computers, Electronics	3.69	2.81
	32	Semiconductors	2.47	1.52
Telecom	33	Telecommunication Services	7.11	5.84
Utilities	34	Utilities	4.31	5.08

Notes: Weights are computed within the GEM2 estimation universe using total market capitalization. Average is taken over the period from January 1997 to January 2008.

Investment style represents another major source of systematic risk. Style factors, also known as *risk indexes*, are designed to capture these sources of risk. They are constructed from financially intuitive stock attributes called *descriptors,* which serve as effective predictors of equity return covariance. Since the descriptors within a particular style factor are meant to capture the same underlying driver of returns, these descriptors tend to be significantly collinear. For instance, price-to-book ratio, dividend yield, and earnings yield are all attributes used to identify value stocks, and they tend to exhibit significant cross-sectional correlation. Although these descriptors have significant explanatory power on their own, naively including them as separate factors in the model may lead to serious multi-collinearity problems. Combining these descriptors into a single style factor overcomes this difficulty, and also leads to a more parsimonious factor structure.

Unlike country and industry factors, which are assigned exposures of either 0 or 1, style factor exposures are continuously distributed. To facilitate comparison across style factors, they are standardized to have a mean of 0 and a standard deviation of 1. In other words, if d_{nl}^{Raw} is the raw value of stock n for descriptor l, then the standardized descriptor value is given by

$$d_{nl} = \frac{d_{nl}^{Raw} - \mu_l}{\sigma_l}, \tag{2.14}$$

where μ_l is the cap-weighted mean of the descriptor (within the estimation universe), and σ_l is the equal-weighted standard deviation. We adopt the convention of standardizing using the cap-weighted mean so that a well-diversified cap-weighted global portfolio, such as MSCI ACWI IMI, has approximately zero exposure to all style factors. For the standard deviation, however, we use the equal-weighted mean to prevent large-cap stocks from having an undue influence on the overall scale of the exposures.

Some of the style factors are standardized on a *global-relative* basis, others on a *country-relative* basis. In the former case, the mean and standard deviation in Equation 3.2 are computed using the entire global cross section. In the latter case, the factors have mean 0 and standard deviation 1 within each country. When deciding which standardization convention to adopt, we consider both the intuitive meaning of the factor and its explanatory power.

Formally, descriptors are combined into risk indexes as follows

$$X_{nk} = \sum_{l \in k} w_l \, d_{nl}, \tag{2.15}$$

where w_l is the descriptor weight and the sum takes place over all descriptors within a particular risk index. Descriptor weights are determined using an optimization algorithm to maximize the explanatory power of the model.

A summary of all style factors and their descriptors and weightings are shown in Exhibit 29.

Exhibit 29: GEM2 Style Factors

GEM2L Style Factor	Purpose	Descriptor Components (Weight)
Volatility	Captures relative volatility	• Historical sigma (0.050) • Historical beta (0.500) • Cumulative range (0.150) • Daily standard deviation (0.300)
Momentum	Captures sustained relative performance	• 12-month relative strength (0.250) • 6-month relative strength (0.375) • Historical alpha (0.375)
Size	Differentiates between large and small cap companies	• Logarithm of market capitalization (1.000)
Value	Captures the extent to which a stock is priced inexpensively in the market	• Forecast earnings to price (0.450) • Earnings to price (0.100) • Book to price (0.200) • Dividend yield (0.100) • Cash earnings to price (0.150)
Growth	Captures stock's growth prospects	• 5-year earnings growth (0.150) • 5-year sales growth (0.150) • Analyst predicted 5-year earnings growth (0.700)
Size Non-Linearity	Captures deviations from linearity in the relationship between returns and logarithm of market	• Cube of logarithm of market capitalization (1.000)
Liquidity	Measures the relative trading activity of a firm's shares in the market	• Monthly share turnover (0.200) • Quarterly share turnover (0.350) • Annual share turnover (0.450)
Financial Leverage	Measures a firm's financial leverage	• Book leverage (0.400) • Market leverage (0.500) • Debt to assets (0.100)

The equity factor returns f_k in GEM2 are estimated by regressing the local excess returns r_n against the factor exposures X_{nk},

$$r_n = \sum_{k=1}^{K_E} X_{nk} f_k + u_n . \tag{2.3}$$

GEM2 uses weighted least squares, assuming that the variance of specific returns is inversely proportional to the square root of total market capitalization.

As described earlier, the GEM2 equity factors include the World factor, countries, industries, and styles. Every stock in GEM2 has unit exposure to the World factor, and indicator variable exposures of 0 or 1 to countries and industries. As a result, the sum of all country factors equals the World factor, and similarly for industries, i.e.,

$$\sum_c X_{nc} = 1, \quad \text{and} \quad \sum_i X_{ni} = 1, \tag{2.4}$$

for all stocks n. In other words, the sum of all country columns in the factor exposure matrix gives a column with 1 in every entry, which corresponds to the World factor. The same holds for industry factors. The GEM2 factor structure, therefore, exhibits exact two-fold collinearity. Constraints must be applied to obtain a unique solution.

In GEM2 we adopt an intuitive set of constraints that require the cap-weighted country and industry factor returns to sum to zero,

$$\sum_c w_c f_c = 0, \quad \text{and} \quad \sum_i w_i f_i = 0, \tag{2.5}$$

where w_c is the weight of the estimation universe in country c, and w_i is the corresponding weight in industry i. These constraints remove the exact collinearities from the factor exposure matrix, without reducing the explanatory power of the model.

Intuitively, the return of the World factor is essentially the cap-weighted return of the estimation universe. As a first approximation, the pure country factors can be regarded as going long 100 percent the particular country, and going short 100 percent the World portfolio. For instance, going long 100 percent Japan and short 100 percent the World results in a portfolio with roughly 91 percent weight in Japan, and -91 percent in all other countries. The pure country factors, however, have zero exposure to industry factors. This is accomplished by taking appropriate long/short combinations in other countries. For instance, the Japanese market is over-represented in the segment corresponding to the Automobile factor. To partially hedge this exposure, the pure Japan factor takes a net short position of -1.08 percent in the US Automobile segment. A similar short position would be found in the German Automobile segment.

The pure Automobile factor can be thought, as a first approximation, to be formed by going 100 percent long the Automobile industry and 100 percent short the World portfolio. A more refined view of the factor takes into account that the net weight in each country is zero. The pure Automobile factor naturally takes a large long position in Japanese automobiles, but hedges the Japan exposure by taking short positions in other Japanese segments.

The pure Volatility factor is perhaps the easiest to understand, as it takes offsetting long and short positions within all segments corresponding to GEM2 factors (e.g., Japan, US, and Automobiles). Note that the weights are not equal to zero for segments that do not correspond to GEM2 factors, such as Japanese automobiles.

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[1] *As of March 31, 2013, as reported on July 31, 2013 by eVestment, Lipper and Bloomberg* *Oct 2013*