

COUNTRY AND SECTOR DRIVE LOW-VOLATILITY INVESTING IN GLOBAL EQUITY MARKETS

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Abstract

Low-risk stocks have historically outperformed high-risk stocks, delivering better long-term returns with less volatility. This counter-intuitive effect has persisted since 1926, violating one of the basic tenets of Finance Theory.

We investigate the role of country and sector effects in low-volatility investing in global equities and find that the benefit of the low-volatility anomaly can be earned through country and sector selection in lieu of individual stock selection. We find that low-volatility investing has a pronounced “anti-bubble” behavior that is driven by country and sector positioning. Additionally, we see that employing a country-sector selection approach mitigates many of the implementation pitfalls associated with the minimum-volatility stock selection portfolio. We conclude that country and sector selection is a more practical approach than individual stock selection for capturing the benefits of low-volatility investing in global equities.

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Research Motivation, Scope, and Methodology

Low-risk stocks have historically outperformed high-risk stocks, delivering better long-term returns with less volatility. This counter-intuitive effect existed as far back as 1926 and has persisted since, violating one of the basic tenets of Finance Theory. Following a recent surge in attention to this anomaly by both researchers and practitioners, low-volatility investing has gained traction as a compelling investment strategy compared to traditional active management and capitalization-weighted indices².

We investigate the extent to which country and sector effects are behind the low-volatility effect. First, we create single sector, country, or country-sector capitalization-weighted baskets of stocks in the MSCI World Index. Examples are “United States Utilities” and “Italian Consumer Discretionary.” We invest in the portfolio of such “units” optimized to minimize predicted risk, using a global equity risk model. We then compare the historical performance of this low-volatility country and sector selection strategy with that of the minimum predicted risk portfolio of individual stocks. If it is similar, we can conclude that country and sector effects are indeed the key drivers of the low-volatility effect.

Our performance analysis period runs from 1978 to 2012³, covering a range of investment conditions and volatility environments. This includes Black Monday, the Japan bubble, the Asian and Russian financial crises of the 1990s as well as the “great moderation” book-ended by the bursting of the tech bubble, the global financial crisis and the European debt crisis. The investable universe consists of the point-in-time constituents of the MSCI World Index. We use GICS sector definitions. All portfolios are long-only and unleveraged. Market capitalization of all stocks is free-float adjusted. Portfolios are re-optimized semi-annually at the end of May and November, following the rebalance schedule of the MSCI low-volatility indices. Portfolio returns are calculated monthly and all performance metrics are reported on an annualized basis. We use Axioma’s AX-WW 2.1 Global Equity Factor Risk Model for portfolio construction starting 1997, the first year for which model data is available. Prior to that we use a custom multi-factor risk model estimated using MSCI data. Details are provided in the appendix.

Empirical Results

Figures 1 and 2 demonstrate the risk/return trade-offs of the low-volatility strategies and the capitalization-weighted index. We see that the realized risk of the country-sector selection strategy is slightly higher than the stock-selection strategy, but this is compensated by a better return. As a result, the risk-adjusted performance of these minimum-volatility portfolios is similar; both strongly outperform the capitalization-weighted index⁴. This implies that a country-sector selection strategy can capture much of the performance benefit of low-volatility investing in global equities. We also see that investing

² We will use the term “Min Vol” to refer to a systematic strategy of investing in a portfolio of securities from a given universe optimized to have minimum predicted volatility based on an estimated risk model, subject to optional investment constraints. There is no guarantee that the resulting portfolio will actually deliver low-volatility returns. We use the broader term “Low Vol” for strategies aimed to have low but not necessarily minimum predicted volatility.

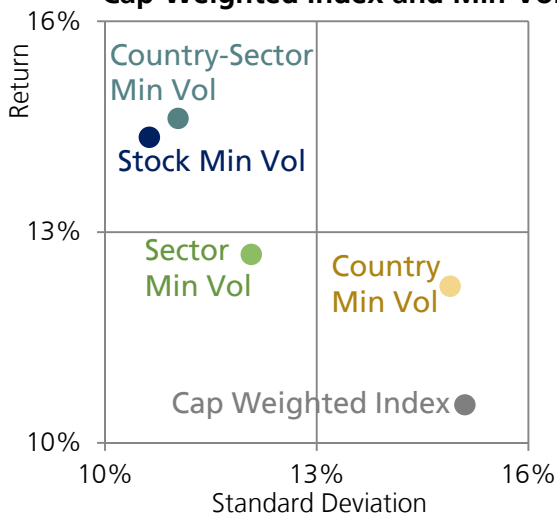
³ 1978 is the first year for which MSCI “deep history” data was available to us after allowing for a seed period to estimate our risk model.

⁴ Calculated as cap weighted total return of investable universe. This closely tracks the MSCI World return with a small tracking error.

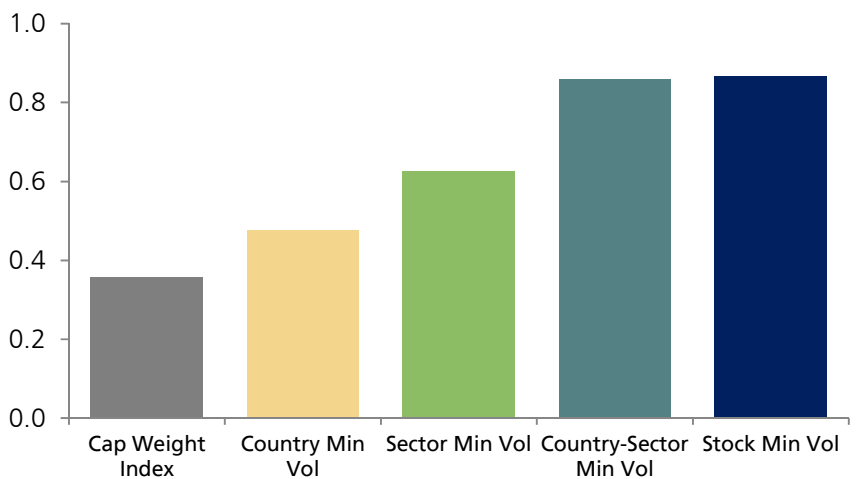
in low-risk combinations of entire country indices or global sector baskets does not give similar benefits. In the appendix we present these performance metrics for the early and later part of our analysis period separately, confirming our findings are consistent over time.

This conclusion seemingly contradicts a recent finding by Baker et al. (2013) that macro effects (country and sector selection) and micro effects (stock selection) contribute about equally to the risk-adjusted performance of low-volatility investing. However, their results reflect the impact of removing country and sector biases from the low-volatility portfolio, and we present similar results later on. Our focus is the efficacy of implementing a low-volatility strategy through investing in suitable country-sector combinations, which is a different and essentially complementary research question.

**Figure 1: Risk/Return Comparison
Cap-Weighted Index and Min-Vol**



**Figure 2: Sharpe Ratio Comparison
Cap-Weighted Index and Min-Vol**



January 1978 to December 2012
Annualized performance statistics; Sharpe ratio uses 3-month treasury bills as risk-free rate
Data source: MSCI, Axioma

Another metric for risk-adjusted return is “alpha” relative to the Fama-French four-factor model. We estimated global factor returns using the methodology outlined in Fama and French (2012) applied to our investable universe, rebalancing the underlying portfolios monthly. Table 1 shows that the low volatility stock portfolio and country-sector portfolio both have similar and statistically significant positive alpha, with factor returns explaining 61.7% of their historical return volatility. Therefore, an investment strategy based on static bets on these four factors cannot fully replicate the pay-off of low-volatility investing. In addition, the results show that both strategies are “low beta” relative to the overall market. Net of the market effect, they have positive exposure to small-cap stocks, and to a lesser extent to value and momentum stocks. More details on the portfolio’s factor exposures are provided in the appendix.

Table 1: Fama-French analysis

Min Vol Strategies Monthly Excess Returns Over Risk-free Rate

| | Monthly Alpha | Regression Betas (t-value) | | | | R ² |
|------------------------|---------------|----------------------------|-------------|------------|-------------|----------------|
| | | market | small size | value | momentum | |
| Stock Min Vol | 0.32% (3.22) | 0.51 (23.74) | 0.42 (9.05) | 0.15 (2.7) | 0.15 (4.19) | 61.7% |
| Country-Sector Min Vol | 0.32% (3.10) | 0.54 (24.12) | 0.40 (8.28) | 0.15 (2.6) | 0.19 (5.02) | 61.7% |

January 1978 to December 2012

Data source: MSCI, Axioma

To verify that the minimum-volatility portfolios of individual stocks and of country-sector units both capture the same investment anomaly, we compare their historical realized volatility and performance characteristics. Figure 3 illustrates that both strategies outperform the capitalization-weighted index throughout most of the period under study. Over the analysis period, their monthly “batting averages”⁵ are 54.5% and 56.4%, respectively. Their pattern of outperformance is similar, with a monthly excess return correlation of 0.93. The few periods of underperformance seem related to strong market rallies, most noticeably during parts of the bull market of the 1980s, the tech bubble of 1999, and the junk rally of March 2009 that followed the financial crisis of 2008. Figure 4 shows that both low-volatility strategies have consistently delivered lower realized risk than the capitalization-weighted index, and more so during periods of market turbulence.

Figure 3: Cap-Weighted Index Return and Min-Vol Excess Return Over Cap-Weighted Index

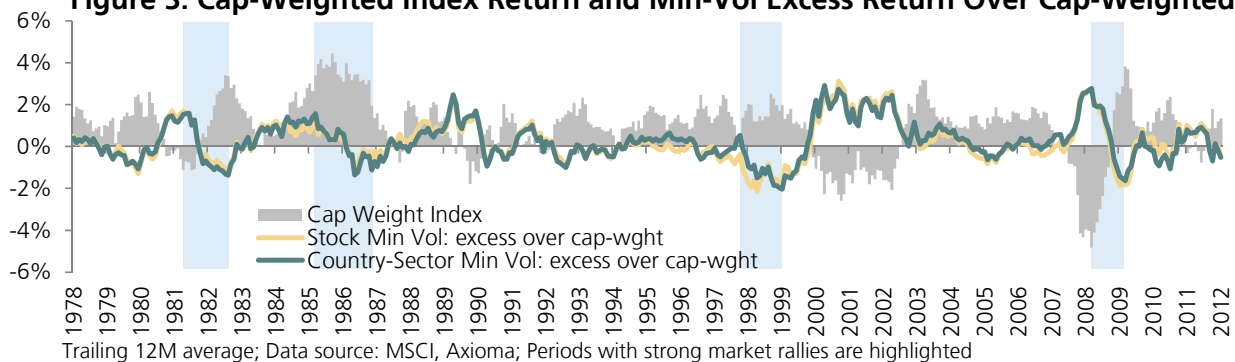
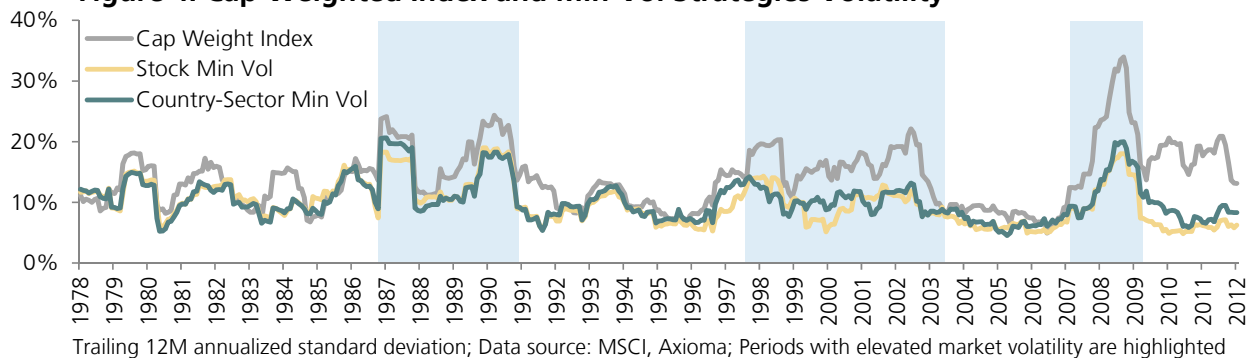
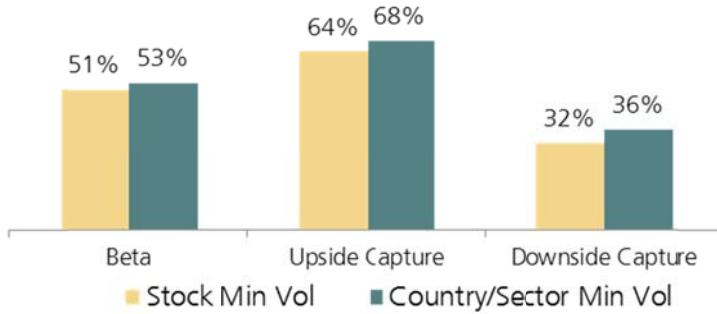


Figure 4: Cap-Weighted Index and Min-Vol Strategies Volatility



⁵ Batting average is the ratio between the number of periods where the strategy outperforms a benchmark and the total number of periods.

Figure 5: Beta and Up/Down Capture⁶ by Min Vol Strategy



January 1978 to December 2012;
Data source: MSCI, Axioma; Relative to Cap Weighted Index

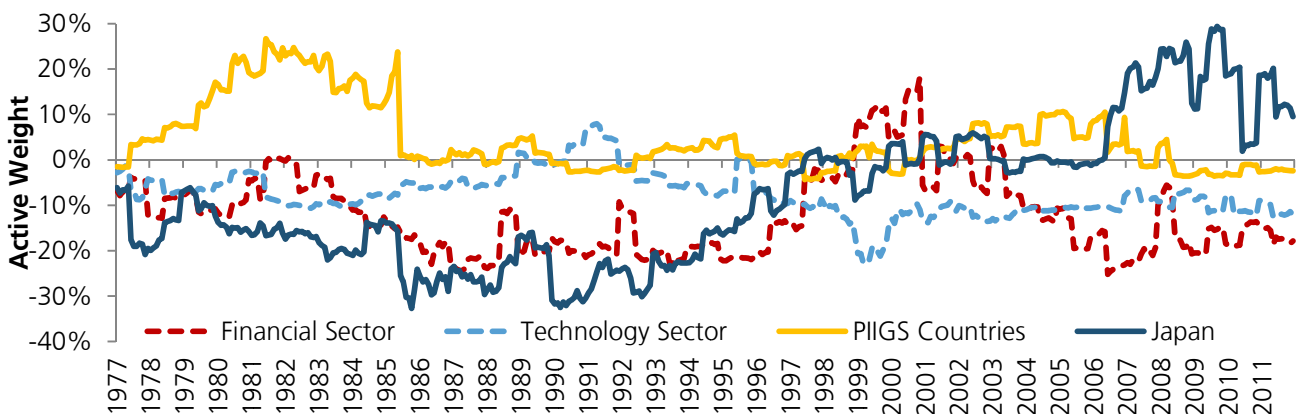
Figure 5 confirms that both strategies are low beta. This suggests that they are defensive but not impervious to market movements, bearing out the performance pattern illustrated in Figure 3.

We also note that both strategies exhibit significantly higher upside than downside capture, on average participating in 66% of up markets but only 34% of down markets. This lack of significant participation in falling markets while maintaining significant exposure to rising markets helps to explain their long-term outperformance.

We also note that both strategies exhibit significantly higher upside than downside

We postulate that much of this favorable return asymmetry results from the “anti-bubble” behavior of low-volatility investing. This was first observed by Blitz and Van Vliet (2007). Since most bubbles form at the country or sector level, the country-sector selection strategy is able to fully capture this effect. Figure 6 illustrates this contrarian behavior, showing selected country and sector bets taken by the stock-based minimum-volatility portfolio relative to the capitalization-weighted index over time. This confirms that the stock-based strategy leads to dynamic country and sector weights. We note that using country–sector units to create the portfolio resulted in similar weights supporting that country and sector are key drivers of the low vol effect.

Figure 6: Active Weight relative to Cap Weighted Index: Select Countries and Sectors
Stock Min Vol



Data source: MSCI, Axioma

⁶ The up and down capture measure how well a manager was able to replicate or improve on phases of positive benchmark returns and how badly the manager was affected by phases of negative benchmark returns. To calculate the up capture, we first form a new series from the manager and benchmark series by dropping all time periods where the benchmark return is zero or negative. The up capture is then the quotient of the annualized return of the resulting manager series, divided by the annualized return of the resulting benchmark series. The down capture is calculated analogously.

In our first example, it may be seen that the Financial sector holdings (shown in red) are neutral at the start of 1983, then move to underweight in the run-up to the US Savings & Loans crisis (late 1980s) and remain so until the aftermath of the Asian and Russian financial crises (1997-1998). They are neutral to overweight from the late 1990's through late 2003, a boom period for financial institutions in which the index weight of this sector grew strongly from about 18% to about 24%. Then, in the run-up to the global financial crisis of 2008, the portfolio moves and remains systematically underweight in this sector, letting up briefly only ahead of the March 2009 junk rally.

Holdings of the "risky" Technology sector (shown in light blue) are similarly under-weight most of the time, only being neutral-to-overweight briefly in the advent of the 1990s technology bubble. They are most strongly under-weight just before this bubble bursts in 2000.

The exposure to the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain) (shown in yellow) is surprisingly high during the early 1980s. This reflects a large overweight of Spain in the aftermath of the Franco regime and the run-up to its EU membership, both of which led to strong economic growth. It next peaks during the "great moderation" of the mid-2000's, then drops below zero ahead of the European debt crisis. Conversely, Japanese stocks (shown in dark blue) are significantly underweight during that country's asset price bubble (roughly 1986 to 1991) and well into the "lost decade" of the 1990s. They are subsequently held roughly at market-weight through mid-2007, spike in the run-up to the financial crisis when they are seen as a safe haven, and return to a neutral or more moderate overweight since mid-2011.

Implementation Considerations

So far our discussion has focused on the performance similarities between both low-volatility investment strategies. We now move on to assess the practicality of their implementation. Table 2 shows the average liquidity profile, turnover and diversification statistics of the underlying portfolios. The country-sector based portfolio exhibits lower average turnover and has more liquid holdings, where liquidity is judged in terms of average market capitalization and position sizes as a percent of average daily volume (ADV). Lower turnover and higher liquidity leads to lower trading costs. The portfolio also holds more stocks. While the stock-based min vol portfolio can match this more desirable profile by adding liquidity, turnover and minimum-diversification constraints in the optimization, this adds complexity to the portfolio construction process. From a review of index providers and active managers, we found that tight constraints were applied to active country and sector weights causing meaningful differences relative to the unconstrained portfolio⁷.

⁷ This was a select review and not comprehensive.

Table 2: Holdings Comparison of Min Vol Strategies and Index

| | Cap Weight Index | Country-Sector Min Vol | Stock Min Vol |
|-----------------------|------------------|------------------------|---------------|
| One-way Turnover* | 7.2% | 79.9% | 112.3% |
| % of ADV held** | 2.3% | 187.3% | 261.4% |
| wght. avg. MCAP (\$B) | 37.9 | 14.1 | 7.1 |
| # Holdings | 1112 | 159 | 96 |

Monthly average from January 1978 to December 2012

*Annualized turnover

** ADV data available from 1997-2012. We calculate % ADV held based on an assumed AUM of 0.006% of the combined market capitalization of all stocks in the investable universe, averaging about \$1.2B over the measurement period.

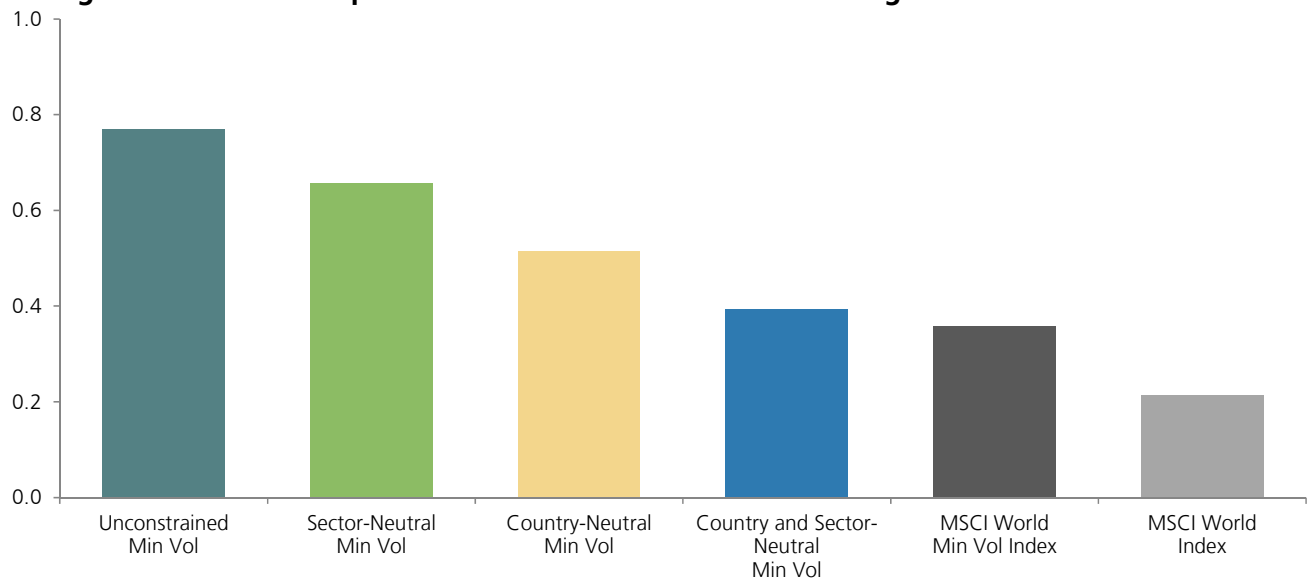
Data source: MSCI, Axioma

The results presented above show that the country-sector min vol strategy earned the same risk-adjusted return as the stock-selection min vol strategy, with additional implementation benefits. A complementary way of looking at the importance of country and sector effects in low-volatility investing is to consider the performance of the stock-selection portfolio when subject to sector and/or country neutrality constraints. Neutrality forces the portfolio to hold the same country and/or sector weight as the capitalization-weighted index. Our review found that constraints of this type are common in low volatility portfolios.

Figure 7 compares the Sharpe Ratios of these strategies to the unconstrained minimum-volatility portfolio. Imposing sector-neutrality or country-neutrality constraints detracts from performance and having both in place has an even larger negative impact. In the presence of sector-neutrality constraints the portfolio is forced to hold higher volatility sectors but can still find shelter in low-risk countries. Conversely, when subject to country-neutrality constraints the portfolio is forced to hold higher-volatility countries and find shelter in low volatility sectors. Nonetheless, the requirement to hold all country and sector combinations at benchmark weight forces holding some stocks that are inherently volatile. For comparison, we include the Sharpe Ratio of the MSCI World Minimum Volatility Index. Its underlying portfolio allows moderate country and sector bets versus the MSCI World Index and limits the exposure to all but one of Barra's risk factors⁸. Risk-adjusted performance suffers as a result of these additional constraints.

⁸ Source: http://www.msci.com/products/indices/strategy/risk_premia/minimum_volatility/

Figure 7: Annual Sharpe Ratio of Stock-Based Min Vol Strategies and Relevant Indices



June 1988 to December 2012

Data source: MSCI, Axioma

Summary and Conclusions

As country and sector effects are key drivers of return dispersion in global equities, we investigate the extent to which they are behind the low-volatility anomaly. We find that most of the benefit of low-volatility investing can be earned through country and sector selection in lieu of individual stock selection. The historical return profile of both implementations is similar; both deliver steady outperformance relative to the capitalization-weighted index over our analysis period except during strong market rallies. This strong showing reflects the high upside and low downside capture of these strategies. We believe this favorable return asymmetry is driven by the anti-bubble behavior of low-volatility investing. This mutes the negative impact on portfolio returns of the major crashes and crises that our analysis period includes. Since most bubbles occur at the country and sector level, a low-volatility country and sector selection strategy fully captures this effect. We also find that this strategy is inherently more liquid, with lower turnover and less concentrated holdings than its stock-selection counterpart. We conclude country and sector selection is a practical alternative to individual stock selection for capturing the benefits of low-volatility investing in global equities.

APPENDIX 1) A Brief Background of Low-Volatility Investing

Recently, low-volatility investing has seen a spike in attention by researchers, though the empirical case for it has been known since the 1970s. Following the development of the CAPM model, it was found that high-beta stocks had in fact not delivered a higher average return than low-beta stocks in the US equity market⁹. Recent studies show that this anomaly has endured ever since, for different ways of constructing low-risk portfolios, in equity markets across the world, and within different asset classes¹⁰. Behavioral and institutional factors that might explain this surprising finding include individual investors gravitating toward stocks with the potential for large gains and displaying overconfidence in their own projections. Additionally, mutual fund managers are motivated to outperform during bull markets rather than bear markets. Meanwhile, transaction cost, limits on leverage, shortsale constraints and the prevalence of benchmarked portfolios¹¹ get in the way of “smart money” arbitraging away the opportunity intrinsic to this market anomaly.

Practitioners have clearly been paying attention to these research findings, with several money management firms recently having launched low-volatility related products. iShares and Powershares each run a suite of low-volatility ETFs that vary in the underlying investable universes (in particular, MSCI and S&P benchmark constituents) as well as the portfolio construction method. iShares uses mathematical optimization to find the portfolio with the lowest predicted risk subject to certain investment constraints. Powershares invests in a basket of a predetermined number of the lowest-volatility stocks with weights inversely proportional to their predicted return volatility. A recent white paper by Standard and Poor’s concludes that “Consistent with the findings of earlier academic research, (...) both principal approaches to constructing low-volatility strategies are equally effective in their ability to reduce realized volatility relative to market cap-weighted portfolios over an intermediate- to long-term investment horizon.”

⁹ e.g., Black et al. [1972], Haugen and Heins [1975]; Baker and Haugen [2012]; Scherer [2012]

¹⁰ e.g., Clarke et al. [2006], Blitz and Van Vliet [2007]; Frazzini and Pederson [2010]

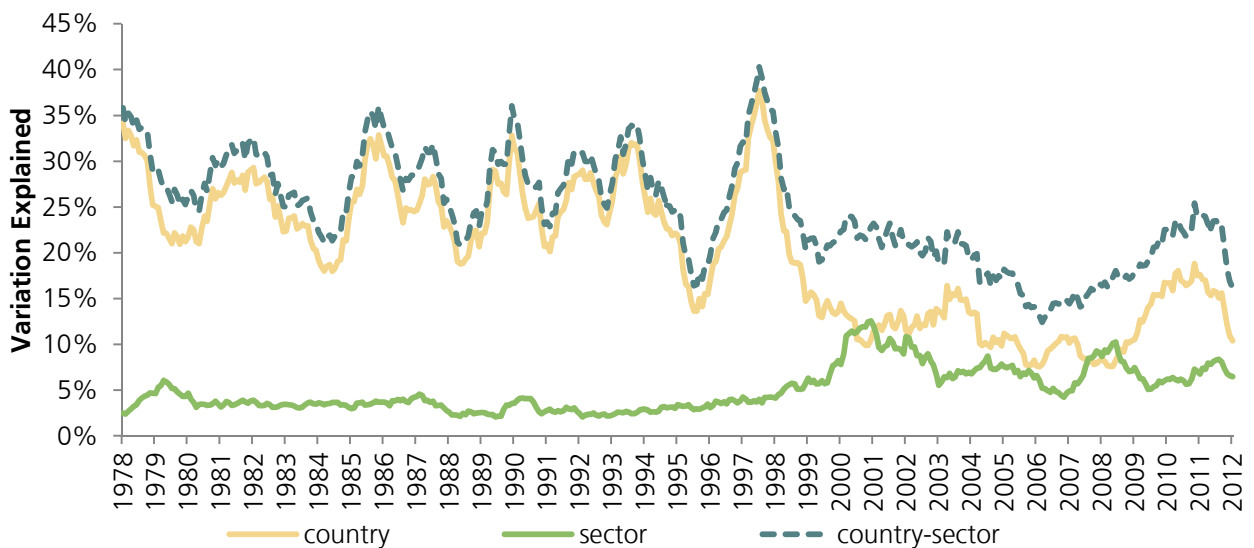
¹¹ Cornell [2009]; Karceski [2002]; Baker et al. [2011]; Kumar [2009]; Li et al [2012]; Frazzini and Pederson [2010]; Diller et al. [2002]; Baker et al. [2011]

APPENDIX 2) Country and Sector Effects in Global Equity Investing

In an increasingly global and connected world, is country of origin still an important return driver or is it the business segment that matters most? Figure 8 shows that the importance of country effects has indeed decreased, particularly during the late 1990s as sector effects started to become more relevant. Country and sector effects each explained an important part of the cross-sectional return variation of the global index over the past decade. Relative importance shifted over time depending on the concerns of investors. Sector was a more important return differentiator than country during the financial crisis, but during the ongoing European debt crisis this has strongly reversed. The numbers we report here on percentage of return variation explained are roughly in line with those found by Li (2010) in his assessment of alternative global equity investment frameworks. He also advocates looking at country and sector combinations.

Figure 8: MSCI World Index:

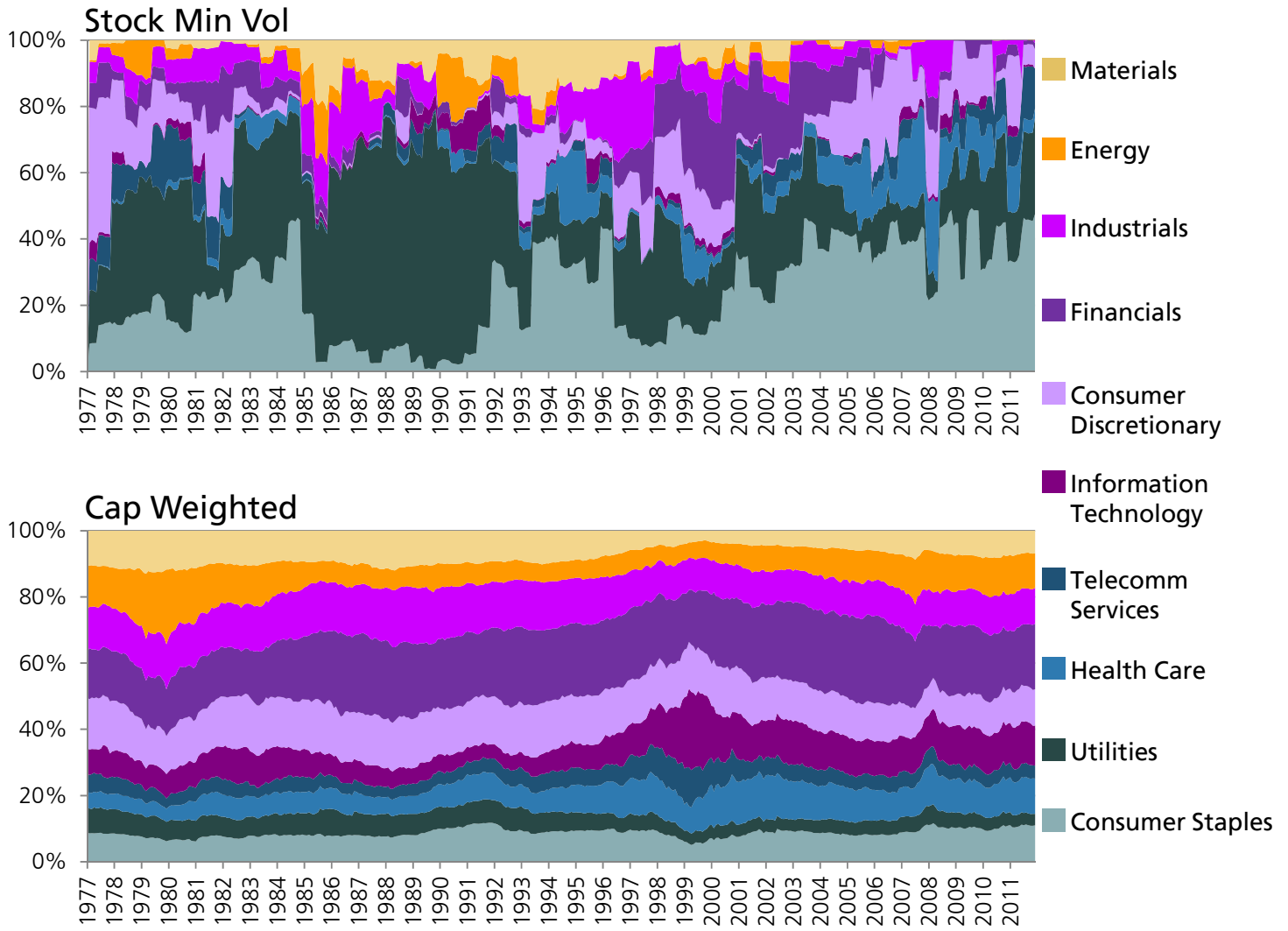
Percent of Monthly Cross-Sectional Return Variation Explained by Countries and/or Sectors



12 month trailing average; Data source: MSCI, Axioma

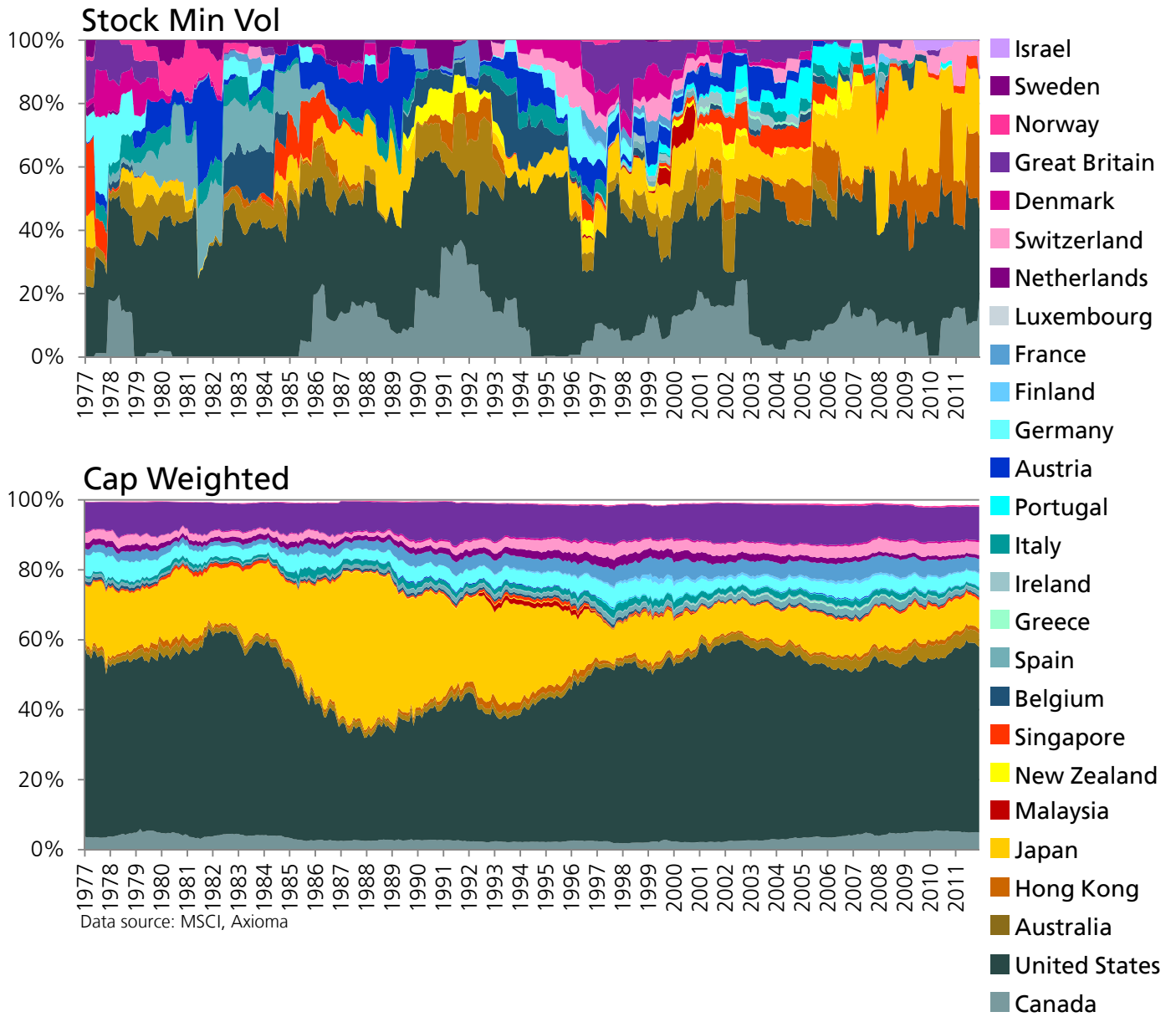
The importance of country and sector membership as risk differentiators is picked up by the risk model, translating into significant differences in country and sector exposures of low-volatility strategies versus the relevant capitalization-weighted index. This is illustrated in Figures 9 and 10, where we show the time-varying portfolio weight of sectors and countries, respectively, for both cap-weight and stock-based min vol portfolios. We also note that the country and sector exposures of the minimum-volatility strategy change significantly over time compared to the capitalization-weight index which tends to be less dynamic. As might be expected, certain stable sectors (Consumer Staples, Utilities) and countries (United States, Japan and Canada) are always included. However, their weight fluctuated considerably.

Figure 9: Portfolio Weight of Sectors Over Time



Data source: MSCI, Axioma

Figure 10: Portfolio Weight of Countries Over Time



Appendix 3) Global Equity Risk Models

Constructing portfolios with minimum predicted risk requires an optimizer and a risk model. We use version 2.1 of Axioma's AX-WW global risk model in our analysis, for which there is data available starting 1997. This model is fundamental-factor based (including market, style, industry, country and currency factors) with a medium-term (1 to 3 months) prediction horizon. Prior to 1997 we use a custom multi-factor risk model supplementing country and sector indicators with six fundamental and technical factors for which we had data available through MSCI's "deep history" database starting 1976. These factors are historical beta (estimated through 36-month rolling regressions), 12-month price momentum, book-to-price ratio, trailing earnings yield, dividend yield, and size measured as the log of market capitalization. To create a consistent sector classification, we compared current MSCI GICS sector definitions with historical MSCI and Datastream industry codes. We used a direct mapping when a unique correspondence was found, and did historical company-level research to assess its sector otherwise.

All factor exposures are standardized after truncating outliers. Monthly factor returns are estimated through multivariate regression of stock returns on all exposures. The factor covariance matrix underlying the fully ex-ante risk model in each month is based on the trailing 36-month sample covariance matrix. The specific risk of each stock with at least 12 months of return history in our data is estimated as the volatility of its residual in the preceding 36 factor return regressions, and set to the cross-sectional median of specific risk otherwise. We tested using a trailing 60-month rolling window to estimate the risk model, rather than 36 months, and the results were similar.

To create a risk model of global sector baskets, country indices, or country-sector combinations, we applied the stock-level risk model to the underlying capitalization-weighted sub-portfolios. As a result the risk model is consistent for the stock-selection and the country-sector selection strategies. Mathematically, the predicted risk of the low-volatility country-sector portfolio will therefore always be between that of the minimum-volatility stock portfolio and the capitalization-weighted index. For sector, country, or country-sector portfolio optimization we used R's Quadprog package as the number of "assets" is small. For the minimum-volatility stock-selection strategy, we used Axioma's portfolio optimizer.

Tables 3, 4 and 5 show our analysis results for each part of our back-tests in which we use a different risk model. They are consistent with the findings for the overall period we presented earlier. For the early period, we make no claim that ours is the best way of constructing a risk model. In fact, we observed its prediction power of the absolute level of risk being poor due to its trailing nature. However, our tests show it is an effective way of creating low-risk portfolios, since it does capture which stocks are relatively the most risky as well as return correlations.

Lastly, Figure 11 shows the range of standardized factor exposures over time for the minimum-volatility stock-selection strategy, as well as the average for the capitalization-weighted index. The major systematic exposures of the low-volatility strategy are low-beta and high-dividend yield. Its exposure to

the size factor hovers around zero, meaning it has a small-cap bias only relative to the capitalization-weighted index.

Table 3: Performance Statistics of Min Vol Strategies and Index by Period

| | Return | Standard Deviation | Sharpe Ratio | Beta | Upside Capture | Downside Capture | |
|-------------|------------------------|--------------------|--------------|------|----------------|------------------|------|
| 1978 - 1996 | Cap-Weighted Index | 15.0% | 13.8% | 0.56 | 1.00 | 100% | 100% |
| | Stock Min Vol | 18.5% | 11.5% | 0.98 | 0.64 | 78% | 39% |
| | Country-Sector Min Vol | 18.3% | 11.6% | 0.95 | 0.65 | 80% | 44% |
| | Country Min Vol | 16.9% | 14.1% | 0.68 | 0.84 | 89% | 72% |
| | Sector Min Vol | 17.1% | 12.6% | 0.78 | 0.82 | 92% | 75% |
| 1997 - 2012 | Cap-Weighted Index | 5.5% | 16.4% | 0.17 | 1.00 | 100% | 100% |
| | Stock Min Vol | 9.6% | 9.4% | 0.74 | 0.39 | 48% | 26% |
| | Country-Sector Min Vol | 10.4% | 10.2% | 0.76 | 0.43 | 55% | 31% |
| | Country Min Vol | 6.9% | 15.7% | 0.27 | 0.87 | 88% | 84% |
| | Sector Min Vol | 7.7% | 11.4% | 0.45 | 0.54 | 57% | 47% |

Data source: MSCI, Axioma

Table 4: Holdings Comparison of Min Vol Strategies and Index by Period

| | 1978 - 1996 | | | 1997 - 2012 | | |
|-----------------------|------------------|------------------------|---------------|------------------|------------------------|---------------|
| | Cap Weight Index | Country-Sector Min Vol | Stock Min Vol | Cap Weight Index | Country-Sector Min Vol | Stock Min Vol |
| One-way Turnover* | 7.0% | 74.1% | 98.0% | 7.5% | 86.7% | 129.3% |
| % of ADV held** | unavail | unavail | unavail | 2.3% | 187.3% | 261.4% |
| wght. avg. MCAP (\$B) | 13.4 | 6.2 | 4.5 | 67.0 | 23.6 | 10.1 |
| # Holdings | 1031 | 168 | 104 | 1207 | 150 | 87 |

*Annualized turnover

** ADV data available from 1997-2012. We calculate % ADV held based on an assumed AUM of 0.006% of the combined market capitalization of all stocks in the investable universe, averaging about \$1.2B over the measurement period.

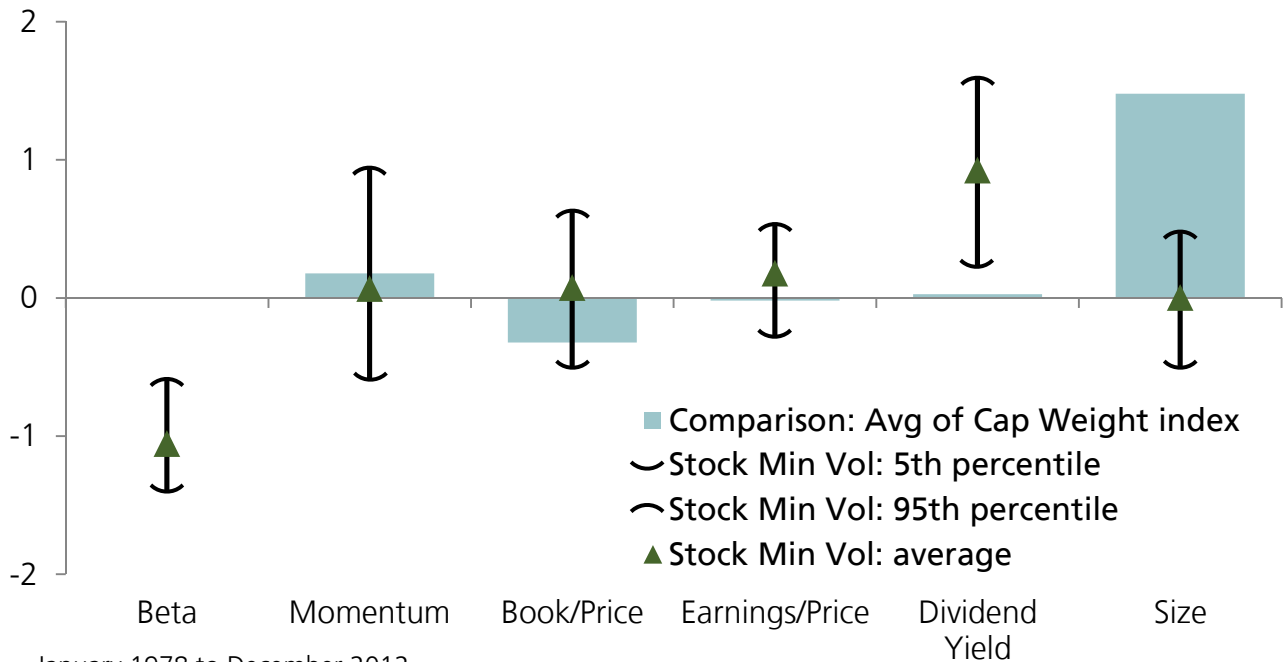
Data source: MSCI, Axioma

Table 5: Fama-French Analysis by Period
Min Vol Strategies Monthly Excess Returns Over Risk-free Rate

| | Monthly Alpha | Regression Betas (t-value) | | | | R ² |
|---------------------------------------|---------------|----------------------------|-------------|-------------|-------------|----------------|
| | | market | small size | value | momentum | |
| 1976 - 1996 Stock Min Vol | 0.26% (1.91) | 0.65 (20.57) | 0.41 (6.92) | 0.15 (1.61) | 0.10 (1.60) | 68.5% |
| 1978 - 1996 Country-Sector Min Vol | 0.24% (1.75) | 0.65 (20.55) | 0.46 (7.74) | 0.11 (1.16) | 0.14 (2.16) | 69.3% |
| 1997 - 2012 Stock Min Vol | 0.32% (2.47) | 0.38 (13.52) | 0.43 (6.43) | 0.20 (3.23) | 0.14 (3.38) | 59.3% |
| 1997 - 2012 Country-Sector Min Vol | 0.36% (2.46) | 0.44 (13.64) | 0.31 (4.13) | 0.22 (3.04) | 0.19 (3.87) | 55.7% |

Data source: MSCI, Axioma

Figure 11: Range of Standardized Factor Exposures for Stock Min Vol Portfolio



January 1978 to December 2012

Data source: MSCI

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