Smart Beta: *Building Low-Volatility Portfolios of ETFs*

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The use of low-volatility (low-vol) strategies was globally rather limited prior to the 2008 financial crisis. Post the large market drawdowns that followed this crisis, we have seen increasing investor appetite for investment strategies employing risk reduction techniques, in particular for low-volatility strategies. Renewed risk aversion has perhaps driven such interest, and the proliferation of products linked to these strategies has perpetuated this interest further.

In fact, despite its relatively recent mainstream appeal, the so-called *low-vol anomaly*, often described as the empirical outperformance of low-volatility equities compared to their higher-volatility peers or simply the benchmark, has been well documented by academic research for more than 10 years.

This interest has spawned the launch of several indexes that have since become benchmarks for low-volatility strategies, with tremendous asset raising observed over the past two years from product providers.

THE LOW-VOLATILITY ANOMALY

Compelling empirical evidence has shown that lower volatility stocks (typically defined by belonging to the bottom decile in terms of two years' historical volatility,

as per the methodology employed in Baker and Haugen [2012]) have historically outperformed their higher-volatility counterparts. This is an especially remarkable observation for two reasons:

Persistence. The observation exists now and over an extensive historical period. Having said that, some people have warned against potential crowding on this strategy, which could potentially lead to short-term underperformance.

Comprehensiveness. As demonstrated by Baker and Haugen [2012], the anomaly extends to virtually all of the world's equity markets. Exhibits 1 and 2 compare Market Cap and Low-Vol approaches for several countries, and demonstrate a consistent risk-reduction and performance enhancement on each market.

Several factors suggest that the anomaly is likely to persist despite the recent sharp rise in interest:

- The **importance of benchmarks** for market participants creates a focus on tracking error instead of total risk, thereby making low-vol stocks less attractive.
- **Leverage constraints** result in return-seeking investors preferring high-risk stocks.

Exhibit 1
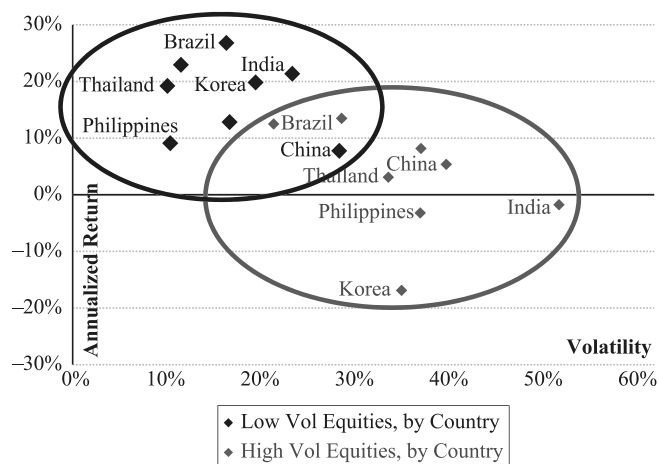### Low-Vol Anomaly in Developed Markets
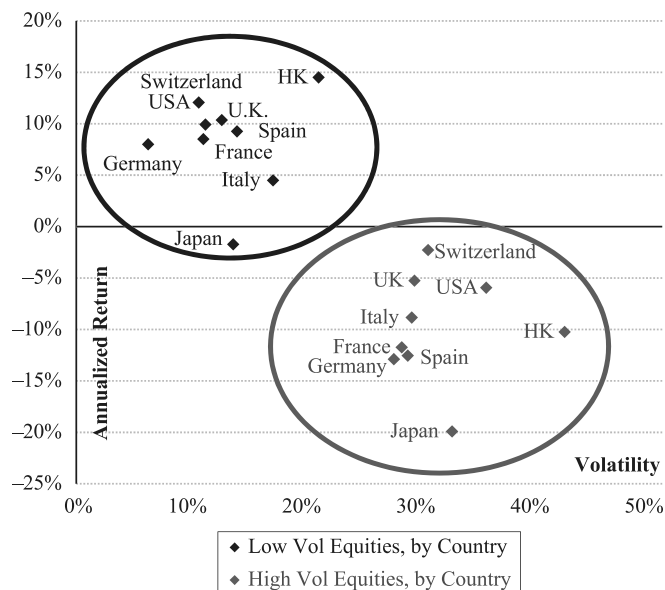
Past performance is not indicative of future results.
Source: Baker and Haugen [2012].

Exhibit 2
Low-Vol Anomaly in Emerging Markets

Past performance is not indicative of future results.
Source: Baker and Haugen [2012].

- Low-vol investments tend to have a longer investment focus and, thus, are avoided by a large number of risk-seeking investors who buy volatile stocks for short-term gains.

Existing Options for Low-Volatility Investing

Low-vol investing to date has typically been implemented through two approaches:

1. **Stock Selection:** investing in the least volatile stocks, typically defined as belonging to the lowest *n*-tile by historical volatility.
2. **Optimization:** a portfolio allocation methodology that aims to find the least volatile portfolio subject to constraints. Such strategies would seek to minimize portfolio risk, which is a function of single stock volatilities as well as pairwise correlations, and would typically rely on an equity risk–modeling framework to cope with the high dimensionality of such a minimization problem.

Both approaches effectively capture the low-volatility anomaly, but the related complexity and operational cost may be prohibitive for an individual investor in order to be considered as a viable pragmatic approach.

An ETF implementation of low-vol strategies may be a compelling pragmatic solution for investors, allowing them to benefit from the increased risk-adjusted returns of a low-volatility optimization approach while managing a cost-efficient and liquid portfolio of ETFs.

The Case for Low-Vol with ETFs

Country/sector allocation is among the most common top-down methodologies used in equity asset allocation and has been well documented. Allocation into specific countries and sectors, rather than single stocks, has several potential advantages for investors:

- Accessibility to such countries and sectors through relatively cheap and liquid ETFs. This is especially true for emerging markets, as investing into European-domiciled ETFs removes the need for complex account-opening procedures with custodians and brokers that would be required for purchasing individual EM stocks.
- As country and sector ETFs already represent diversified equity exposures, an investor would typically need to invest in only 10 to 15 ETFs, thus creating a clear and simple portfolio to monitor, compared to typical low-vol individual stock

portfolios that often comprise in excess of 100 stocks.

- Last but not least, as the results of our analysis show, a Min-Variance methodology implemented through country/sector allocations provides a very similar risk–return profile to common low-volatility/Min-Variance strategies.

What prompted our interest in exploring such an approach is the paper from De Boer et al. [2013], which demonstrates that a country/sector allocation approach may indeed enable an investor to capture a significant proportion of the low-vol risk premium that is observable in most equity markets.

The aim of this article is to adopt a pragmatic approach to low-volatility investing across both EM and DM, with the aim to improve the risk–return profile of benchmark index exposure through a simple Min-Variance allocation into ETFs.

Min-Variance in a Nutshell

Following Harry Markowitz's seminal work on Mean Variance Optimization (MVO) (Markowitz [1952]), the concept of a "mean–variance (optimized)" portfolio has become the de facto standard within the investment management community. The mean–variance portfolio, which by construction should deliver the best trade-off in terms of risk–reward, is undeniably an elegant theoretical solution for investors. Nonetheless, it usually requires substantial effort in parameter estimation and, among other difficulties, the well-known one of forecasting asset returns. It is therefore not surprising that results obtained by such an approach, which are heavily dependent on parameter estimation, are often highly unstable across time.

The Min-Variance Portfolio, defined within the MVO approach, is the only mean–variance optimal portfolio that is fully determined without the need for any asset return expectations. The only required parameter is the covariance matrix, which has typically demonstrated temporal stability.

For any investment universe, in the absence of specific investment constraints, the Min-Variance Portfolio is defined as the outcome of a very simple formula. As one naturally introduces specific investment constraints (e.g., diversification limits and maximum weights),

finding the Min-Variance portfolio involves an iterative algorithm to solve for the optimal portfolio. In this article, we consider the following constrained quadratic optimization problem:

$$\min_w \quad w' \Sigma w$$

Subject to:
$$\begin{aligned}
&\Sigma w(i) = 1, &&\text{(i)}\\
&\text{Max } w(i) = 10\%, &&\text{(ii)}\\
&\forall i \; 0 \leq w(i) \leq 1, &&\text{(iii)}\\
&\forall i \; s.t.\, w(i) < 1\% \Rightarrow \text{set } w(i) = 0, &&\text{(iv)}
\end{aligned}$$

where w is a vector of portfolio weights, and Σ is a variance–covariance matrix. Constraint (i) ensures the portfolio is fully invested, constraint (ii) ensures we have adequate portfolio diversification, constraint (iii) prevents short selling, and constraint (iv) prevents impractical allocations that may be generated by the algorithm.

Min-Variance: A Key "Smart Beta" Methodology

Portfolio optimization methodologies have attracted prolific academic research. A key area of focus has been to find alternatives to some of the recognized flaws of market-cap-weighted indexes and to provide so-called smart beta solutions.

We may try to summarize these solutions as the following:

- **De-concentration**: equal-weighting strategies aim at reducing large concentration of market-cap indexes toward a limited number of large-cap stocks.
- **Risk Reduction**: Min-Variance optimization methodologies aim to achieve risk reduction without using any forecast on future market returns.
- **Diversification**: Methodologies such as Maximum Diversification or Minimum Correlation tend to optimize the metrics suggested by their names.

Min-Variance, as a smart beta strategy, tries to achieve a better risk–return profile for an equity portfolio compared to a market-weighted or equal-weighted approach, while reducing portfolio risk.

Min-Variance through Country/Sector Allocation

The aim of the article is to answer this question: Could a Min-Variance portfolio strategy be implemented pragmatically using ETFs? And if so, how would such an ETF-based portfolio strategy compare with more traditional Min-Variance portfolio strategies?

On the basis of the constraints presented above, we backtested two hypothetical portfolios (one for EM and one for DM) and ran a series of historical simulations in order to:

1. Analyze the benefits of this approach, and
2. Verify the robustness of the methodology toward each parameter.

We had to cope with the issue of the relatively short track record for the ETFs contemplated for inclusion in the two hypothetical portfolios. To overcome this issue, we considered the relevant country and sector MSCI Net Return indexes (i.e., total return index with withholding tax assumption as calculated by MSCI) as proxies for the respective ETFs. To calculate the backtested performance of the hypothetical portfolios an additional 60 bps were deducted from the net performance of the relevant MSCI indexes used as proxies to approximate the average TER that would have applied on the ETFs. The backtested performance of the hypothetical portfolios doesn't include the portfolios rebalancing costs.

ETF-BASED MIN-VARIANCE ON DEVELOPED MARKETS

Analysis of the Investable Universe

With regard to developed markets (DM), we considered the country- and sector-specific MSCI Net Return Indices related to the following countries and sectors:

Countries. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States.

Sectors. World Consumer Discretionary, World Consumer Staples, World Energy, World Financials, World Health Care, World Industrials, World Information Technology, World Materials, World Telecommunication Services, World Utilities.

To ensure the investability of the strategies we selected, we mapped these indexes to the ETFs available in Europe[1] and globally. For some countries, the only available ETF is providing exposure to a specific—capped—version of the relevant MSCI Index.

A few comments on our findings regarding the ETF coverage of DM countries and sectors:

- The db X-tracker ETFs range provides full coverage of the MSCI DM sectors.
- The only MSCI country indexes that are not represented through ETFs are Portugal and Greece.
- The indexes linked to Austria, Belgium, Hong Kong, Ireland, New Zealand, and Sweden are currently available only through U.S.-domiciled ETFs.

In order to make sure that the results would be easily implementable by a European investor, results shown below are those generated based on the most restrictive universe, i.e., utilizing only MSCI indexes available through Europe-domiciled ETFs.

ETF-Based Min-Variance on DM: Main Results

We ran several historical simulations based on the methodology described above, typically combining several parameter configurations. Among others, these configurations included the rebalancing frequency and the observation window for the variance–covariance matrix.[2]

As shown in Exhibits 4 and 5, there is stability in the results we obtained; the set of parameters has little impact on the final results. For the sake of showing concrete results, the simulations below are based on a semi-annual rebalancing and one-year observation window for the variance–covariance matrix.

In Exhibit 3, the historical simulation of the country/sector allocation methodology is compared with the MSCI World and MSCI World Minimum Volatility indexes.
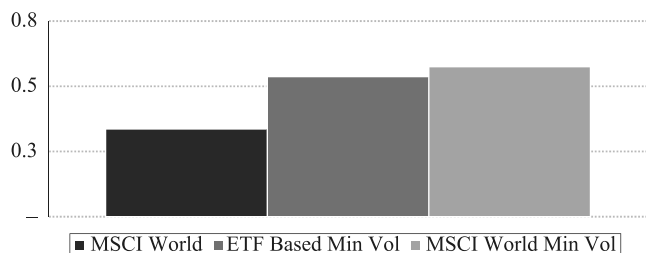
Both low-vol strategies consistently outperform the market-cap approach, based on historic simulated data (Exhibit 4).

Exhibit 3
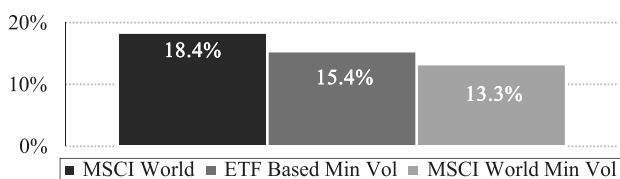**ETF-Based Min-Vol Portfolio (DM)**
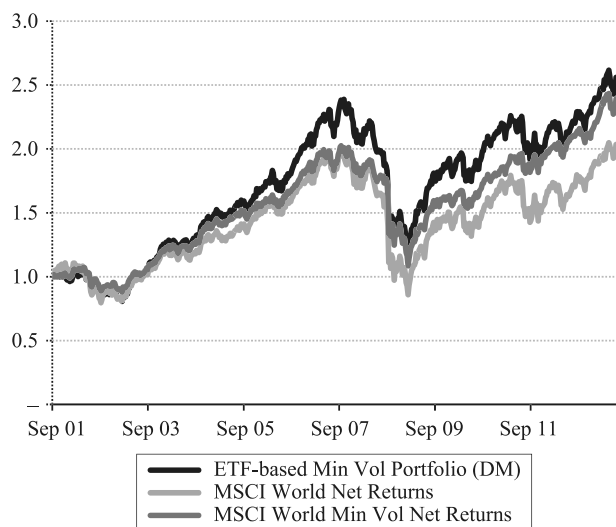
Past performance, actual or simulated, is not indicative of future results.
Sources: Deutsche Bank, Bloomberg.

Exhibit 4
Sharpe Ratio of DM Low-Vol Strategies

Past performance, actual or simulated, is not indicative of future results.
Sources: Deutsche Bank, Bloomberg.

Exhibit 5
Volatility of DM Low-Vol Strategies

Past performance, actual or simulated, is not indicative of future results.

Comparing the ETF-based, low-vol portfolio and the single-stock, MCSI Min-Vol Index, the former seems to outperform during the pre-crisis environment, and then converges with the MSCI Min-Vol Index.

In order to adequately judge a risk-reduction methodology, it is more relevant to compare the risk-adjusted return (compared to raw returns) obtained versus benchmark indexes and low-volatility techniques.

The results in Exhibit 4 show a very similar historic Sharpe Ratio for both MSCI Min-Vol and the ETF-based strategy. Both significantly outperform the MSCI World in both returns and risk-adjusted returns.

The ETF-based, low-vol strategy enables the volatility to decrease from 18.4% (MSCI World) to 15.4% for the period sampled.

Min-Variance on Developed Markets: Allocation

Several market observers have argued that low-vol strategies are in fact demonstrating significant biases towards specific sectors (typically utilities or consumer goods), which would, in large, explain their attractive past performance. While it is actually difficult to differentiate the real driver from the "consequence," low-vol strategies are indeed demonstrating specific sector biases over time, and this is indeed what we intend to exploit through this approach.

When one generally considers a global low-volatility strategy, specific countries may also demonstrate a relatively low volatility for structural or short-term reasons, hence showing up as potential candidates for inclusion within a country/sector allocation. Simulated historical allocation of the hypothetical portfolio reveals that several sectors demonstrate temporal stability, namely Utilities, Telco, IT, Materials, and Industrials.

Whilst some structural corrections followed in 2002–2003, after the bursting of the IT bubble, it is important to observe the temporal stability of the allocation to countries and sectors, which is subsequently reflected in the reasonable annual (one-way) turnover of 35% for this strategy, as exemplified in our hypothetical portfolio. This is in contrast to Kuo and Li [2013], who find that turnover for low-volatility strategies can be significantly higher.
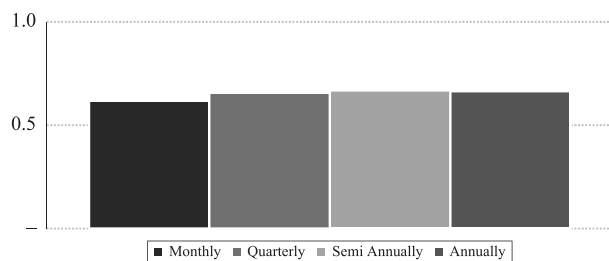
EXHIBIT 6
Stability of Sharpe Ratio with Variance–Covariance Horizon

Legend: ■ 1M ■ 3M ■ 6M ■ 1Y ■ 2Y ■ 4Y
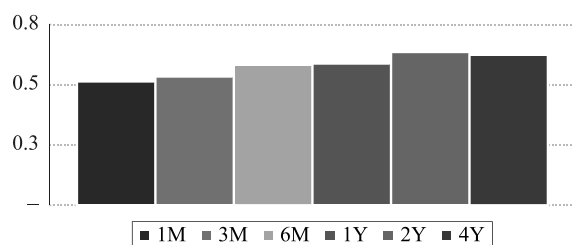
Past performance, actual or simulated, is not indicative of future results.

EXHIBIT 7
Stability of Sharpe Ratio with Rebalancing Frequency

Legend: ■ Monthly ■ Quarterly ■ Semi Annually ■ Annually

Past performance, actual or simulated, is not indicative of future results.

Stability of the Results

As a general exercise of model validation, it is of paramount importance to verify the stability of the portfolio construction versus the change of important parameters in order to avoid "data mining," which has the tendency to translate into disappointing realized results.

As mentioned above, the two main parameters for the simulation methodology described previously are the rebalancing frequency and the observation window used for the determination of the variance–covariance matrix.

Rebalancing frequency has a direct impact on portfolio turnover, as the Min-Variance algorithm is recalibrated at each rebalancing date on the basis of the updated variance–covariances. Even though the observation window is usually quite large (e.g., 1Y), ETF volatilities do change over time, and such a rebalancing

frequency would trigger re-allocation and re-weighting, and thus increase the turnover.

These two tests demonstrate the stability and robustness of this methodology to both parameter inputs (the variance–covariance matrix), as well as the rebalancing frequency.

As demonstrated below, this Min-Variance methodology demonstrates equally appealing properties when applied to EM country and sector indexes.

ETF-BASED MIN-VARIANCE ON EMERGING MARKETS

Analysis of the Investable Universe

As in the case for developed markets, the country- and sector-specific MSCI World Net Return Index of the following countries and sectors were considered:

- **Countries**: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, Turkey
- **Sectors**: EM Consumer Discretionary, EM Consumer Staples, EM Energy, EM Financials, EM Health Care, EM Industrials, EM Information Technology, EM Materials, EM Telecommunication Services, EM Utilities.

These indexes were mapped to the ETFs available both in Europe and globally. By order of preference, the existence of a Europe-domiciled ETF and then a U.S.-domiciled vehicle was checked. For some countries, the ETF is available only through the capped version of the index.

In terms of product coverage in emerging markets across countries and sectors, the db X-trackers ETFs range has one of the largest, with full coverage of the EM sectors indexes, as well as a very dense penetration of the various EM countries.

To our knowledge, there are currently no MSCI country indexes in ETF format for the Czech Republic, Egypt, Hungary, Israel, Jordan, or Morocco.

The indexes linked to Peru and Colombia are currently available only through U.S.-domiciled ETFs.

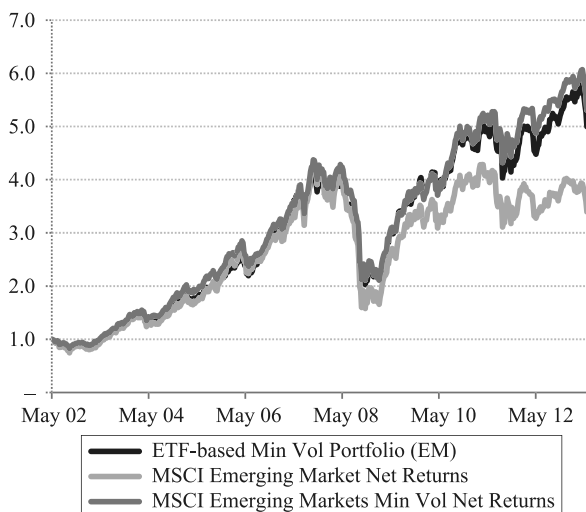## Min-Variance on Emerging Markets: Main Results

As we did for the DM study, we restricted the investable universe to the European-domiciled ETFs.

An investor with access to OTC swaps on the remaining countries would be able to achieve significant improvement on their risk-adjusted returns, but likely with high implementation cost.

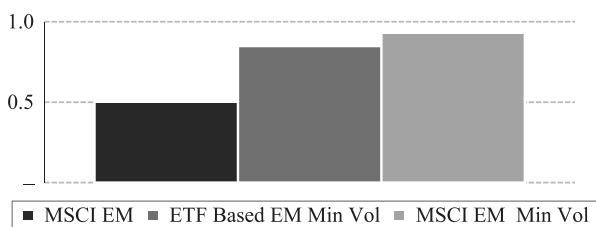We used the same parameters as in the DM study for the observation window as well as for the rebalancing frequency.

Exhibit 8 shows the historical simulation of the EM hypothetical portfolio, compared with MSCI EM Index, as well as with its corresponding MSCI Min-Vol Index peer. Exhibit 9 compares the Sharpe Ratios of these strategies.[3]

One observes very similar properties and conclusions as those observed for DM: The simulated historical performance of the EM Min-Vol ETF-based hypothetical portfolio is very close to that of the single-stock minimum variance index, and minimum variance significantly outperforms the benchmark MSCI EM Index in terms of both absolute return and risk-adjusted return.

Volatility reduction, as shown in Exhibit 10, is significant and both low-volatility strategies provide the same level volatility reduction, from 24% to 18%.

This is a persuasive result, reinforcing the opportunity of utilizing country and sector ETFs for reducing the risk of investing in emerging markets equities.

Min-Variance on Emerging Markets: Allocation

It is interesting to see whether the historical allocation of an EM country/sector allocation methodology would exhibit the same traits as for DM.

Observations yielded very similar results regarding:

- Overall stability of the portfolio, as shown again by a reasonable 36% one-way turnover.
- Several sectors demonstrate temporal stability in allocation, in particular Utilities, Consumer Staples, and Healthcare.

Of note, specific countries such as Chile, Malaysia, the Philippines, and Mexico demonstrate a nearly constant exposure within the EM low-vol portfolio.
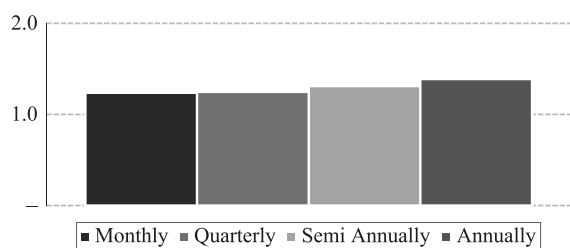
E X H I B I T   8
ETF-Based Min-Vol Portfolio (EM)

Past performance, actual or simulated, is not indicative of future results.
Sources: Deutsche Bank, Bloomberg.

E X H I B I T   9
Sharpe Ratios of EM Low-Vol Strategies

Past performance, actual or simulated, is not indicative of future results.

E X H I B I T   10
Volatility of EM Low-Vol Strategies
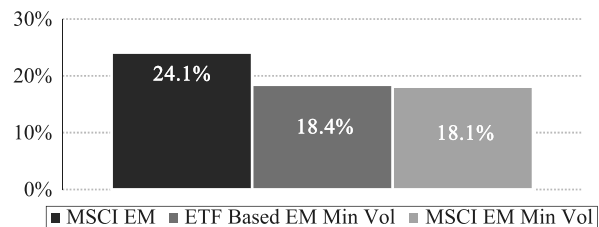
Past performance, actual or simulated, is not indicative of future results.
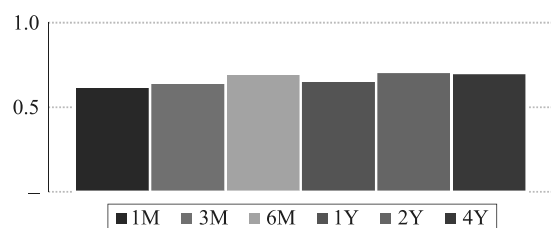
Stability of Sharpe Ratios of EM ETF-Based Strategy vs. Rebalancing Frequency

Past performance, actual or simulated, is not indicative of future results.

Stability of Sharpe Ratios of EM ETF-Based Strategy vs. Variance–Covariance Observation Window

Past performance, actual or simulated, is not indicative of future results.

Stability of the Results on Em

As we did for DM, we tested the stability of the Sharpe ratio obtained with various set of parameters. Exhibits 11 and 12 show the strong stability of the results as pertain to each parameter.

CONCLUSIONS

There has been *increased interest in risk-reduction strategies*. Among these, low-volatility strategies have enjoyed significant inflows, making them one of the most sought-after smart beta strategies. *Such strategies have been applied across both developed markets and emerging markets.*

The so-called Low-Vol Anomaly (empirical outperformance of low-volatility equities versus their higher-volatility peers) has been well documented during the past 10 years in academia, as well as among market participants.

Within this article, we revisited low-volatility strategies and investigated the *implementation of Min-*

imum Variance portfolios using country and sector ETFs. Our analysis has shown that:

- Low-volatility portfolios can be built using ETFs. Such DM and EM ETF-based low-vol hypothetical portfolios exhibit enhanced risk return profiles compared to MSCI World and MSCI Emerging Markets Indices, respectively.
- ETF-based low-vol portfolios may have pragmatic advantages, such as costs and operational benefits, compared to more traditional low-vol portfolio strategies.

ENDNOTES

[1]This article employs a Europe-centric approach and we primarily used Europe-domiciled ETFs that, from an operational and tax perspective, are easier to invest into by a European investor. A universe of U.S.-domiciled ETFs is available on request.

[2]The performance data shown for the ETF-based Min-Vol portfolios (DM above and EM thereafter) are simulated and have been calculated based on the historical performance of indexes used as proxies for ETFs (minus an assumed 60 bps TER cost) selected according to the methodology described previously. These simulated returns do not represent historical returns of actual products or portfolios issued or managed in the past. In simulating the past performance of these hypothetical portfolios, no rebalancing costs were assumed.

[3]These simulated returns do not represent historical returns of actual products or portfolios issued or managed in the past. In simulating the past performance of the ETF-based Min-Vol portfolio (EM), no rebalancing costs were assumed

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