Insights

Volatility reduction: How minimum variance indexes work

Minimum variance indexes, which apply rules-based methodologies with the aim of minimizing an index's volatility, are popular among market participants interested in smart beta. In this FTSE Russell *Insights*, the third in a series of three covering risk-based indexes and their applications, we review minimum variance indexes in detail.

We discuss the reasons for the recent popularity of the minimum variance approach. We also note the importance of the design choices facing the creator of a minimum variance index, which can determine the index's suitability for use by market participants as a benchmark or as the underlying target for an index-replicating portfolio or financial product.

Using the example of a minimum variance index constructed from the Russell 1000® Index, we also review the reasons for why a minimum variance strategy has captured reduced volatility in index levels and examine its recent valuation levels.

Why the interest in volatility reduction?

In an environment of near-zero official interest rates and low bond yields, investors increasingly rely on the equity market to meet long-term return targets. At the same time, the bear markets of 2000-2002 and 2007-2008 are a reminder of the downside risks inherent in equity investing.

The FTSE Russell Smart Beta Survey 2016, which gathered responses from more than 250 large asset owners worldwide with over US$2 trillion under management, showed that, after return enhancement, risk reduction was the most popular investment objective cited by investors evaluating smart beta.[1] Smart beta is a generic term for indexes using alternative weightings to benchmark specific risk and return goals.

Some categories of investor, for example European insurance companies subject to the "Solvency II" Directive, are increasingly required to reflect their liability profiles in their asset portfolios, incentivizing them to find solutions and tools that help manage downside risks while also seeking returns.

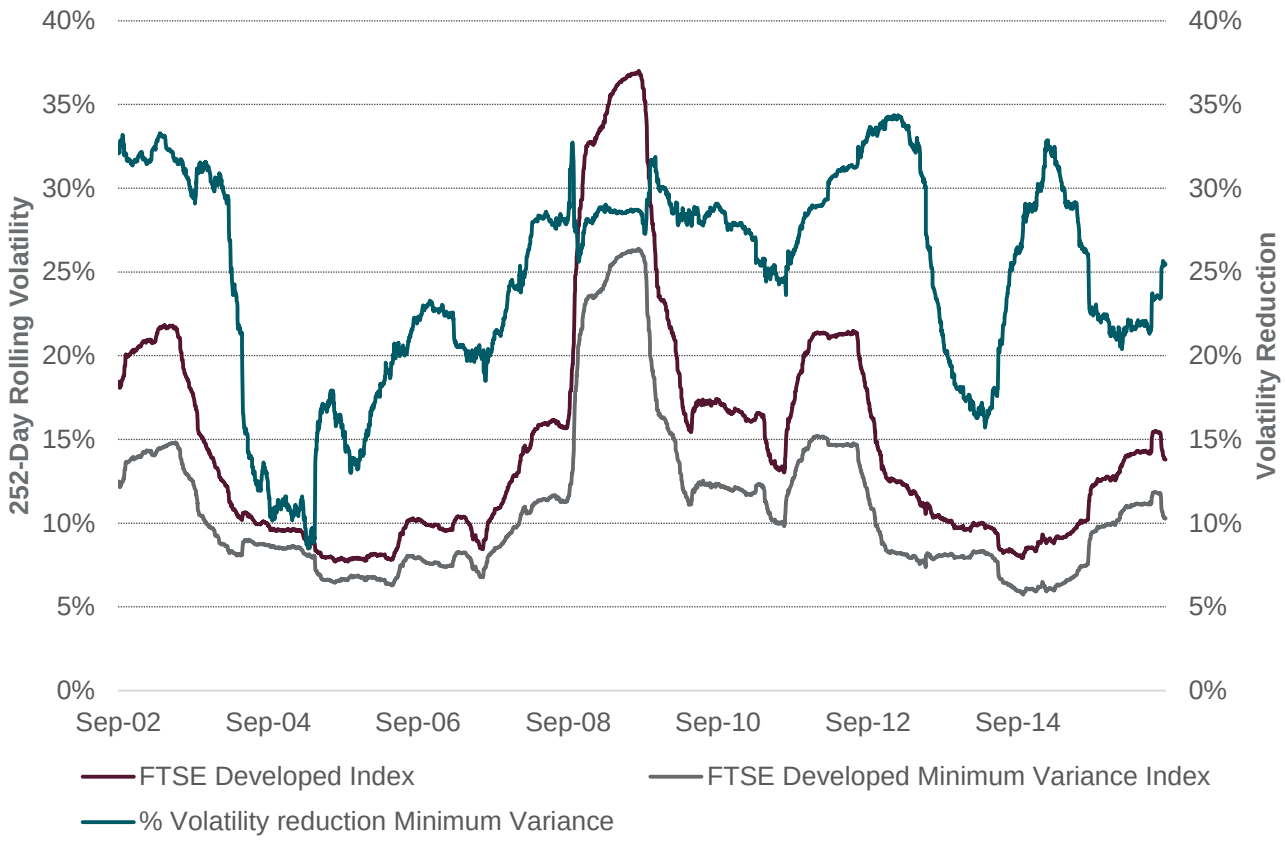
Minimum variance indexes apply a rules-based methodology to constrain volatility in a reference index while also maintaining exposure to the equity market. Asset owners have therefore employed these tools as part of their own risk-reduction strategies. At the same time, minimum variance index methodology is not designed to benchmark a specific return objective: any deviation in index values from the capitalization-weighted reference benchmark are an incidental outcome of the volatility-minimizing strategy.

The efficacy of a minimum variance index in reducing volatility can be seen from the chart and table below where we compare the past volatility of the FTSE Developed Minimum Variance Index with the volatility of its capitalization-weighted reference index, the FTSE Developed Index. The FTSE Developed Index measures the performance of mid and large cap stocks in global developed markets and represents around 98% of the world's investable market capitalization.

Exhibit 1 demonstrates that, over the period between 2001 and 2016, the minimum variance approach consistently had a 20-30 percent index volatility reduction by comparison with the capitalization-weighted reference benchmark.

[1] 2016 FTSE Russell Smart Beta Survey: 46% of respondents cited risk reduction, 58% cited return enhancement

Exhibit 1. Volatility comparison: FTSE Developed vs. FTSE Developed Minimum Variance



Source: FTSE Russell.

The minimum variance index also suffered a smaller maximum drawdown in the 2007 - 2008 bear market than the reference benchmark (see Exhibit 2). And it shared to a greater extent in the equity market's upward moves than in its downward moves (expressed in the table as a higher-up capture ratio than down capture ratio).

Exhibit 2. Volatility and drawdown reductions from the minimum variance approach

	FTSE Developed	FTSE Developed Minimum Variance
Geometric Mean Return (%)	7.27	11.42
Volatility (%)	16.35	11.86
Volatility Reduction (%)		27.47
Sharpe Ratio	0.44	0.96
Maximum Drawdown (%)	-57.37	-46.30
Up Capture Ratio		90.21
Down Capture Ratio		64.35

Source: FTSE Russell. Data from September 2001 to November 2016. Past performance is no guarantee of future results. Returns shown may reflect hypothetical historical performance. Please see the end for important legal disclosures.

Competing approaches to volatility reduction

Minimum variance is not the only index construction approach focused on capturing reduced equity market volatility in its index composition.

A simple alternative low volatility approach is a *risk-weighted* index, where the index's constituents are weighted by the inverse of their historical volatility (the lower the volatility, the higher the index weighting).

Another approach is to construct a *low volatility factor* index. Here, the index methodology focuses on capturing the factor premium historically associated with low volatility stocks.[2]

A comparison of the historical index-level volatility reduction resulting from these three approaches, based on the capitalization-weighted Russell 1000 Index universe, shows that minimum variance has produced higher levels of index-level volatility reduction than the two alternative approaches over an extended period (see Exhibit 3).

Exhibit 3. Volatility reduction from three alternative low volatility index approaches

Source: FTSE Russell. Data from June 2000 to December 2016. The chart shows the rolling 252 day volatility reduction relative to the reference benchmark, the capitalization-weighted Russell 1000 index. Past performance is no guarantee of future results. Returns shown may reflect hypothetical historical performance. Please see the end for important legal disclosures

It's noteworthy that both the simple risk-weighted (inverse volatility) approach and the low volatility factor approach achieved relatively low levels of index-level risk reduction over the period (typically 0–10%).

The minimum variance approach succeeded in producing higher levels of risk reduction primarily because, as well as focusing on stocks' past volatilities, it fully exploited the correlation structure of the equity market.

In fact, minimum variance indexes may select individual stocks with higher levels of volatility if this produces a correlation (i.e., a risk reduction) benefit to the overall index—a notable difference with the risk-weighted approach or the low-volatility factor approach.

[2] For an introduction to factors and the objectives of factor indexes, see http://www.ftserussell.com/files/research/objectives-factor-indexes

Constructing a minimum variance index

Using historical data, minimum variance indexes achieve their objective of producing the lowest possible index volatility by utilizing the correlations and past volatilities of each stock. In common with several other risk-based indexes, the minimum variance portfolio is calculated by means of a mathematical optimization algorithm.[3]

For the minimum variance indexes in the FTSE Russell Global Minimum Variance Index Series, the optimization has three steps:

1. Define the index's objective (in this case, to minimize long-only portfolio variance, defined as:

   $$\sigma^2 = W^T C W$$

   where *W* is the vector of stock weights and C is the covariance matrix)

2. Set appropriate constraints (FTSE Russell's minimum variance methodology includes constraints on industry and country weights, individual stock weights and the number of index constituents, which must not be fewer than half the number of stocks in the underlying universe)

3. Run the optimization (this is an iterative process, meaning that the optimization proceeds via a series of steps to arrive at the desired outcome, with each step representing an approximate solution, and each step improving on the previous step in terms of meeting the outcome)

The importance of constraints

If run without constraints, the minimum variance optimization would be likely to result in a heavily concentrated stock portfolio within the index, unsuitable for practical use as an equity benchmark both because of high weightings in individual constituents and the resulting high levels of internal turnover when the index is rebalanced.

However, constraints such as diversification and turnover limits represent a trade-off between optimality (the lowest possible variance) and practicality (the suitability of the resulting index for use by market participants, whether as a performance benchmark or as the underlying target for an index-replicating fund or financial product).

By setting relatively high diversification targets (for example, by requiring that not fewer than half the number of stocks in the underlying universe be represented in a minimum variance index), FTSE Russell aims to ensure that its indexes are broad, diversified and investable.

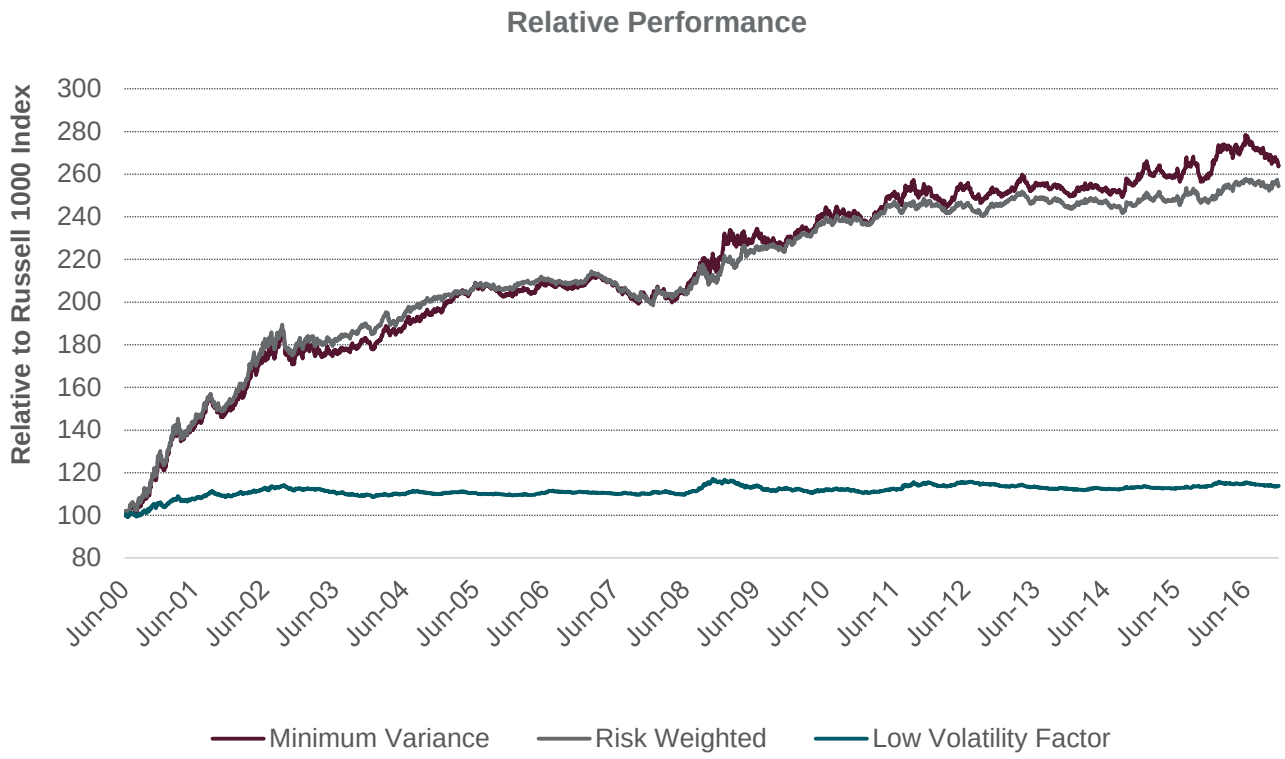
For market participants wishing to compare minimum variance indexes from different providers, it's important to understand the role played by constraints in the optimization algorithm and to assess their impact on the likely capacity, turnover and performance of the index.

Performance and factor exposure of low volatility approaches

In Exhibit 4 we show the index levels between 2000 and 2016 of the three low-volatility approaches outlined above: minimum variance, risk-weighted (inverse volatility) and low volatility factor indexes, shown relative to the capitalization-weighted Russell 1000 Index.

[3] See the second *Insights* of this series, "Understanding risk-based index construction", for further detail on optimizations.

Exhibit 4. Performance of low volatility indexes relative to Russell 1000 Index



Source: FTSE Russell. Data from June2000 to December 2016, shown relative to the Russell 1000 reference index. Past performance is no guarantee of future results. Returns shown may reflect hypothetical historical performance. Please see the end for important legal disclosures.

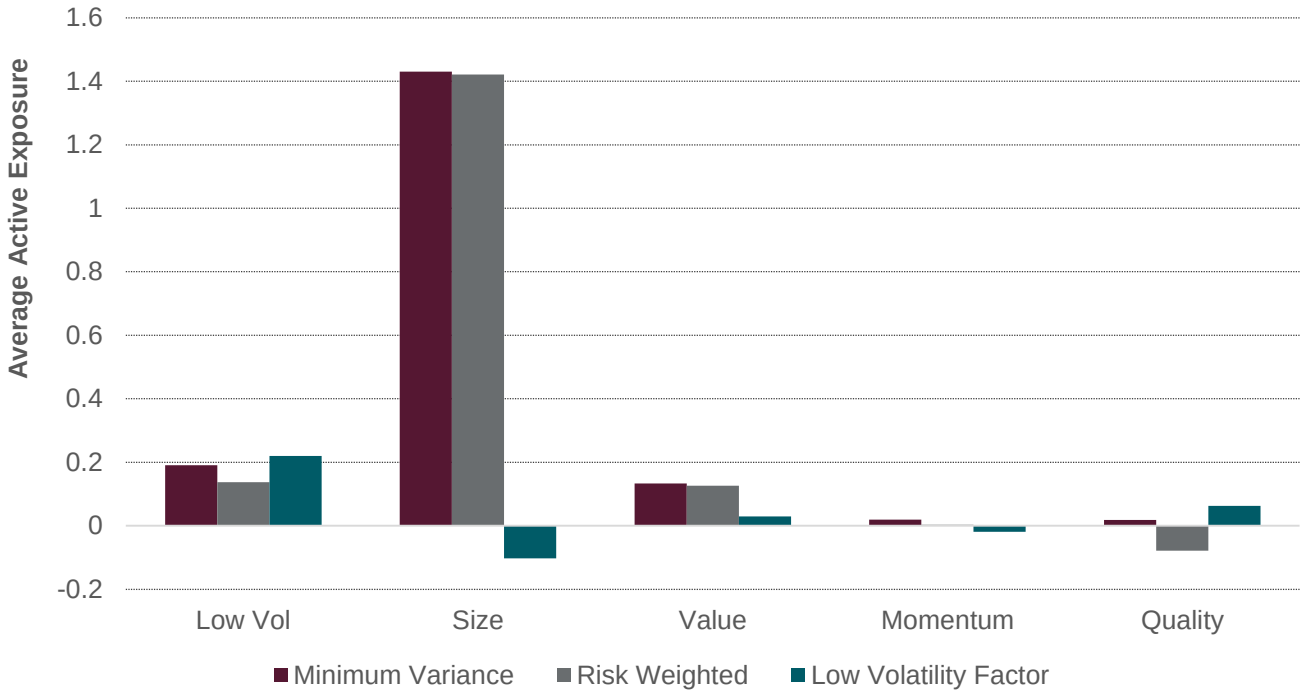
Two things stand out. First, although the historical performance of an index is not a guarantee of future results and, as mentioned earlier, the minimum variance, risk-weighted and low volatility factor indexes are not designed to benchmark an explicit return objective, all three low volatility approaches produced higher index values than the capitalization-weighted reference benchmark over the sixteen-year period. At the same time, they produced lower average levels of volatility.

Second, the minimum variance and risk-weighted approaches produced substantially higher index values than the low volatility factor index. The reasons for this difference in index performance can be seen in charts showing the factor exposures through time of the three index approaches (see Exhibit 5).

While the minimum variance, risk-weighted and low volatility factor indexes have all had active exposure to the low volatility factor over the period, only the first two indexes have had positive exposure to the size factor (and, to a much smaller extent, to the value factor).

Over this particular sixteen-year period, exposure to the size factor has helped generate higher index values for the minimum variance and risk-weighted index approaches. However, in the case of the minimum variance index, this occurred without a concurrent rise in index volatility (see Exhibit 4), an initially surprising result given the above-market volatility traditionally associated with the size factor. Again, this can be seen as a result of the focus on stocks' correlations inherent in the minimum variance methodology.

Exhibit 5. Average active factor exposure of three different low volatility index approaches



Source: FTSE Russell. Data from June 2000 to December 2016. Factor exposures are shown relative to the Russell 1000 reference index. Past performance is no guarantee of future results. Returns shown may reflect hypothetical historical performance. Please see the end for important legal disclosures.

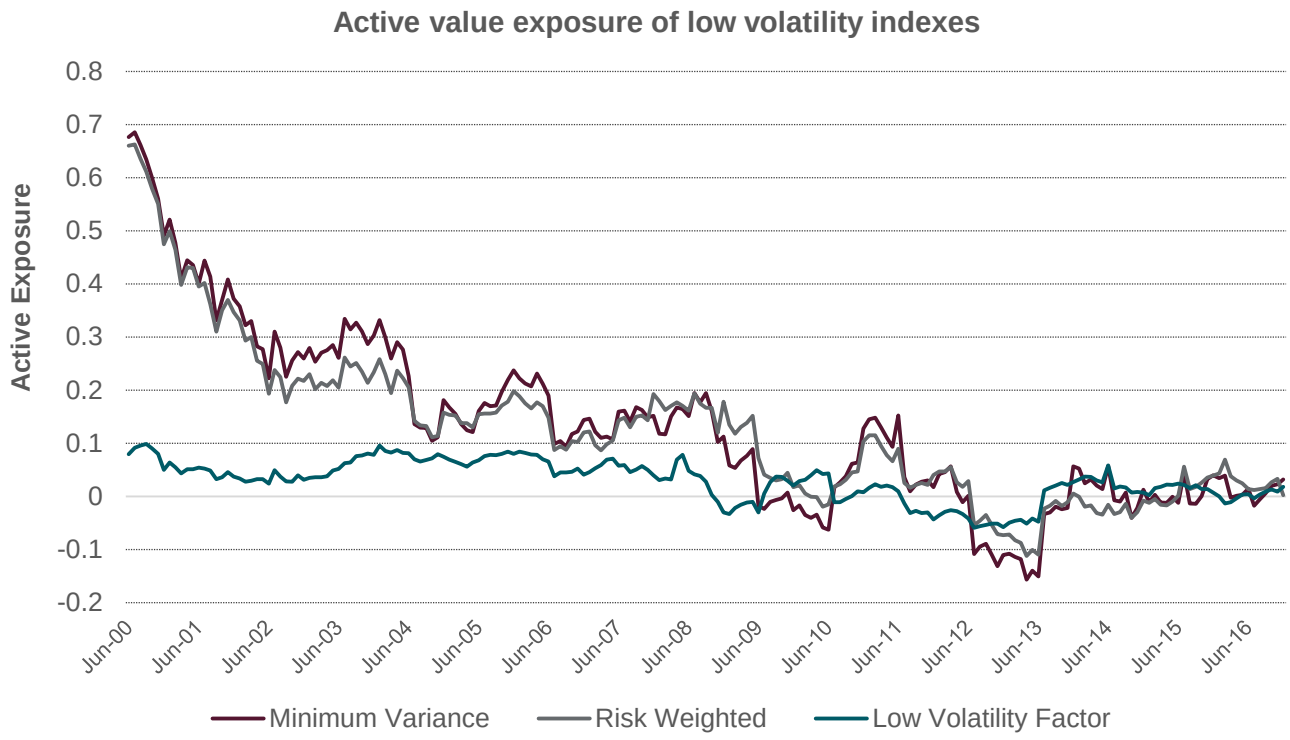
Is low volatility expensive?

It's important to remember that, as an index approach, minimum variance does not look to benchmark an explicit return target: its goal is index volatility reduction, and the overall index performance is incidental to this goal.

Nevertheless, the combination of below-average historical volatility and above-average historical returns offered by minimum variance in many markets has, unsurprisingly, caught the attention of investors. Financial products referencing or tracking low volatility or minimum variance indexes have attracted substantial inflows during recent years.

In response, some market participants have recently expressed the view that low volatility strategies have become expensive and are subject to a performance reversal. While it's not the role of an index provider to express a view on the attractiveness or otherwise of particular strategies or to comment on future performance, FTSE Russell does measure the active value factor exposure of the three low volatility approaches outlined above (see Exhibit 6).

Exhibit 6. Active value factor exposure of three different low volatility index approaches



Source: FTSE Russell. Data from June 2000 to December 2016. Factor exposures are shown relative to the Russell 1000 reference index. Past performance is no guarantee of future results. Returns shown may reflect hypothetical historical performance. Please see the end for important legal disclosures.

Clearly, while the low volatility factor index has had past levels of exposure to the value factor that are in line with the capitalization-weighted reference index, the minimum variance and risk-weighted indexes have had higher levels of value exposure, particularly in the early part of the last decade. As at December 2016, the active value factor exposure of all three low volatility approaches was near zero (i.e., in line with that of the reference index). On this measure, the three approaches were neither cheap nor expensive.

Addressing investors' demand for risk reduction

By explicitly targeting reductions in index-level risk, therefore, minimum variance indexes help address the current demand from market participants for an index that combines equity exposure with lower volatility. By using information on stocks' correlations as well as their past levels of risk, minimum variance indexes have been able to achieve greater levels of index risk reduction than alternative low volatility approaches. Moreover, the constraints set by index providers when minimum variance indexes are constructed play an important role in determining the usability of the resulting benchmarks. The past factor exposures of minimum variance indexes can help explain the high historical index performance accruing to this strategy. However, index users must recognize that while such index performance may be welcome to some market participants, minimum variance indexes are always constructed with the aim of reducing index level volatility rather than to benchmark a particular investment return.

For more information about our indexes, please visit ftserussell.com.

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