Russell Research

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The Russell-Axioma Developed ex-U.S. Factor Indexes (Long-only)*

The Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) comprise a powerful set of tools for investors seeking to access and manage factor exposures in developed equity markets outside the United States. These indexes are based on the same design principles and construction methodology that underpin the Russell-Axioma U.S. Factor Indexes. This paper provides an overview of the Russell-Axioma Factor Indexes and includes an introduction to equity factor indexes; a discussion of the Russell-Axioma Factor Index construction methodology and its benefits; and a description of the factors currently implemented in the series. We review and report on the investment performance of the Developed ex-U.S. Factor Indexes, with an examination of long-term performance, standard performance measures and the performance of market-neutral strategies based on the indexes. Finally, we review the effectiveness of the Russell-Axioma index methodology and examine its success in limiting index size, reducing turnover and maintaining factor strength and purity.

Overview of the Russell-Axioma Developed ex-U.S. Factor Indexes (Long-only)

The Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) are based on the Russell Developed ex-U.S. Large Cap Index, which provides Russell's depiction of the opportunity set for equity investing in developed markets outside the United States.[1]

* The author would like thank David Cariño, Mark Paris and Kyla Roberts for helpful comments and suggestions.

[1] In particular, the Russell Global Indexes use global rules for defining large cap companies, rather than the country- or region-relative methods used by other index providers. For information on the design of the Russell Global Indexes, see http://www.russell.com/indexes/data/global_equity/russell_global_indexes_methodology.asp.

These factor indexes offer efficient exposure to the momentum, market beta and volatility factors.

"Factors" are the drivers of the consistent performance patterns observed in equity markets – the drivers that affect the risk and returns of stocks. For example, researchers have observed that the returns of a stock are systematically influenced by its size, or market capitalization.[2] The "size factor" identifies this effect.

Indexes can be constructed to isolate specific factors. Standard industry practice, pioneered by Russell, is to construct separate large cap and small cap indexes. This practice gives investors representations of the large cap and small cap investment opportunity sets. It also provides index proxies for the aggregate behavior of large and small cap stocks. For example, the Russell 2000® Index is a widely used proxy for the performance of U.S. small cap stocks.

Style indexes, such as the Russell Developed ex-U.S. Large Cap Growth and Value indexes, can also be considered to deliver exposures to "style factors" (here, as the names indicate, growth and value).

In recent years, the importance of identifying additional factors for investment performance and risk management has become evident. The Russell-Axioma U.S. Factor Indexes are based on three key additional factors – medium-term momentum, market sensitivity ("beta") and volatility, as they are defined by the Axioma AX-WW 2.1 World-Wide ex-USA Equity Factor Risk Model.[3]

The Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) deliver the same types of factor exposures and are based on the same methodology as the Russell-Axioma U.S. Factor Indexes. Like the U.S.-based indexes, optimization is used to track a target index while minimizing turnover and exposures to non-targeted factors. The term "non-target factor exposures" refers to exposure imbalances, which are defined relative to a parent index. Style, sector, industry, currency or country exposure imbalances are possible. Factor purity refers to a low level of non-target factor exposures.

The target factor index used in optimization is based on a standard factor-construction process that starts by rank-ordering stocks in the benchmark index by their factor scores. Starting with the stocks with the highest (or lowest) factor scores, stocks are added to the target index with market cap weights until the target portfolio has a total capitalization of 35% of the benchmark index. For example, the high momentum target index is constructed by ordering stocks by their total return performance over approximately a year, selecting the highest-momentum stocks that add up to 35% of total index capitalization and weighting these stocks by their market cap. This set of stocks becomes the target portfolio, or "naïve factor index."

An important aspect of the Russell-Axioma optimization methodology is the use of optimization constraints to limit the number of stocks in an index, the turnover of the index and the exposure of the index to non-targeted factors.

[2] Investor interest in equity factors increased during the 1990s after carefully performed academic studies appeared to demonstrate the importance of factors. "Common risk factors in the returns on stocks and bonds," by Eugene Fama and Kenneth French (in *Journal of Financial Economics*, 1993, vol. 33, pp. 3–56), is perhaps the key paper in this literature. From the financial economics perspective, the first question is whether a factor can be considered a "priced risk factor," meaning that exposure to the factor should be expected to generate a return for bearing a systematic risk. The Fama and French analytic framework achieved statistical results consistent with the assessment that size and value are priced risk factors.

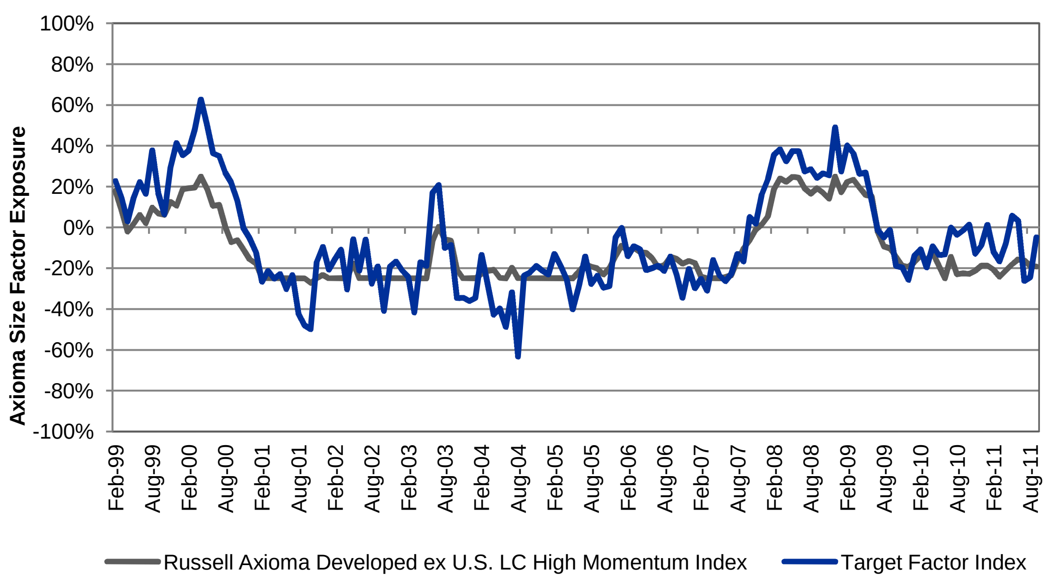
[3] For more information on the Russell-Axioma Factor Indexes (Long-only) methodology, see "Russell-Axioma Factor Indexes (Long-only)," available at http://www.russell.com/indexes/documents/russell-axioma-long-only-factor-indexes-overview.pdf.

Perhaps the clearest benefits of optimization are the reduction in the number of names and the reduction in trading turnover of optimized indexes relative to their naïve target indexes. The Russell-Axioma Developed ex-U.S. Large Cap methodology limits the number of different stocks in a factor index to 400. The average number of stocks held over the 12-year simulated history is 332 across all indexes. In contrast, the average target factor index holding is 472 stocks.

The target index is rebuilt every month. Monthly index rebuilding for a dynamic factor such as momentum can result in considerable turnover. The high momentum target index has an average monthly turnover of 21.3%, or an annual turnover of 256%. Optimization reduces monthly turnover to 6.5% and annual turnover to 78%. This 70% reduction in turnover is important for the investment value of products based on these indexes. Lower turnover reduces the market impact of rebuilding, transaction costs in trading and, potentially, tax liabilities. (See also “Holdings and turnover reduction,” below.)

Non-target factor exposures are constrained to be within 25% of corresponding benchmark exposures. Figure 1 illustrates the effects of non-target factor exposure constraints. It charts the time-series variation in the size factor exposure of both the Russell-Axioma Developed ex-U.S. Large Cap High Momentum Index and its target index. A zero size-factor exposure means that the size exposure is the same as that of the Russell Global ex-U.S. Large Cap benchmark. Positive size exposure means there is a large cap tilt relative to the benchmark, and negative size exposure means a tilt toward small cap. It can be seen, for example, that the target high momentum index increases its size exposure to 63% in the period leading up to April 30, 2000, and then reverses course and decreases size exposure to –50% on October 31, 2001. Optimization is able to keep the maximum size exposure of the Russell-Axioma High Momentum Index at 25% and the minimum exposure to –27%.

Figure 1 / Russell-Axioma Developed ex-U.S. Large Cap High Momentum and target factor indexes' (Long-only) size factor exposures, monthly February 1999 to October 2011.



Source: Axioma

Figure 1 also shows that target index factor exposures may fluctuate considerably over time. Optimized index exposures fluctuate less, and almost entirely within the desired bound of +/−25% of benchmark exposure. There is, however, a trade-off between reducing non-target factor exposures and maintaining both low tracking error to the target index and low turnover. The Russell-Axioma methodology sacrifices some non-target factor exposure reduction when the "costs" in tracking error or turnover are too high. The optimized index exposure of −27% on October 31, 2001, is an example of when the non-target factor exposure constraint is relaxed.

Finally, it can be seen in Figure 1 that there are months when the optimized index exposure is greater, in absolute terms, than the target index exposure and is close to the exposure limit. Optimization allows increases in non-target factor exposures within overall exposure limits in order to reduce tracking error, turnover or other non-target factor exposures that exceed the 25% limit. (See also "Target and non-target factor exposures," below.)

The Russell-Axioma Developed ex-U.S. Factor Indexes series

There are five factor indexes in the Russell-Axioma Developed ex-U.S. Large Cap (Long-only) series. These represent the same factors introduced to date in the U.S. Large Cap and the U.S. Small Cap factor indexes series: high momentum, low beta, low volatility, high beta and high volatility. As with the U.S. factor indexes, factor definitions are based on those used in the Axioma risk model:

The High Momentum Index defines momentum as the total return over the period from 250 to 20 days before the date of index construction. The last 20 days are excluded due to the phenomenon of short-term return reversal.

The Low Beta and High Beta indexes define beta relative to the Russell Developed ex-U.S. Large Cap Index. The betas used in the construction of the target beta indexes are based on the covariance matrix of the Axioma risk model. The risk model and these betas are designed for forecasting over a three- to six-month horizon.

The Low Volatility and High Volatility indexes are based on volatility calculations that use a 60-day trailing window. Many volatility indexes, particularly those used in reported research, are based on much larger windows. Volatility, however, is a very persistent stock characteristic, and the correlation between indexes based on short-term and long-term historical windows is quite high.

After growth and value, momentum is the most widely studied equity factor. High momentum stocks have historically tended to outperform low momentum stocks, on both an absolute and a risk-adjusted performance basis. This phenomenon has been the subject of academic research for almost 20 years.[4]

There is a relationship between beta and volatility. Conceptually, the total volatility of a stock can be broken down into two components, systematic and idiosyncratic volatility. Systematic volatility is market-driven volatility. Idiosyncratic volatility is stock-specific volatility. Beta is the basic measure of systematic volatility. Stocks with high betas tend to have high idiosyncratic volatility as well. However, stocks with low betas may still have high idiosyncratic volatility.

Understanding the effects of beta and volatility on stock performance is one of the most interesting and important areas of contemporary research regarding the dynamics of equity markets. Classical financial theory based on the Sharpe CAPM predicts that the expected return of a stock should be proportional to its beta.

[4] An excellent recent global study of momentum is provided by Ilya Figelman in "Stock return momentum and reversal: A comprehensive study," *Journal of Portfolio Management*, Fall 2007, pp. 51–67.

According to this theory, idiosyncratic volatility is predicted to have no effect on expected return because it is a risk that can be diversified away.

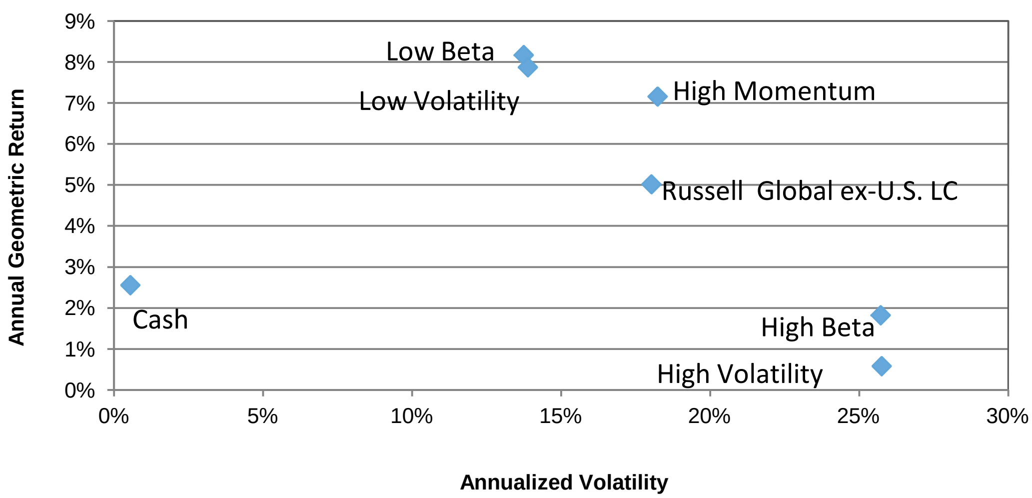
Considerable evidence has accumulated in recent years to show that beta is a poor predictor of expected returns and that idiosyncratic volatility does reduce expected returns.[5] The performance of the Russell-Axioma Factor Indexes is consistent with this research. Over significant holding periods, the low beta and low volatility indexes have outperformed the high beta and high volatility indexes.[6]

Overall performance

The risk/return profiles of the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) are summarized in the chart shown in Figure 2. The chart is based on the full available performance history, which includes simulated performance data.[7] This history commences with the market close on January 31, 1999. The chart is based on monthly total returns from February 1999 to October 2011.

In Figure 2, the horizontal axis represents annualized standard deviation and the vertical axis represents annualized total return. The annualized return of an index is the annual return that compounds to the total change in the value of the index over the complete performance history (assuming reinvestment of dividends).

Figure 2 / Risk/return profiles of Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), based on monthly returns over the period February 1999 to October 2011.



Source: Axioma

[5]An accessible introduction to the topic which advances the hypothesis that this effect is at least partially driven by the drive of investment managers to outperform their benchmarks is provided by "Benchmarks as limits to arbitrage: Understanding the low volatility anomaly," by Malcolm Baker, Brendan Bradley and Jeffrey Wurgler, *Financial Analysts Journal*, Jan./Feb. 2011, pp. 40–54. A global survey of the volatility effect is provided in David Blitz and Pim van Vliet's "The volatility effect: Lower risk without lower return," in the *Journal of Portfolio Management*, Fall 2007. The first paper to document penalization of idiosyncratic volatility is Andrew Ang, Robert Hodrick, Yuhang Xing and Xiaoyan Zhang's "The cross-section of volatility and expected returns," published in the *Journal of Finance*, 2006, pp. 259–99.

[6] Exposure to volatility in institutional investment manager portfolios is documented in Bob Collie and John Osborn, "Defensive equity: Is the market mispricing risk?" Russell Research, June 2011.

[7] In simulated performance, the index construction methodology is applied to historical data to derive index values for time periods prior to the methodology's development.

The general historical pattern evident in Figure 2 is that: 1) high momentum has had higher returns to the benchmark, at comparable volatility; 2) the low beta and low volatility indexes have had higher returns compared to the benchmark, at lower relative volatility; and 3) the high beta and high volatility indexes have had lower returns compared to the benchmark, at higher relative volatility. This pattern in returns is similar to that found for the Russell-Axioma U.S. factor indexes and the research discussed above.[8]

General performance statistics

Table 1 reports historical performance statistics for the same indexes and time periods as those represented in Figure 1. Average annual returns are more indicative of typical short-term performance than are geometric returns. It can be seen in Table 1 that the average returns of the high beta and high volatility indexes were considerably higher than their geometric returns. This suggests short-term investment opportunities for an investor with market timing ability. Annualized standard deviations provide a feeling for the size of average annual deviations.

The beta statistic represents the average sensitivity of an index to changes in the Russell Developed ex-U.S. Large Cap Index over the course of a month. Beta is the average percentage change in the index associated with a percentage increase in the core index. Not surprisingly, the high beta and high volatility indexes had high betas, and the low beta and low volatility indexes had low betas. It is perhaps surprising that the beta of the high momentum index was less than one. Similarly, the U.S. Large Cap High Momentum Index (Long-only) had beta of 0.96 to the Russell 1000® Index. These betas suggest that momentum strategy returns are similar to those of the market during large market moves. Momentum outperformance must then be greater at other times.

Table 1 / Performance statistics for Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), monthly simulated historical total returns over the period February 1999 to October 2011.

	Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only)						
	High Momentum	Low Beta	Low Volatility	High Beta	High Volatility	Russell Dev ex-U.S. LC	Risk-free rate
Average annual return	8.96%	9.20%	8.92%	5.32%	4.05%	6.56%	2.56%
Geometric annual return	7.16%	8.17%	7.87%	1.83%	0.59%	5.02%	2.56%
Annualized standard deviation	18.23%	13.74%	13.88%	25.71%	25.74%	18.02%	0.55%
Monthly standard deviation	5.26%	3.97%	4.01%	7.42%	7.43%	5.20%	0.16%
Beta to Russell Dev ex-U.S. LC	92.17%	70.29%	70.64%	137.38%	136.54%	---	–0.15%
Sharpe ratio	25.24%	40.82%	38.27%	–2.86%	–7.67%	13.65%	---
Maximum drawdown	52.69%	44.74%	45.28%	71.55%	72.40%	56.63%	0.00%

Source: Axioma

Return volatility attenuates the relationship between average and annualized returns. The annualized return is approximately equal to the average arithmetic return minus one half of the return variance. The resulting drain on performance due to volatility is thus approximately 3.3% for the high beta index and only 0.9% for the low beta index.

[8] See Barry Feldman, "The Russell-Axioma U.S. Long-only Factor Indexes," Russell Research, October 2011.

The volatility differences in these indexes builds in a 2.4% long-term drain on any arithmetic return performance advantage that high beta might have over low beta.[9]

Sharpe ratios are a measure of return per unit of volatility. The reported Sharpe ratio is based on the annualized geometric return minus the annual risk-free rate (here, represented by LIBOR and with a 2.56% value of annualized return over the simulated history). This quantity is then divided by the annualized standard deviation. The low beta and low volatility indexes have had the highest Sharpe ratios, higher than the core index over the complete history. High momentum has also had a high Sharpe ratio.

The maximum drawdown for an index is the greatest peak-to-trough decline in value over the observed history. The high beta and high volatility indexes have had by far the highest maximum drawdowns (see Table 1). The high momentum maximum drawdowns are similar to those of the Russell Developed ex-U.S. Large Cap Index. This pattern is similar to that found for the Russell-Axioma U.S. factor indexes.

Historical performance profiles

Table 2 shows the geometric return, standard deviation and Sharpe ratios for trailing one-, three-, five- and 10-year windows ending October 31, 2011. Volatilities can be seen to have been relatively stable over different time horizons, as might be expected. Returns and Sharpe ratios have varied widely over the investment horizon. High beta and high volatility performed very well over the three-year horizon. Low beta and low volatility had consistently superior returns and Sharpe ratios, while momentum performed poorly over the last year and the last five years.

Table 2 / Multiple-horizon risk/return statistics for Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), monthly simulated historical total return data, January 1999 to October 2011.

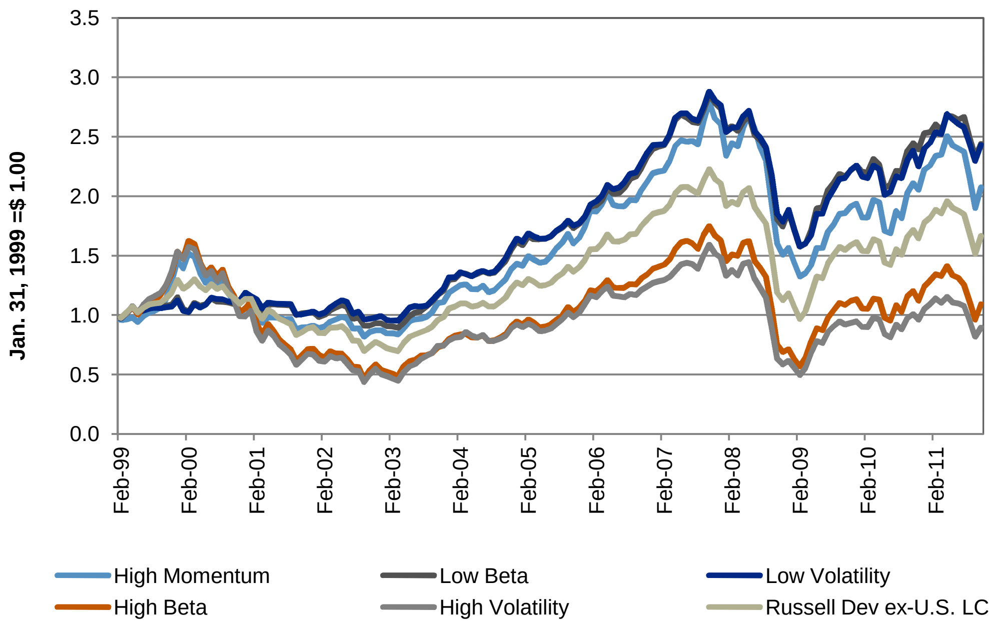
	Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only)					
	High Momentum	Low Beta	Low Volatility	High Beta	High Volatility	Russell Dev ex-U.S. LC
1-year annualized geometric return	–1.7%	–0.2%	1.9%	–9.2%	–11.2%	–3.0%
3-year annualized geometric return	9.0%	10.5%	9.5%	13.3%	12.2%	11.9%
5-year annualized geometric return	0.2%	1.8%	1.3%	–3.6%	–5.8%	–1.0%
10-year annualized geometric return	8.8%	9.2%	9.2%	5.1%	3.7%	6.9%
1-year annualized standard deviation	22.3%	14.2%	16.3%	29.4%	26.1%	21.7%
3-year annualized standard deviation	22.1%	16.8%	17.4%	31.0%	29.8%	23.2%
5-year annualized standard deviation	22.4%	17.1%	17.4%	30.8%	30.4%	23.1%
10-year annualized standard deviation	18.1%	14.2%	14.4%	26.0%	26.1%	19.0%
1-year Sharpe ratio	–0.08	–0.03	0.10	–0.32	–0.44	–0.15
3-year Sharpe ratio	0.40	0.62	0.53	0.42	0.40	0.50
5-year Sharpe ratio	–0.06	0.02	–0.01	–0.16	–0.24	–0.11
10-year Sharpe ratio	0.38	0.51	0.51	0.12	0.07	0.26

Source: Axioma

[9] For a general discussion of volatility drag, see Bob Collie, "The volatility paradox: When winners lose and losers win," Russell Research, July 2011.

Figure 3 shows cumulative performance of the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) and the Russell Developed ex-U.S. Index over this period (initial value is $1.00 at January 31, 1999).

Figure 3 / Cumulative performance Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), February 1, 1999 to October 31, 2011.



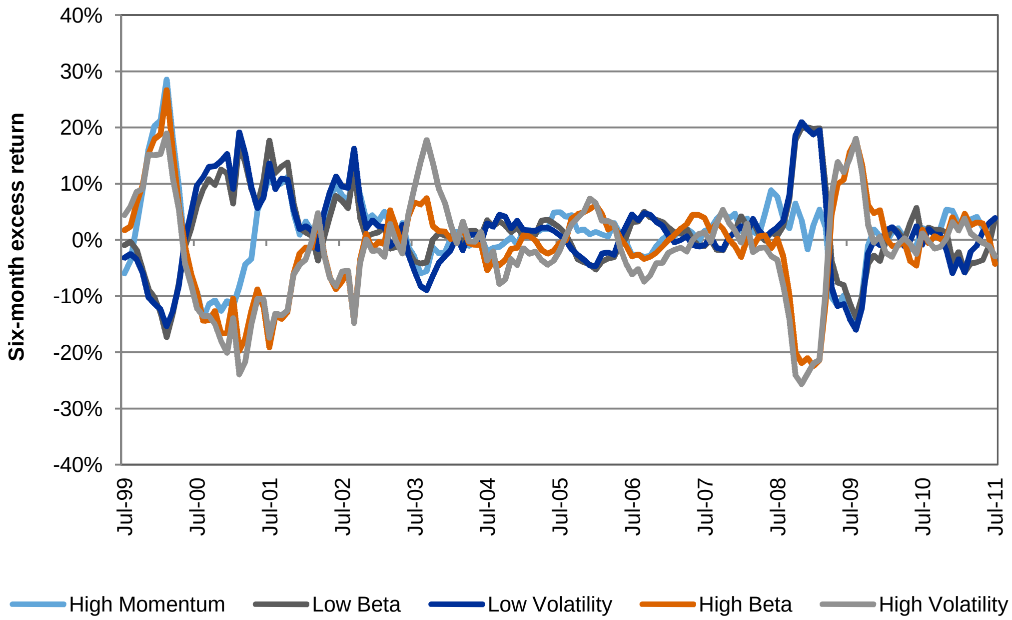
Source: Axioma

The general pattern of performance seen in Figure 3 is consistent with the risk/return profile of Figure 2. Low beta, low volatility and momentum outperformed the benchmark while high beta and high volatility underperformed the benchmark. Low beta and low volatility tracked each other closely over the period of analysis. High beta appears to have performed consistently better than did high volatility. There were two basic performance regimes: the first, where high beta and high volatility outperformed the other factor indexes, ended around year-end 2001. From that time forward, the dominant pattern of low beta and low volatility outperformance is visible. Notice that high momentum closely tracked high beta and high volatility in the early period and switched to tracking low beta and low volatility in the later period.

Another useful perspective on performance that focuses on short-term performance trends is attained by examining short-term history excess returns relative to the benchmark. Figure 4 charts rolling six-month performance relative to the Russell Developed ex-U.S. Large Cap Index. This outperformance is calculated as the geometric difference in cumulative total returns between the factor indexes and the benchmark over the six months ending on a particular date. This chart shows how position held for six months in one of the factor indexes would compare to a position in the benchmark at particular points in time.

Particularly evident in Figure 4 are the large excess returns during the periods of financial stress associated with the technology bubble during 1999 and 2001 and the financial crisis from July 2008 to the end of 2009. Momentum, high beta and high volatility had high performance going into the technology bubble but declined sharply after the peak in February 2000. This decline was mirrored by a peak in the low beta and low volatility indexes.

Figure 4 / Six-month excess returns of Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), monthly July 1999 to October 2011.



Source: Axioma

The pattern during the financial crisis of 2008 to 2009 was similar to the return pattern during the technology bubble. During the first phase of the crisis, the low beta and low volatility indexes strongly outperformed the other factor indexes; then high beta and high volatility strongly outperformed the other factor indexes in the recovery phase sparked by the quantitative easing program undertaken by the U.S. Federal Reserve in March 2009.

The isolated peak of high volatility six-month excess return at 17.8% as of September 30, 2003, identifies the period of greatest difference between the six-month cumulative returns of the high beta and high volatility indexes over the period of analysis. The corresponding high beta performance was 7.45%. This time period coincided with the start of market recovery, visible in Figure 3. Greater performance differentials between the beta and volatility indexes may be more likely under such circumstances, where shifting impacts of idiosyncratic volatility exposure might be taking place.

Excess return correlations

The correlations between factor indexes give indication of the similarity of factor returns over short periods of time – for example, one to three months. The correlations reported here are based on returns in excess of the return of the benchmark. Excess returns are the appropriate return measure to use in order to focus on factor relationships and to remove the common movements of the factor indexes driven by the market and currency exchange rates.

Ideally, excess return correlations between different unrelated factors should be close to zero, and excess return correlations between opposed related factors (e.g., large cap high beta and large cap low beta) should be close to minus one. A correlation of minus one implies that when one index goes up relative to the benchmark, the other index will go down to the same degree.

Table 3 presents excess return correlations of the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) relative to the Russell Developed ex-U.S. Large Cap Index. Looking at Table 3, high momentum correlations with other indexes were all close to zero. The correlations of the high and low legs of the beta and volatility indexes were also close to minus one. The only significant departure from the ideal pattern was the 90%+ absolute value of correlations between the beta and volatility indexes. These correlations reflect the strong beta content of the volatility indexes. These exposures could not be neutralized without seriously degrading success in tracking target factor exposures.

Table 3 / Monthly excess return correlations for Russell-Axioma U.S. Large Cap Factor Indexes (Long-only), February 1999 to October 2011.

	Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only)				
	High Momentum	Low Beta	Low Volatility	High Beta	High Volatility
High Momentum	100%				
Low Beta	4%	100%			
Low Volatility	12%	91%	100%		
High Beta	–5%	–96%	–91%	100%	
High Volatility	–10%	–88%	–94%	91%	100%

Source: Axioma

The correlations between the Russell-Axioma Developed ex-U.S. Large Cap and Russell-Axioma U.S. Large Cap factor indexes (long-only) may also be of interest. These correlations, based on excess returns to each index's benchmark, are presented in Table 4. The benchmark for the Russell-Axioma U.S. Large Cap Factor Indexes is the Russell 1000® Index. The correlations on the diagonal running from the top left to the bottom right report the correlations between the same factor indexes in the Developed ex-U.S. and U.S. large cap markets. For example, the top left cell reports a correlation of 68% between the momentum indexes in these two markets.

Table 4 / Monthly excess return correlations between the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) and the Russell U.S. Large Cap Factor Indexes (Long-only), February 1999 to October 2011.

	Dev ex-U.S. High Momentum	Dev ex-U.S. Low Beta	Dev ex-U.S. Low Volatility	Dev ex-U.S. High Beta	Dev ex-U.S. High Volatility
U.S. LC High Momentum	68%	4%	5%	–1%	–1%
U.S. LC Low Beta	11%	77%	73%	–74%	–68%
U.S. LC Low Volatility	4%	81%	79%	–79%	–73%
U.S. LC High Beta	–2%	–67%	–68%	70%	67%
U.S. LC High Volatility	1%	–63%	–67%	67%	70%

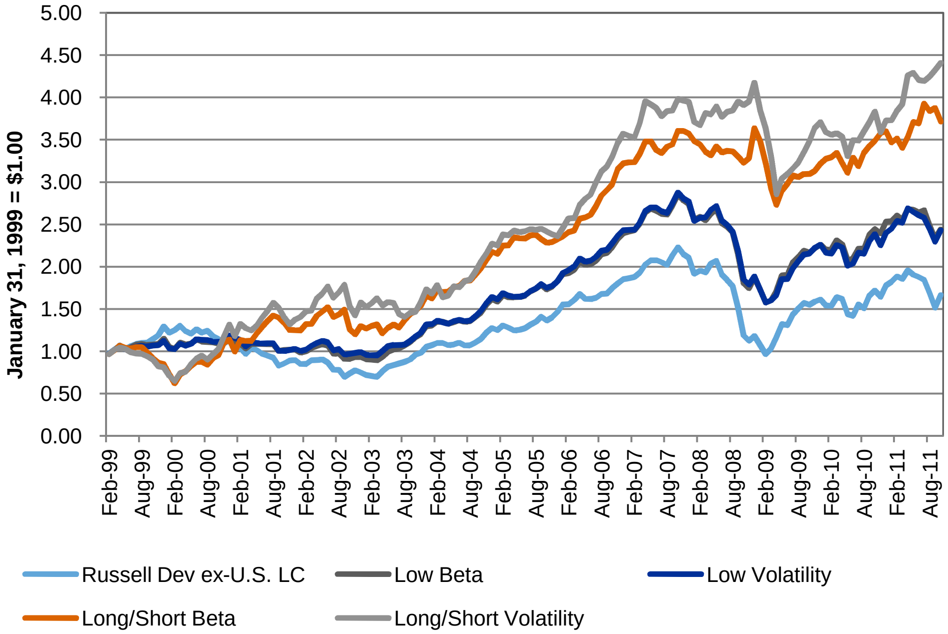
Source: Axioma

The general pattern of correlations between the developed ex-U.S. factor indexes shown in Table 3 can also be seen to hold in the cross-correlations reported in Table 4. The average excess return correlation between the corresponding factors (e.g., U.S. and developed ex-U.S. momentum) over the common history period is 73%. Opposing-leg correlations, such as between low beta and high beta across the developed ex-U.S. and U.S. markets, are negative and of similar magnitude. These results suggest similarity in factors across markets after controlling for market and exchange rate movements.

Long/short strategies

Long/short beta and volatility strategies are easily implemented with the Russell-Axioma Factor Indexes. The key to these strategies is that the low beta or low volatility leg must be approximately twice as large as the high beta or high volatility leg in order to be market-neutral, i.e., to have a beta close to zero. The strategies examined here are net 100% long and gross 200% long/100% short. The necessity for this type of weighting to achieve market neutrality derives directly from the betas reported in Table 1. For example, over the period of the available history, the low volatility beta is 0.71 and the high volatility beta is 1.37. The expected beta of the long/short volatility strategy would then be 2 * 0.71 – 1.37 = 0.05.

Figure 5 / Summary statistics for long/short beta and volatility indexes weighted 200% long the low beta or volatility leg and 100% the high beta or volatility leg, Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), monthly data February 1999 to October 2011.



Source: Axioma

Figure 5 shows the cumulative performance of the Russell Developed ex-U.S. Large Cap Index, the Russell-Axioma Developed ex-U.S. Large Cap Low Beta and Low Volatility indexes (Long-only) and the 2x-long/1x-short beta and volatility strategies. It can be seen that the long/short strategies have outperformed the long-only strategies. It should also be noted that while the beta of these strategies was very low, it is clear that the long-term performance profile still broadly followed the benchmark. Market neutrality over monthly reporting periods does not imply market neutrality over long horizons.

Table 5 reports summary statistics for long/short beta and volatility strategies constructed in this manner. Note that the resulting portfolio is 100% long. These strategies have volatility comparable to that of the Russell Developed ex-U.S. index, with lower maximum drawdowns, much higher average and geometric returns and substantially higher Sharpe ratios. The maximum long-only Sharpe ratios were 0.41 for low beta and 0.38 for low volatility. These results illustrate the potential value of the Russell-Axioma Factor Indexes in the construction of more sophisticated factor strategies.

Table 5 / Summary statistics for long/short beta and volatility indexes weighted 200% long the low beta or volatility leg and 100% the high beta or volatility leg, Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only), monthly data February 1999 to October 2011.

	Long/Short Beta	Long/Short Volatility
Average annual return	13.21%	14.00%
Geometric annual return	11.57%	12.16%
Annualized standard deviation	17.20%	18.16%
Monthly standard deviation	4.96%	5.24%
Beta to Russell Dev ex-U.S. LC	0.03	0.05
Sharpe ratio	0.52	0.53
Maximum drawdown	42%	38%

Source: Axioma

Holdings and turnover reduction

Here we examine the success of the Russell-Axioma factor index methodology in reducing the number of different stocks held and in reducing turnover relative to the target indexes. Turnover is measured by average turnover over the period of the simulated history and maximum turnover for any single monthly index rebuild. Table 6 reports the average and maximum number of names held and the average and maximum turnover for each Russell-Axioma index and for its associated target index. Turnover is reported on a one-way basis, meaning the fraction of the index that is bought or sold in order to rebuild the index.

Table 6 / Monthly portfolio construction statistics for the Russell-Axioma Developed ex-U.S. Large Cap factor and target indexes (Long-only), February 1999 to October 2011.

	Russell-Axioma Factor Indexes				Target Factor Indexes			
	Average Names Held	Maximum Names Held	Average One-Way Turnover	Maximum One-Way Turnover	Average Names Held	Maximum Names Held	Average One-Way Turnover	Maximum One-Way Turnover
High Momentum	355	400	6.5%	26.5%	456	652	21.3%	41.3%
Low Beta	377	400	4.3%	22.7%	601	829	14.6%	32.9%
Low Volatility	362	400	5.0%	19.0%	373	596	16.9%	35.7%
High Beta	277	373	7.0%	29.2%	349	492	14.1%	33.9%
High Volatility	288	400	3.5%	25.5%	581	825	15.9%	36.8%

Source: Axioma

Regarding holdings reduction, it can be seen in Table 6 that the number of names in the optimized indexes was limited (by construction) to 400. The maximum number of names in the target indexes ranged from 492 to 825. The average number of names in the optimized indexes ranged from 288 to 377 and in the target indexes from 349 to 601. On average, there were 27% fewer names in the optimized Russell-Axioma index than in the target index.

Table 6 also reports that average monthly turnover ranged from 3.5% to 7.0% for the optimized indexes, in contrast to 15.9% to 21.3% for the target indexes. The average reduction in turnover was 68%.

Tracking error control

Tracking error is a standard measure for quantifying the degree to which one index tracks another. There are two relevant types of tracking error: predictive and realized. In the optimization process, the Axioma optimizer uses information from the Axioma risk model to predict the next month's tracking error relative to the target index. Realized tracking error is the root mean square error of the difference in actual return streams, which is approximately the standard deviation of the difference in return streams.

Table 7 / Monthly tracking errors and average monthly excess returns for Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) relative to target factor indexes, February 1999 to October 2011.

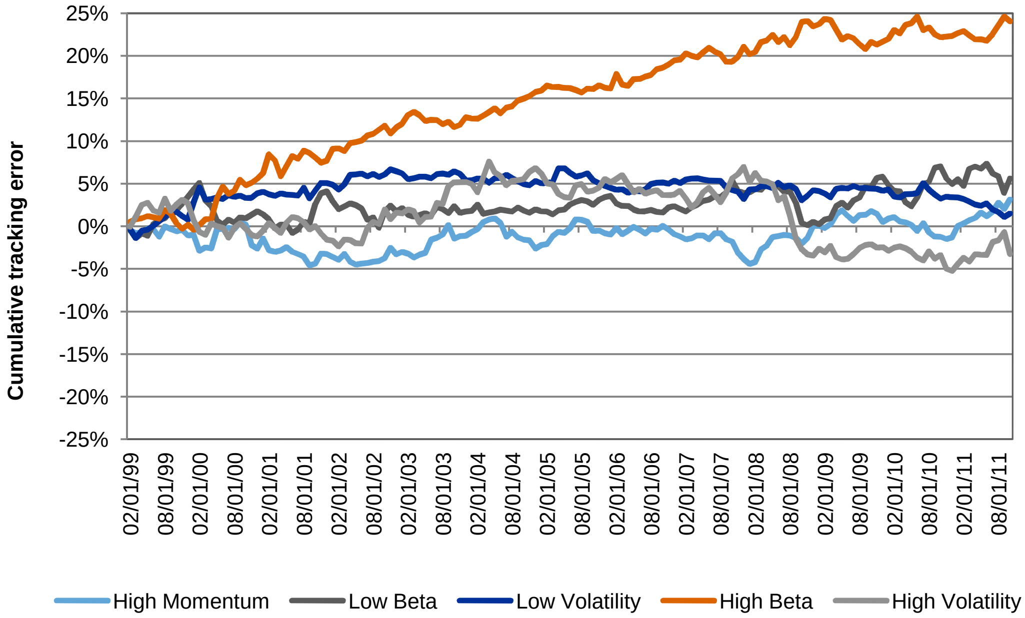
	Average Predicted Tracking Error	Maximum Predicted Tracking Error	Average Realized Tracking Error	Maximum Realized Tracking Error	Target Tracking Error	Average Return Difference	Error Auto-correlation
High Momentum	2.10%	5.60%	0.71%	2.33%	2.00%	0.02%	5.27%
Low Beta	2.30%	3.00%	0.76%	2.26%	3.00%	0.04%	–4.64%
Low Volatility	1.60%	2.60%	0.51%	2.08%	2.00%	0.01%	–4.86%
High Beta	2.20%	6.80%	0.64%	2.43%	2.00%	0.14%	2.49%
High Volatility	2.90%	6.80%	0.90%	1.97%	3.00%	–0.02%	0.00%

Source: Axioma

Table 7 reports averages and maximums for both predicted and realized tracking errors for all indexes, along with the average return difference between optimized and target indexes and the autocorrelation in these differences. It can be seen that both average and predicted realized tracking errors were uniformly larger than the corresponding realized tracking errors.

The average return difference was 4 basis points per month or less for all indexes except high beta, which had a positive return average difference of 14 basis points per month. The last column reports the time series first-order autocorrelations of the return differences between the optimized and target indexes, which is the correlation between returns for two consecutive months. These autocorrelations were quite small, implying that there was no simple consistent pattern in the return differences between the optimized and target indexes.

Figure 6 / Cumulative tracking error of Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) vs. their target indexes. Monthly performance, February 1999 to October 2011.



Source: Axioma

Figure 6 shows cumulative tracking error over time. The return differences for each month are cumulated in a geometric fashion as if an investor were long the optimized index and short the target index. It can be seen that for four of the indexes, the maximum cumulative error was about 8%. For high beta, however, it was about 25%, which was the cumulative effect of the 14-basis-points-per-month return difference. This drift was steady over time and added to the performance of the high beta index.

Target and non-target factor exposures

Our final examination of aspects of the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) concerns target and non-target factor exposures.

All reported factor exposures – often called, as above in this paper, "tilts" – are measured on the basis of standardized z-scores generated by the Axioma risk model. These scores are constructed so that a factor exposure which is the same as that of the benchmark is scored as zero.

Table 8 reports on the average target factor tilts for all developed ex-U.S. factor indexes. Average target tilt is the average tilt of the target factor index used for optimization. The average tilt difference is the average difference between the Russell-Axioma factor index and its target index. Maximum tilt difference is defined analogously. In Table 8, the average tilt difference was consistently in the direction of the benchmark from the target index and was between approximately 10% and 20% of the average target tilt. We can see that the maximum tilt differences have been considerably greater. These tilts reveal that optimization somewhat reduced month-to-month factor exposure. Table 7, however, shows that this reduction in month-to-month factor exposure had little effect on tracking error and return performance.

Table 8 / Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) tilts, monthly data February 1999 to October 2011.

	Average Target Tilt	Average Tilt Difference	Maximum Tilt Difference
High Momentum	81.5%	–8.2%	15.9%
Low Beta	–82.7%	16.5%	27.6%
Low Volatility	–72.6%	15.1%	39.1%
High Beta	88.7%	–15.9%	52.5%
High Volatility	87.0%	–7.9%	8.0%

Source: Axioma

Non-target factor tilts include other style factors and sector, industry, country and currency exposures. These exposures are difficult to summarize quantitatively due to the sheer numbers of dimensions involved. Non-target factor exposures tend not to experience reductions as dramatic as those associated with turnover, and this is particularly the case with style factor exposures. A feeling for the exposure patterns of the Russell-Axioma Developed ex-U.S. Factor Indexes is provided here through a set of charts reporting non-target factor exposures for the high momentum index.

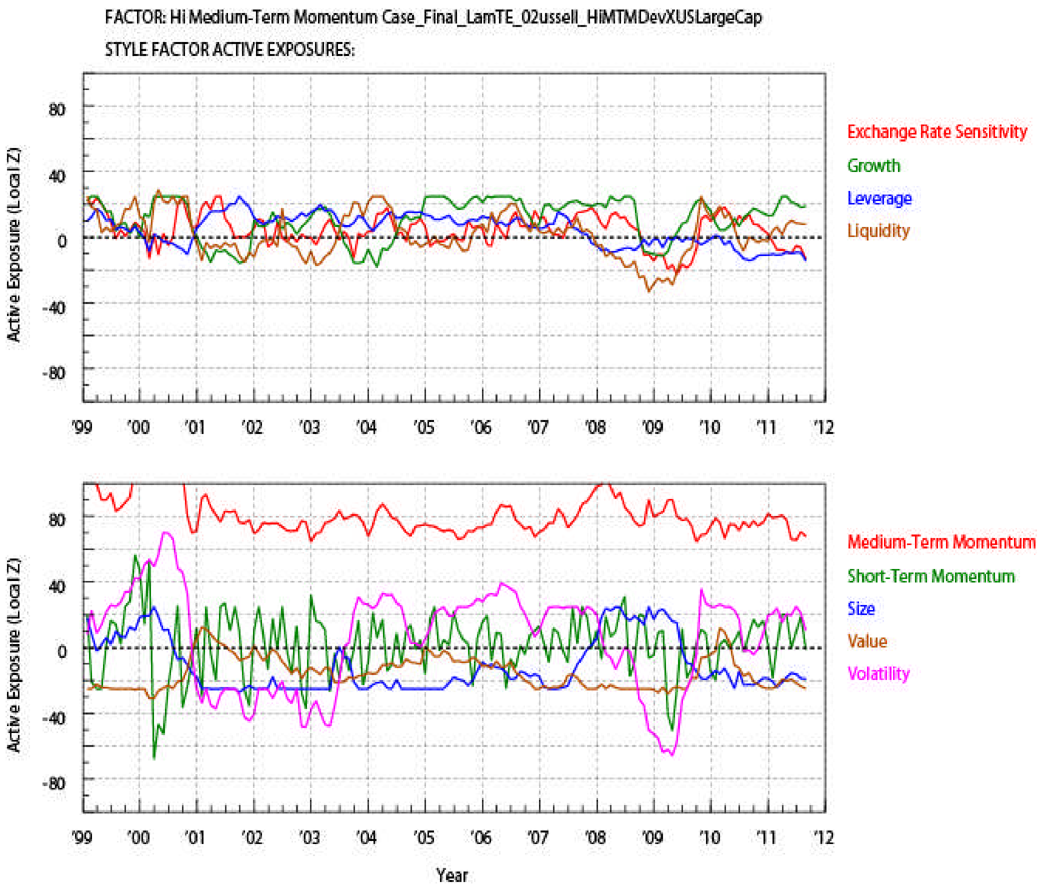
Figure 7 reports style factor exposures using two panels. The goal of optimization is to limit style factor exposures to 25%. The top panel reports exchange-rate sensitivity, growth, leverage and liquidity factors. In Figure 7, exposures to these factors rarely exceeded 25%. The principal exception is liquidity during late 2008 and early 2009. It can be seen that negative liquidity exposure increased steadily over the course of 2008, peaking toward the end of the year and then reversing. This exposure was too costly to constrain, “costly” here meaning increases in tracking error, turnover and other non-target exposures. On the other hand, positive growth exposure was constrained to approximately 25% over a period covering much of 2005 and 2006 and over the period from 2007 to 2008 as well.

The second panel of Figure 7 reports medium- and short-term momentum, size, value and volatility exposures. The medium-term momentum exposures are the target factor exposures. The size exposure is the same as the optimized index exposure shown in Figure 1. Negative size exposures (i.e., a small cap tilt) were successfully constrained over the 2001 to 2003 and 2004 to 2005 periods. Positive size exposures in the periods 1999 to 2001 and 2008 were also successfully constrained. Short-term momentum and volatility exposures were not constrained, but value exposures were (from 2007 to 2009).

Currency exposures are reported in Figure 8. Almost all currency exposures fell into the approximate +/–10% range. Euro exposures in 2000, yen exposures in 2004 and 2006 and pound exposures in 2009 were slightly greater than 10% in magnitude.

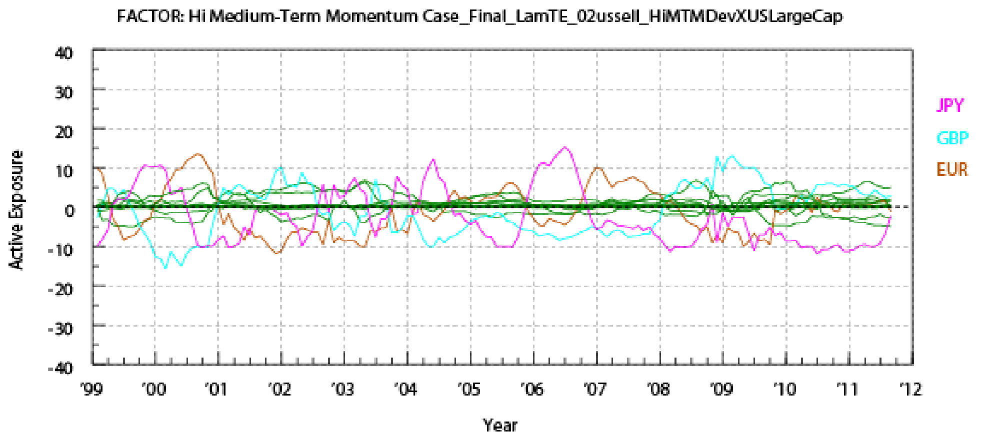
Sector exposures are reported in Figure 9. Almost all sector exposures fell within approximately +/–10% of the benchmark. The two exceptions to the pattern were Information Technology over the 1999 to 2001 period and Financials in the period between 2008 and 2010. None of these exposures broke the 25% constraint, although during 2001 the Information Technology exposure came close.

Figure 7 / Style factor exposures of the Russell-Axioma Developed ex-U.S. Large Cap High Momentum Index. Monthly performance, February 1999 to October 2011.



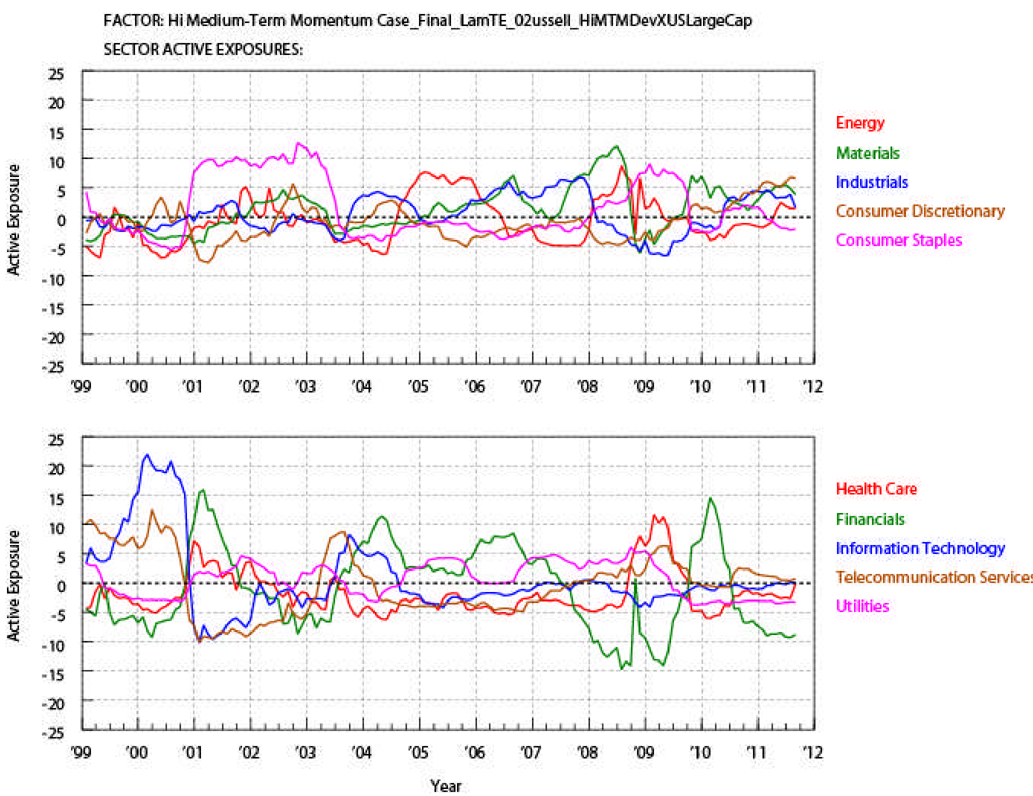
Source: Axioma

Figure 8 / Currency exposures of the Russell-Axioma Developed ex-U.S. Large Cap High Momentum Index. Monthly performance, February 1999 to October 2011.[10]



Source: Axioma

Figure 9 / Sector exposures of the Russell-Axioma Developed ex-U.S. Large Cap High Momentum Index. Monthly performance, February 1999 to October 2011.



Source: Axioma

[10] Minor exposures represented with green lines include the Canadian dollar, Australian dollar, Swiss franc and the Hong Kong dollar.

Conclusion

The results presented in this paper demonstrate that the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) can provide effective momentum, beta and volatility exposures – and that optimization greatly reduces holdings and turnover and successfully constrains many non-target factor exposures while maintaining low tracking error to the naïve target factor indexes.

The simulated historical performance of the Russell-Axioma Developed ex-U.S. Large Cap Factor Indexes (Long-only) is qualitatively similar to that of the Russell-Axioma U.S. Large Cap Factor Indexes (Long-only). This suggests that both index families can provide the framework for implementing strategic and tactical large cap factor tilts, either to hedge or to accentuate investor factor exposures. Such tilts may now be based on Russell-Axioma Large Cap indexes (Long-only) for U.S., developed ex-U.S. and developed markets portfolios. The long/short beta-neutral strategies demonstrated here suggest that these indexes might serve as foundations for hedge fund strategies seeking to leverage the relative outperformance of low beta and low volatility strategies.

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