Research

Implementation considerations for defensive strategies

A look at three approaches

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Introduction

With the increased availability of non-cap-weighted indexes, investors can now make more efficient allocation decisions by more precisely mapping their investment goals and constraints to the strategies used to build their portfolios. This requires a deep understanding of their investment needs, objectives and the outcomes they expect from the strategies under consideration.

Such decisions are often influenced by changes in the macroeconomic cycle and market sentiment. This is particularly true when considering defensive and cyclical investment strategies. At the time of this writing, for instance, market attitudes toward risk appeared to be at an inflection point. Optimism amid signs of a synchronized global growth recovery a year ago has given way to profound risk aversion more recently as concerns about global trade, tightening US financial conditions and a flattening US yield curve eroded investor confidence. The recent outbreak of market turbulence after a protracted period of calm has refocused investor attention on the potential long-term benefits of defensive strategies.

In a recent paper [1], we discussed the implementation issues institutional investors should consider when making choices about factor investing. The key take-away was that investors need to understand the performance characteristics and the ability of individual factors to meet their investment objectives. Specifically, our research divided the primary factors into three performance groups: defensive, diversified and dynamic. By understanding the performance patterns of the factor groups and how they co-move in relation to the market, investors are better able to form realistic expectations of how these factors may contribute to their portfolio's future performance.

> **The recent outbreak of market turbulence has refocused interest in defensive strategies**

OBJECTIVES
- Performance
- Risk

PORTFOLIO CONSTRUCTION
- Exposures
- Risk characteristics

OUTCOMES
- Performance
- Risk
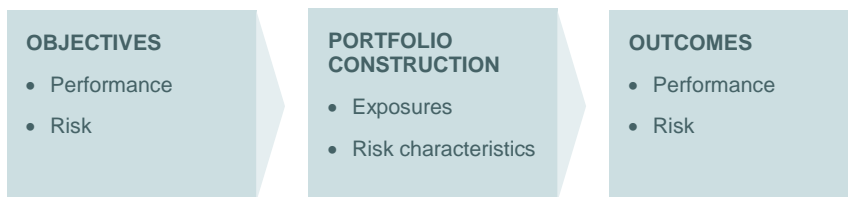
This paper extends this line of inquiry into the defensive investment realm, with a focus on Low Volatility Factor (LVF), Minimum Variance (Min Var) and Equal Risk Contribution (ERC) strategies. All three use volatility metrics to build portfolios that are defensive in that they have lower volatility than the cap-weighted benchmark. Although this is not an exhaustive list (other well-known strategies include Maximum Diversification [2]), these approaches share the dominant characteristics that define most defensive strategies.

"Low volatility" and "minimum variance" are sometimes, although incorrectly, used interchangeably (see [3]). However, they have very distinct objectives, portfolio construction methodologies and investment outcomes. In the pages that follow, we detail these differences and offer some insight into how investors should think about integrating them into their portfolios.

2. Defensive strategies – An overview

Generally speaking, defensive strategies are those that have relatively higher payoffs during broad market downturns and relatively lower payoffs in rising markets. In our previous paper on factor strategy implementation, we highlighted the classic defensive factors as Volatility and Quality.

Low Volatility factor strategies overweight stocks that are less volatile than the broad market and, thus, tend to fall less when the market drops. Quality strategies have increased exposure to attributes associated with corporate strength such as higher-than-average profitability and lower leverage. Investors often gravitate to less volatile and/or high-quality stocks during market selloffs as they seek protection from the economic and financial shocks driving the market lower. While Dividend Yield investing offers some defensive characteristics, it is best considered a hybrid strategy that contains elements of the more cyclical Value effect during most periods but behaves more like a risk on/ risk off strategy in times of market stress.

This paper focuses on only the Low Volatility factor strategy within a more general examination of volatility-reducing strategies. The other two strategies covered here – Min Var and ERC – also use volatility measures in portfolio construction. However, because they are not specifically designed to obtain factor exposure, we do not call them factor strategies. Min Var strategies select and weight stocks with the objective to minimize the portfolio's volatility without necessarily obtaining specific factor exposures. Min Var portfolio construction is generally achieved via optimization and so requires constraints to ensure the portfolio has appropriate characteristics such as industry and stock diversification.

ERC has no specific objective other than diversification and depends only on the methodology requirement that each stock in the portfolio has the same contribution to total portfolio risk. Because ERC does not seek specific factor exposures as an objective, we view it as an alternative weighting approach rather than a factor strategy.

In this paper, we detail the characteristics and return patterns of three popular defensive strategies

Table 1. Strategy overview

	Low Volatility Factor	**Minimum Variance**	**Equal Risk Contribution**
Objective	Return enhancement	Volatility reduction	Diversification
Methodology	Maximize low volatility exposure (subject to diversification)	Minimize portfolio volatility (subject to diversification)	Equalize risk contributions
Drivers	Variance	Variance, correlation	Variance, correlation

When choosing a defensive strategy, prudent investors will explicitly consider the payoff pattern they require to meet their investment needs. A simple way to do this is to consider a base-case alternative in which the investor allocates part of the portfolio to cash. If an investor wants a 20% reduction in risk from the benchmark, the easiest way to accomplish that is to allocate 20% to cash and the remaining 80% to a portfolio tracking the benchmark. This reduces volatility by 20%, but also foregoes 20% of the portfolio's participation in the equity premium.

Furthermore, performance will be perfectly correlated with that of the benchmark, so there is no difference in performance timing.

For investors to stay fully invested, the defensive strategy needs to outperform such a benchmark-plus-cash allocation. Intuitively, while the benchmark-plus-cash strategy offers a symmetric response to market movements, investors actually want an asymmetric response—that is, one that offers protection when markets fall without sacrificing an equal amount of participation when markets rise. Defensive strategies seek to do this by using portfolio construction methodologies that deviate from benchmark weightings to provide beneficial asymmetric return and risk characteristics relative to the benchmark.

Before reviewing the performance characteristics of these strategies, we will examine their objectives, portfolio construction methodologies and the impact of this construction on portfolio exposures.

Low Volatility Factor

The chief objective of a LVF strategy is to gain persistent exposure to the historical premium associated with the low volatility effect. While there are various rationales, the foundational support for this strategy is an "anomaly" documented in academic and financial-market research dating back to the 1970s, which found that stocks with lower volatility (or beta) tend to produce higher risk-adjusted returns than the broad market over time (see [4] and [5]). This outcome conflicts with conventional capital-asset pricing theory, which holds that higher risk (as measured by volatility) should be rewarded with higher expected return in equilibrium. Thus, the main motivation behind the LVF strategy is to improve long-term portfolio performance.

Low Volatility Factor strategies seek persistent exposure to low-volatility stocks

In a standard implementation of LVF, portfolio managers calculate a volatility score based on a stock's volatility. They then build a portfolio that tilts away from the benchmark by overweighting less volatile stocks and underweighting those with high volatility. As stock volatility tends to be relatively stable over time, the result is a portfolio with constant exposure to this factor. Note that the strategy does not define how much exposure is required—that decision is left up to the investor.

Minimum Variance

By contrast, the objective of a Min Var strategy is to lower the portfolio volatility. A fundamental difference compared to LVF is that in addition to volatility the Min Var portfolio construction also considers the correlation between stocks. Portfolio construction is usually done with an optimizer that attempts to minimize total portfolio volatility.

Min Var seeks to minimize portfolio volatility via optimization (with constraints)

The optimizer is happy to include stocks with higher volatility if their correlations are low enough to lessen overall portfolio volatility. Min Var's stock volatility profile, then, is not as obvious as that of the LVF portfolio as it may contain highly volatile stocks.

The final portfolio depends crucially on the constraints imposed during the optimization. This addresses a potential problem with the Min Var approach, which is that an unconstrained optimization can produce highly concentrated portfolios that may be unpalatable to investors. For that reason, most Min Var strategies prudently impose constraints to ensure the portfolio is diversified across important dimensions such as country, industry and stock, while

maintaining low portfolio volatility. In fact, once the constraints are satisfied, Min Var's objective to minimize portfolio volatility has been achieved. There are no relative performance expectations and no ambiguity about how much exposure to take or relative performance expectations, as there is with LVF. As for factor exposure, while the inclusion of less volatile stocks may lead to higher relative (risk-adjusted) performance, that is a by-product of the construction, not its objective.

Equal Risk Contribution

ERC strategies take a completely different approach. Rather than having a portfolio objective related to outperformance or lower volatility, they focus on a construction methodology with the goal of providing a well-diversified portfolio. Portfolio concentration generally increases the risk of a portfolio by relying heavily on just a few stocks or industries to drive performance. Diversification is intended to avoid this by allowing all stocks to contribute to performance.

The most naïve diversification approach is to equal-weight all stocks in the portfolio. This treats all stocks the same if we consider only portfolio weights. However, not all stocks have the same risk profile. To avoid risk concentration, differences in stock risk should also be considered. Intuitively, if all stocks had the same risk profile, then an ERC portfolio would be an equal-weighted portfolio. If we assumed that all stocks have different volatilities but the same correlations, then an ERC portfolio would be an inverse volatility-weighted portfolio. However, correlations are not the same for all stocks and, therefore, the ERC construction methodology considers both volatility and correlation in determining portfolio weights that give each stock the same contribution to total risk.

The volatility profile of the stocks in an ERC portfolio is straightforward but not strict. As lower-risk stocks need more capital weight to contribute the same amount of risk, stocks in the portfolio tend to have lower-than-average risk. The lower risk can come from lower volatility or from lower average correlations. Like the Min Var portfolio, there is a trade-off in that higher volatility stocks can have higher weights if they have sufficiently low enough correlations with other stocks to lower total risk.

The result is that the ERC portfolio tends to have lower risk and is more diversified than the benchmark, which protects it from the shocks that can hurt concentrated portfolios. However, since there are no explicit performance-enhancing expectations built into these strategies, they achieve their objective merely via appropriate portfolio construction.

ERC strategies consider both volatility and correlations to equalize risk contribution

3. Exposure comparisons

To illustrate the main differences of the LVF, Min Var and ERC approaches, we ran back-tests using three FTSE Russell index methodologies:

- FTSE Developed Minimum Variance (see [6] for details)

- FTSE Developed Equal Risk Contribution (see [7] for details)

- FTSE Developed Low Volatility Factor Index constructed by using the FTSE Russell tilt methodology (see [8] for details), with an exponent of 1 on the Volatility factor.

All simulations and calculations were done in FTSE Russell's Analytics+ research platform using monthly data from October 2003 through October 2018.[1] Returns are in USD and comparisons were made against the FTSE Developed Index as the benchmark.

Before delving into a comparison of performance and characteristics, it is interesting to consider the differences that the methodologies have on exposures, both factor and categorical. Some of the exposures, such as on Volatility, are intentional, but many of them are by-products of the portfolio construction methodology.

Factor exposures

We are most interested in low volatility exposure. Exhibit 1 shows that the LVF portfolio has the highest exposure to this factor, as expected since that is the explicit objective of this approach. Unsurprisingly, Min Var also has material low volatility exposure (though it has diminished lately) as such portfolios are likely to include many low-volatility stocks.

Unsurprisingly, LVF has the highest exposure to the (low) Volatility factor, followed closely by Min Var

The situation is more complicated for ERC because there are two opposing effects. ERC naturally tends to favor lower risk stocks. By design, it diversifies the portfolio based on each stock's risk profile by allocating more capital (or weight) to lower risk stocks to match the risk contribution of higher risk stocks. However, there is another important effect of ERC related to the Size exposure. If we assume that all stocks have identical correlations, the ERC portfolio would be an inverse volatility portfolio. As there is greater similarity in volatilities than in market capitalizations, an inverse volatility portfolio bears a greater resemblance to the equal-weighted portfolio and, consequently, has a large Size exposure relative to the cap-weighted index. However, as small-cap stocks tend to be more volatile, the final relative low Volatility exposure depends on the relative magnitude of these two effects.

FTSE Russell's methodology tempers this pattern by applying ERC only to the large-cap stocks; mid-caps are held at their cap weights for implementation purposes. The net result is seen in Exhibit 1, which shows that ERC had higher low-volatility exposure[2] than the benchmark early in the period then consistently lower exposure to this factor in more recent years.

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[1] Back-test data runs from October 2003 through October 2018. While most of our data dates before September 2003, our ERC index data starts then, so this analysis is based on the overlapping period. Rebalancing was done semi-annually in March and September, corresponding to the FTSE Russell review schedule.

[2] All portfolio factor exposures are measured as the portfolio weighted average of factor Z-scores.

Exhibit 1: Unsurprisingly, LVF has the highest Low Vol factor exposure
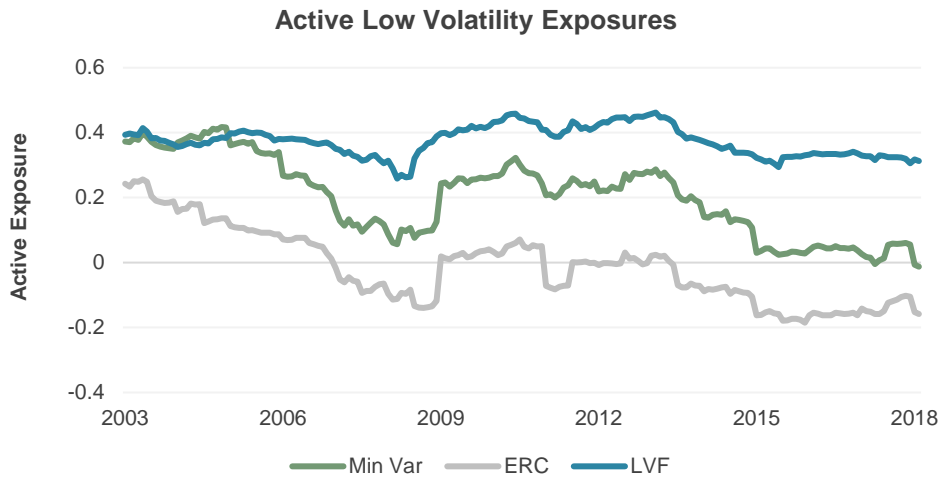
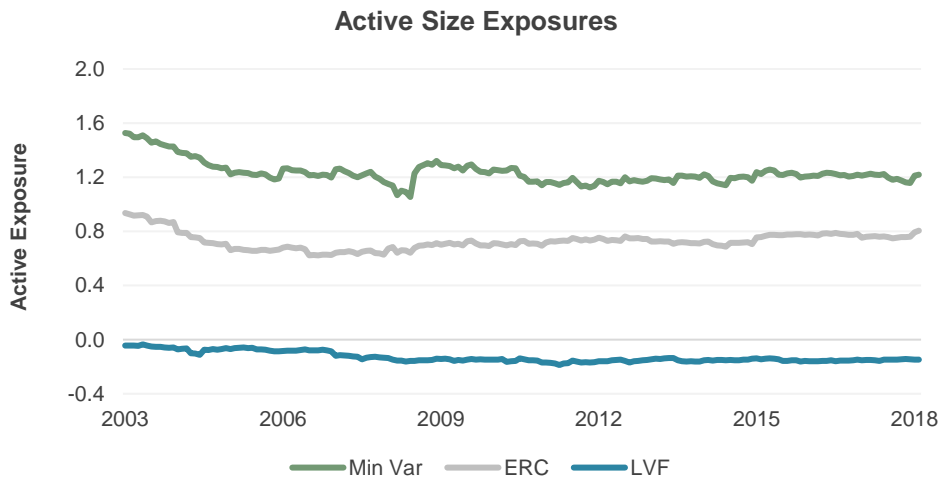### Active Low Volatility Exposures

Min Var — ERC — LVF

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

The second most influential factor in these three approaches is Size. Exhibit 2 below shows the active (small) Size exposure of the three portfolios. Min Var is intended to be highly diversified and so is constrained to hold many names, resulting in considerable (small) Size exposure. The FTSE Russell ERC implementation holds mid-cap stocks at cap weight but balances risk across the large-cap stocks, thereby tilting away from mega-cap stocks and leaving the portfolio with a smaller Size profile than the benchmark. In the case of LVF, however, the portfolio tilts away from the benchmark in the direction of low-volatility stocks. Since low-volatility stocks tend to be large caps, LVF has a slightly negative Size exposure.

LVF's Size underweight reflects the high correlation between low Volatility and large caps

Exhibit 2: Min Var has the most significant (small) Size exposure

Active Size Exposures

Min Var — ERC — LVF

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

The next three charts show active exposures for the remaining factors. The Quality exposure of each portfolio tends to be slightly higher than that of the benchmark, as (low) Volatility and Quality tend to be correlated. The active Momentum exposure fluctuates, reflecting the recent performance of the indexes. Finally, the active Value exposure indicates these defensive portfolios have moved from being cheap versus the benchmark to relatively expensive and then back to cheap again.

Exhibit 3: Quality tilts have fluctuated but have fallen recently
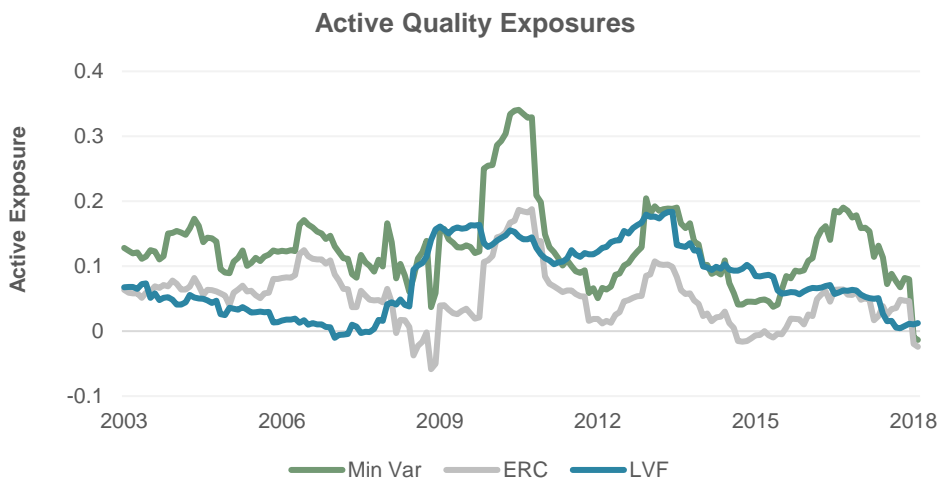
Active Quality Exposures

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

Exhibit 4: Momentum exposure is now negative for all three portfolios
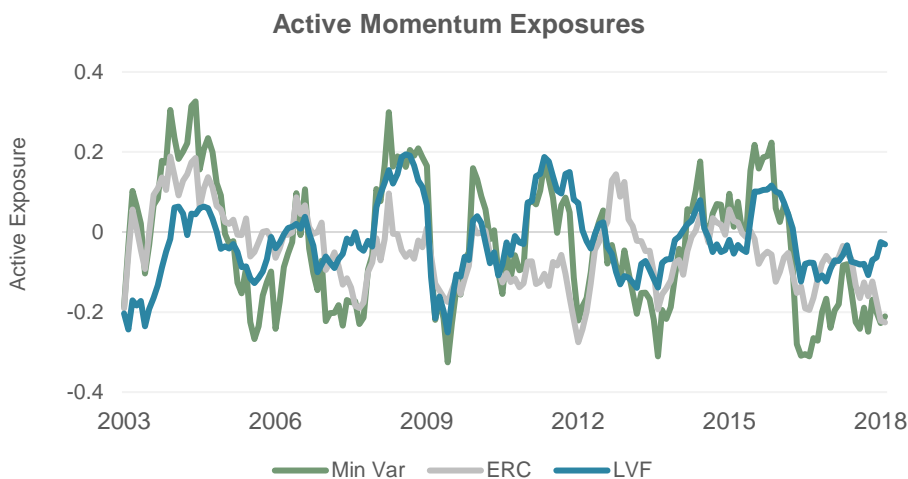
Active Momentum Exposures

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

Exhibit 5: Value tilts have also varied over time, less so for LVF
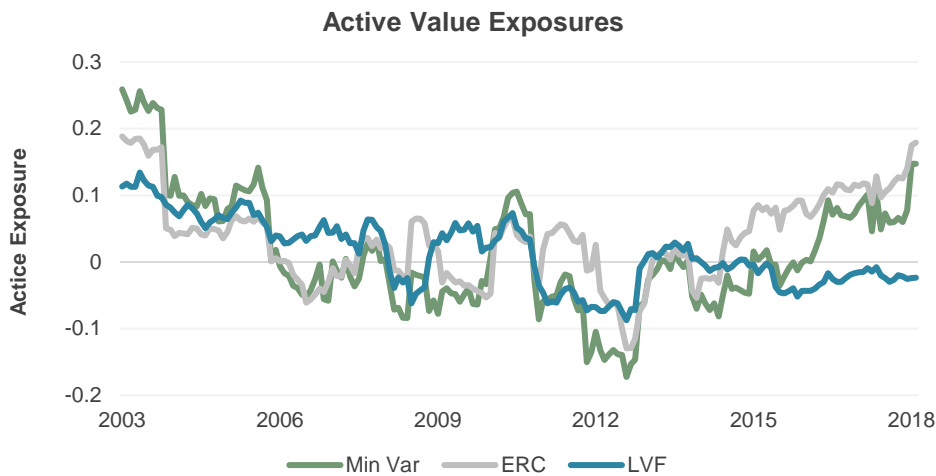
**Active Value Exposures**

Industry exposures

In addition to factors, defensive strategies also possess inherent differences in exposures to industries and countries. The LVF portfolio construction methodology relies on tilting away from the cap-weighted benchmark, while the Min Var and ERC methodologies are less constrained by the benchmark. In this section, we highlight a couple of the more interesting differences in industry exposures.

Exhibit 6 shows the active weight of Utilities, which is the quintessential defensive industry, reflecting the low volatility of its stocks. All three defensive portfolios overweight Utilities, but Min Var has by far the largest exposure, which has spiked recently as markets have grown more risk averse.

Construction methodologies vary, producing significant differences in industry exposures

Exhibit 6: Min Var's Utilities exposure has spiked recently
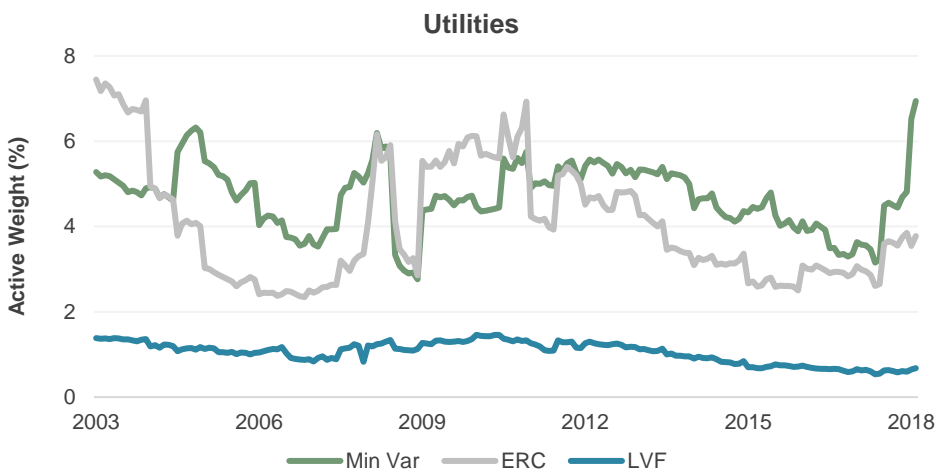
Utilities

In contrast, the Technology sector is typically more cyclical, so we would expect defensive portfolios to be underweight. As Exhibit 7 shows, that has generally been the case for all three approaches. Since the global financial crisis, however, LVF has seen its Technology exposure rise and even move to a modest overweight in the immediate aftermath of the crisis. Meanwhile, active weights to the sector have turned increasingly more negative for Min Var and ERC over the past five years.

Exhibit 7: LVF's Technology exposure has risen post-crisis
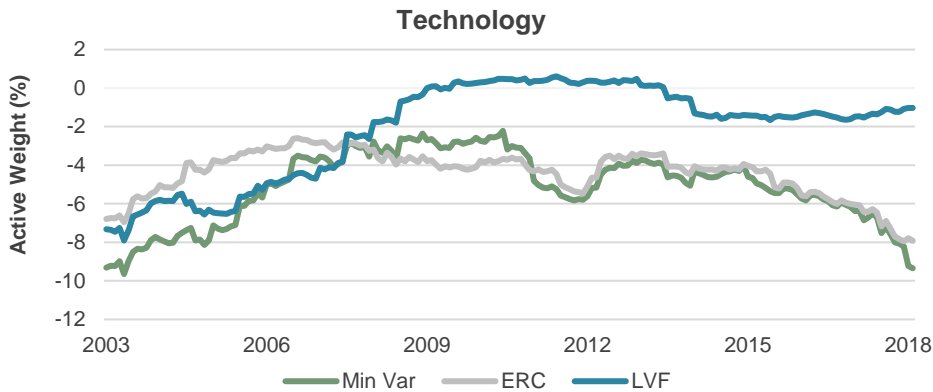
Technology

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

Country exposures

Countries have different volatility and correlation characteristics and, thus, can have a major impact on the performance of defensive global portfolios, as we illustrate with the following examples.

Country exposures also vary, with major implications for risk and return outcomes

Because LVF only considers stock volatility, its active exposure to Hong Kong has been broadly in line with the benchmark since 2003. Both the Min Var and ERC use correlations in considering risk and have consistently held a large overweight, reflecting the diversification benefits of holding Hong Kong.
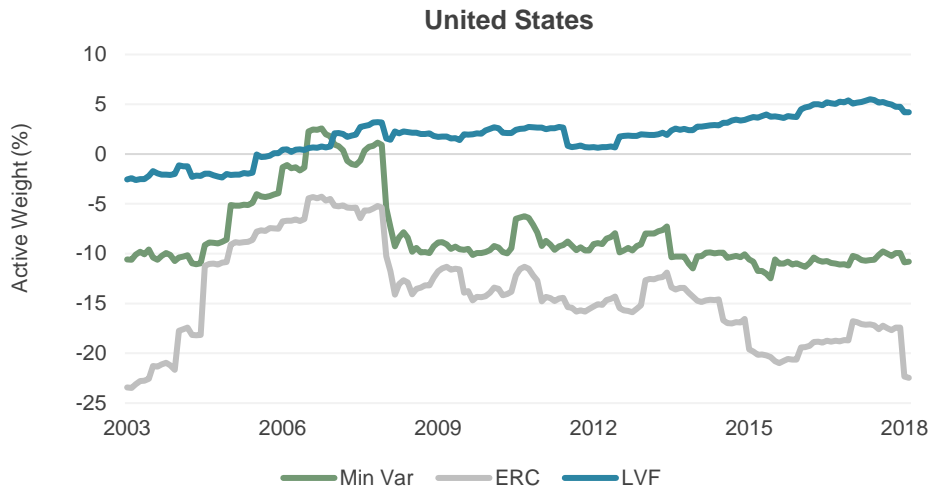
Exhibit 8: Min Var and ERC have large overweights to Hong Kong
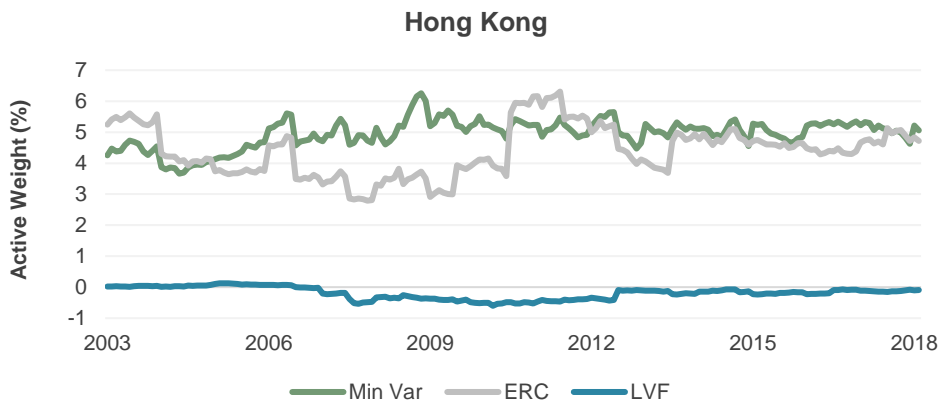
Hong Kong

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

Exhibit 9 shows the defensive portfolios' exposures to the US, which is a very large weight in the cap-weighted benchmark. Since LVF tilts away from the benchmark toward less volatile stocks, it tends to add weight to the large US position. Min Var, on the other hand, considers correlations to reduce portfolio volatility and does so by shifting weight away from the US into other countries for diversification purposes. ERC diversifies away from the US even more, which has resulted in the largest underweight to the US of the three portfolios.

Exhibit 9: LVF's US exposure has risen post-crisis; ERC's has fallen

United States

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

4. Performance comparisons

Over the examined period, all three defensive portfolios outperformed the FTSE Developed Index, with Min Var performing the best. All approaches also reduced portfolio volatility, with Min Var registering the most significant decrease. Min Var's volatility reduction has been almost twice that of LVF, and ERC's reduction is even smaller than LVF's. A similar pattern is observed for maximum drawdown, with Min Var providing the best downside protection of the three portfolios. Min Var had the largest tracking error, but its return advantage more than made up for it, with Min Var recording an information ratio (IR) almost twice that of the other two portfolios.

Despite defensive attributes, all three portfolios exhibit interesting payoff patterns

Table 2: Index performance − September 2003 to October 2018

	FTSE Developed	Min Var	ERC	LVF
Geometric Return % p.a.	8.12	11.03	9.03	8.83
Volatility % p.a.	16.45	13.49	15.31	14.86
Return/Risk Ratio	0.49	0.82	0.59	0.59
Relative Performance				
Geometric Excess Return % p.a.	--	2.69	0.84	0.66
Tracking Error % p.a.	--	4.63	2.84	2.30
Information Ratio	--	0.58	0.30	0.29
Volatility Reduction % p.a.	--	17.99	6.93	9.67
Maximum Drawdown %	-50.51	-39.28	-45.50	-46.63

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

Table 3 details each portfolio's Capture ratios, which indicate average participation in the market returns in up and down markets. The average Capture ratio measures the cyclicality of the portfolio, with numbers below 100 indicating defensiveness. Note that these averages convey information about defensiveness that is similar to that of the standard Beta, which is shown in the last row. Of the three, Min Var is the most defensive. However, the Capture Difference measures the asymmetry of returns, or the advantage an investor may potentially gain over a full market cycle, given the Capture ratios.

All three portfolios have outperformed the benchmark, particularly Min Var

This asymmetry with market returns is an important reason that investors may prefer a defensive strategy over a benchmark-plus-cash strategy. It is informative to examine how a baseline benchmark-plus-cash strategy would fare according to these statistics. If 20% of a portfolio was held in cash and 80% in the benchmark, then both upside and downside capture would be 80, yielding an average Capture ratio of 80. Similarly, its market beta would be 0.80.

While the benchmark-plus-cash strategy would be defensive, its symmetric response to market movements would bring its Capture Difference to zero. In contrast, all three of these defensive portfolios would benefit from an asymmetric response, with Min Var demonstrating the most pronounced and beneficial asymmetry of the three approaches.

Table 3: Capture ratio summary* − September 2003 to October 2018

	Min Var	ERC	LVF
Up Capture % p.a.	89.3	95.6	93.7
Down Capture % p.a.	69.4	88.9	87.2
Capture Average	79.4	92.2	90.4
Capture Weighted Average	82.7	93.4	91.5
Capture Difference	19.9	6.7	6.5
Beta	0.80	0.92	0.90

*Up Capture ratios show the ratio of portfolio returns to benchmark returns when the benchmark performance is positive. In other words, it indicates how much the strategy "captures" when the benchmark is rising. Down capture ratios are calculated only when benchmark returns are falling. Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

From these statistics, we can see that all three portfolios are defensive in that they have average Capture ratios below 100, but that Min Var is significantly more defensive than the other two. Min Var also has a significantly higher volatility reduction. This is not surprising as volatility reduction is the objective of the Min Var strategy, whereas it is a side-effect of the other two portfolios.

Despite their defensive attributes, the three portfolios have also shown interesting differences in payoff patterns. Table 4 shows the correlation of monthly excess returns. Min Var and ERC have a fairly high correlation of 0.83, most likely because they both consider volatility and correlation in their portfolio construction. On the other hand, the excess returns of ERC and LVF are far less correlated, at only 0.41, reflecting the less significant role played by volatility in the construction of the ERC portfolio compared to that of LVF.

Table 4: Excess return correlations

	Min Var	ERC	LVF
Min Var	1.00	0.83	0.74
ERC	0.83	1.00	0.41
LVF	0.74	0.41	1.00

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

The differences in performance patterns can also be seen in Exhibit 10, which shows annualized excess returns calculated over a rolling 36-month window. One important qualitative difference in excess returns since the global financial crisis is that ERC has lagged both LVF and Min Var. Intuitively, while a bias to low volatility has generally been rewarded, the benefits of diversification have been limited because performance has been relatively concentrated. Specifically, ERC's overweight to Japan and underweight to the US have been detrimental.

Exhibit 10: All three portfolios lagged their benchmarks this year
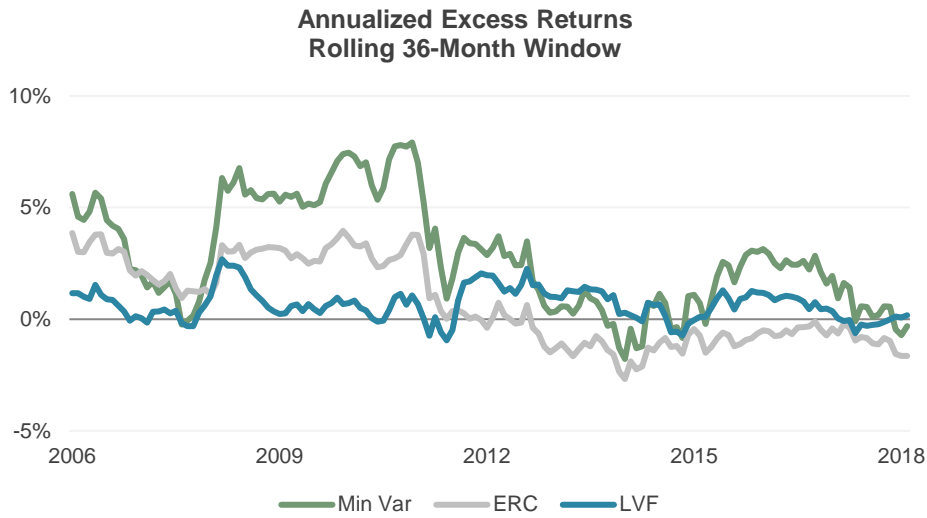
Annualized Excess Returns
Rolling 36-Month Window

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

5. Implementation comparison and outcomes

In the following section, we dissect the key implementation characteristics and outcomes of each strategy to get a better sense of their differences.

Volatility

Since all three defensive approaches focus on risk measures, we will start with an examination of absolute volatility. Exhibit 11 shows a 36-month rolling annualized standard deviation of returns for each portfolio and the benchmark, as represented throughout this paper by the FTSE Developed Index. There was a big spike in volatility during the global financial crisis that pushed the benchmark volatility above 25%. Annualized volatility for all three of the defensive indexes has been generally lower than that of the benchmark over the period examined, but most significantly for Min Var.

Exhibit 11: All three portfolios are less volatile than the benchmark
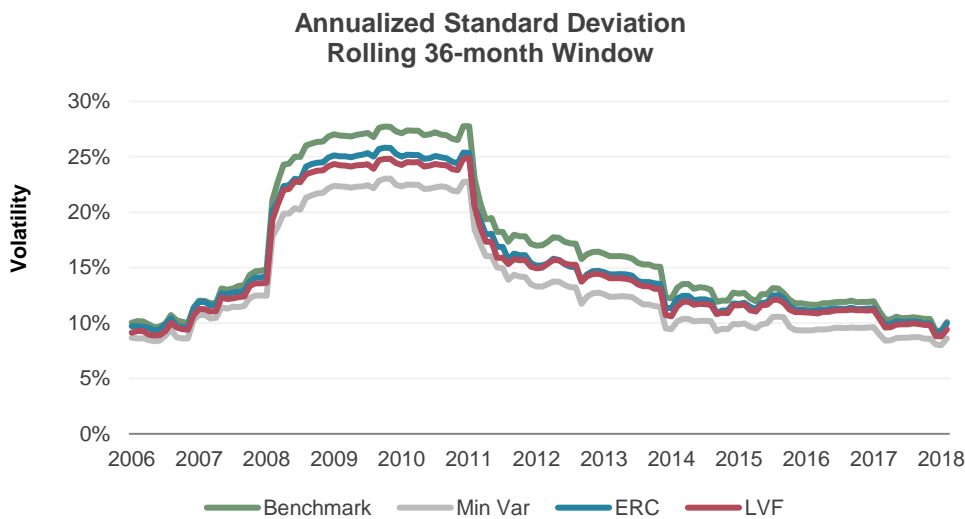
Annualized Standard Deviation
Rolling 36-month Window

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

Exhibit 12 shows the volatility reduction of each defensive portfolio, calculated as the percentage reduction relative to the rolling 36-month standard deviation of the benchmark. This makes the differences clearer: Min Var has reduced volatility by about 10-25%, while LVF and ERC reduced it by much less. In this regard, Min Var accomplished its objective of reducing portfolio volatility, especially during periods of heightened volatility when it is most needed.

Exhibit 12: Min Var reduced volatility the most; ERC the least
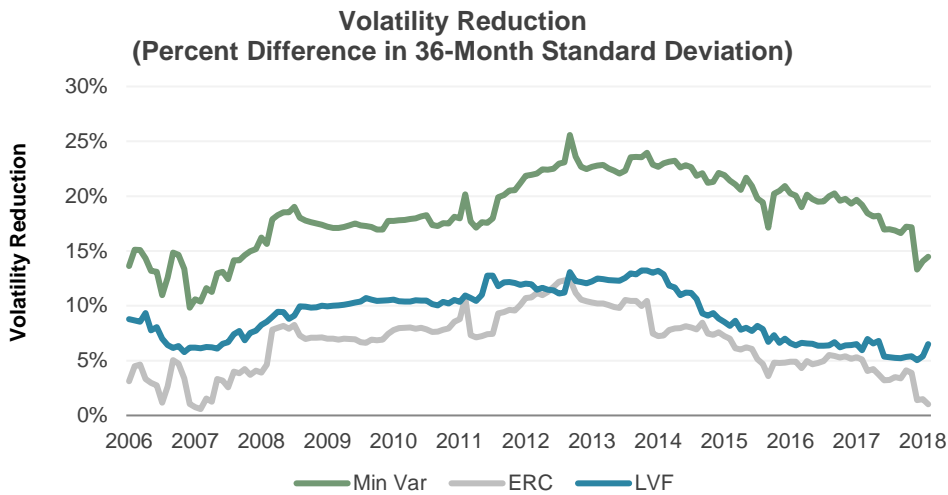
**Volatility Reduction
(Percent Difference in 36-Month Standard Deviation)**

Another risk-related characteristic worth mentioning is tracking error, a commonly used measure of portfolio risk. However, because it refers specifically to active risk, this metric is not very useful in the context of risk-related strategies (as seen in Exhibit 13). Min Var has the highest tracking error of the three approaches, precisely because it reduces the absolute risk of the portfolio the most. Indeed, Min Var is constructed without regard to the benchmark, so Min Var's high tracking error is not surprising. LVF, on the other hand, is constructed relative to the benchmark, which explains why tracking error is low. ERC's tracking error is also relatively low because risk-balancing occurs for large-cap stocks, but mid-caps are closely tied to the benchmark.

Exhibit 13: Min Var has consistently had the highest tracking error
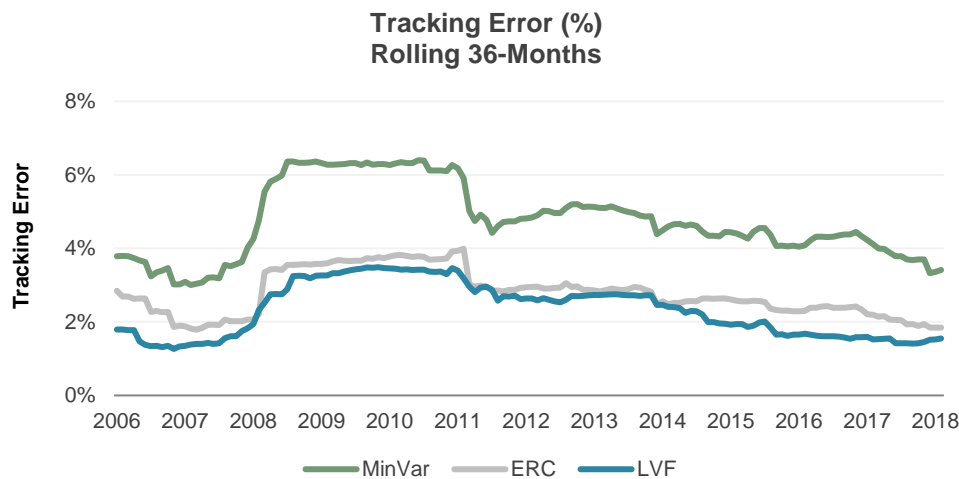
**Tracking Error (%)
Rolling 36-Months**

Diversification

The third important metric to consider is diversification, which we assess by comparing each portfolio's Effective N, or the hypothetical number of stocks needed to represent a given portfolio. At the extreme, a portfolio with all its weight in one stock would have an Effective N of one, and an equal-weighted portfolio has an Effective N equal to the number of stocks in the portfolio.

As shown in Exhibit 14, the benchmark generally had an Effective N of 300-400, demonstrating the normal concentration of a cap-weighted index. Interestingly, LVF has even greater concentration because it starts at the benchmark and tilts toward lower volatility stocks, which tend to be larger-cap stocks.

Min Var, by contrast, has much greater diversification, with an Effective N consistently around 1,000. This is by design, as FTSE Russell's Min Var index construction methodology applies diversification constraints, including requiring a minimum number of stocks in the index. It is worth noting that without these constraints, minimum variance optimizations can result in very concentrated portfolios. Hence, the specific implementation of Min Var is critical. As expected, ERC also is highly diversified, although the Effective N has varied considerably over time. Since its objective is to obtain risk diversification, ERC's Effective N indicates that it has achieved its objective.

ERC is the most diversified of the three defensive portfolios, in keeping with its main objective

Exhibit 14: ERC has been the most diversified recently, LVF is the least
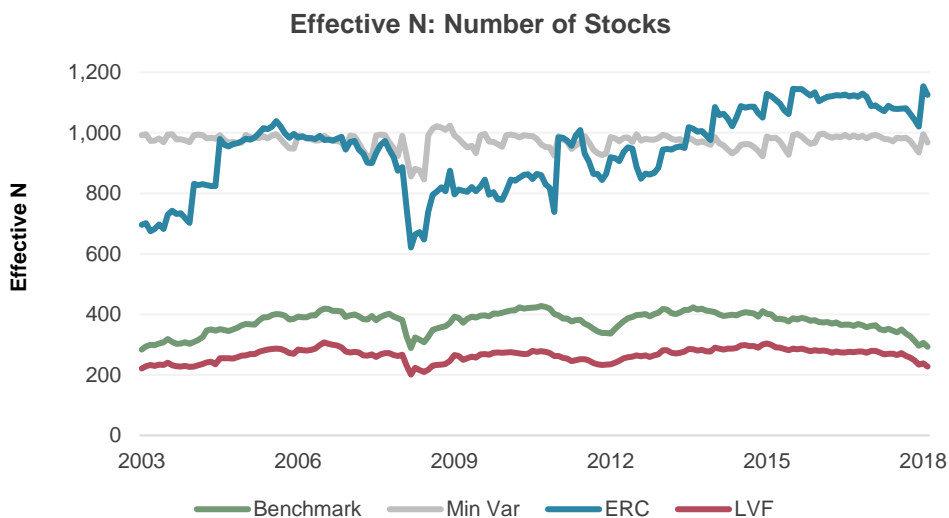
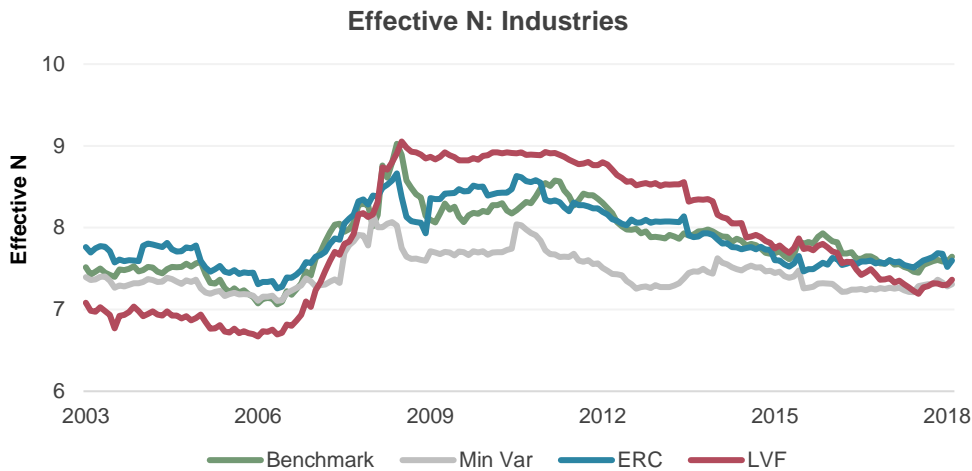**Effective N: Number of Stocks**

Source: FTSE Russell. Data from September 2003 to October 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

There are other important dimensions by which to measure diversification. In the two Exhibits below, we show the Effective N for industries and countries. There are 10 industries, so an equal-weighted industry portfolio would have the maximum Effective N of 10. Because of industry concentration, the Effective N for the three defensive portfolios tends to be less than that, although they show similar numbers.

The LVF portfolio had more industry concentration early in the period examined but is more diversified during the middle of that period. ERC has had an Effective N in line with the benchmark, while Min Var exhibited slightly lower diversification in the middle years of the period. Toward the end of the period, the numbers were quite similar for all three indexes.

Exhibit 15: Industry concentrations have converged

Effective N: Industries

The country Effective Ns may come as a surprise to some. Because of the large weight of the US, the country Effective N for the FTSE Developed Index tends to be quite low, with the LVF portfolio showing even lower numbers because of its relatively bigger tilt to the US. Both the ERC and Min Var portfolios have higher country Effective Ns, indicating more diversification across countries than the benchmark.

**Exhibit 16: ERC and Min Var are more diversified by country than LVF**
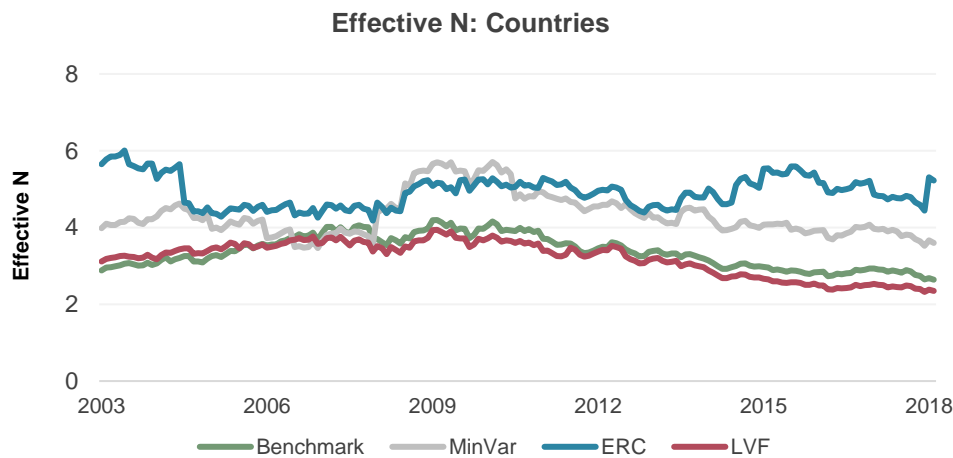
Effective N: Countries

Capacity

Exhibit 17 shows portfolio capacity ratios, which are calculated as the inverse of the portfolio weighted stock level capacity ratios. These numbers can be interpreted as a percent of the benchmark level of capacity. The benchmark portfolio is the most liquid portfolio and, by definition, has a capacity ratio of 100. LVF has very high capacity since it starts at the cap-weight and tilts towards low volatility stocks, which tend to be large-cap stocks.

**Exhibit 17: LVF is the most liquid of the three defensive portfolios**
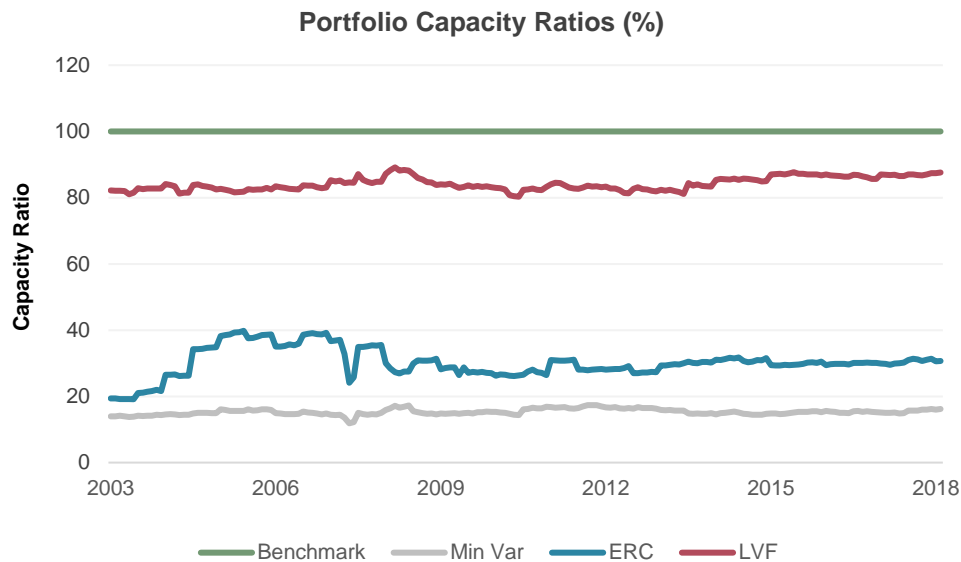
Portfolio Capacity Ratios (%)

Capacities are lower for ERC and Min Var, with ERC the higher of the two, reflecting its lower weight in the smallest stocks. This is primarily because FTSE Russell applies the ERC construction methodology only to large-cap stocks. Mid-caps and stocks with insufficient data are held at their investable market-capitalization weights (see [9]). Exhibit 18, top, shows the total index weight in different size groups of the cap-weighted index, as of the FTSE Russell March 2018 Index Review. Exhibit 18, bottom, shows the average stock weight in the comparable segment of the cap-weighted index.

The optimization-based Min Var portfolio puts more demand on the less liquid stocks at the bottom of the capitalization distribution and, thus, has a lower capacity ratio than does ERC. As expected, the LVF weight distribution sticks much closer to the benchmark distribution.

Exhibit 18: Total weight and average stock size group (March 2018)

Portfolio Weight by Size Group (%)
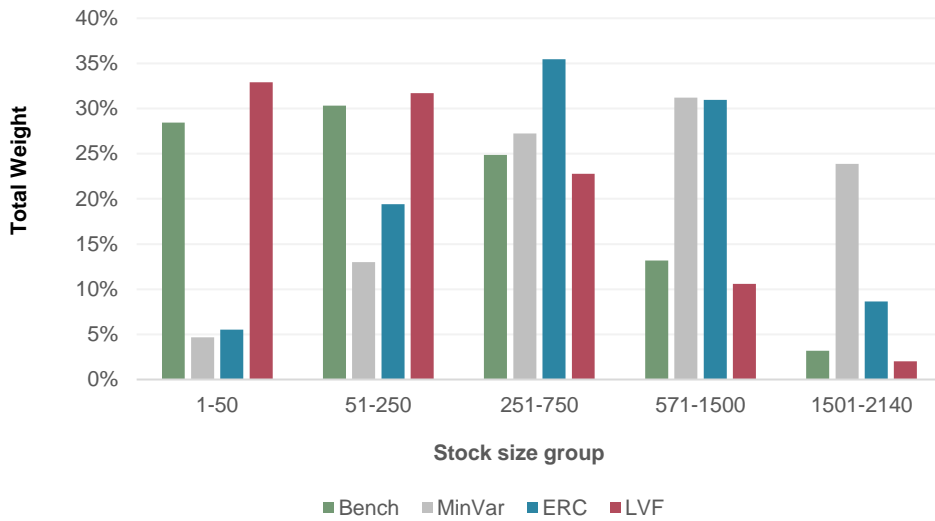
Average Stock Weight by Size Group (%)
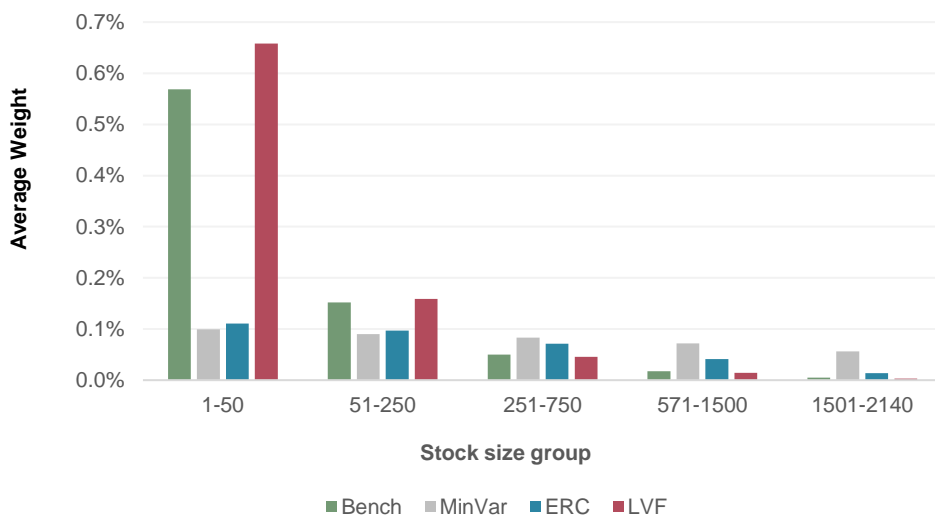
Source: FTSE Russell. Data as of March 31, 2018. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Past performance is no guarantee of future results. Please see end for important legal disclosures.

Turnover

Another index implementation characteristic to consider is turnover. Our turnover numbers are calculated as annualized two-way turnover. It should be noted that all indexes were rebalanced semi-annually (March and September) in our back-test to make the results more comparable.

LVF has a low annualized turnover, of approximately 17.6% per year.[4] For any strategy that tilts away from a cap-weighted index, most of the turnover typically arises from changes in factor score. The volatility measure used here is based on weekly returns calculated over a five-year window, which is very stable, resulting in a low turnover.

ERC's annualized turnover is also quite low, at 38.8%. In addition to changes in volatility, changes in correlations also contribute to turnover. Furthermore, the covariance matrix is calculated using two years of data. Thus, we would expect both the correlation and volatility measures to be less stable than the volatility factor used in LVF. However, the risk-balancing methodology dampens big changes in positions. At 62.8%, turnover of Min Var is higher but still not extreme.[3] In contrast to ERC, the weights in Min Var can be quite sensitive to risk estimates as it seeks to minimize the portfolio volatility.

[3] Previous research has shown that the PCA covariance estimation methodology shared by both Min Var and ERC reduces the turnover by generating a stable covariance matrix. See [6].

[4] Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Min Var, ERC and LVF data is back-tested. Please see the end for important legal disclosures.

6. Attribution

The measures examined above show that each defensive portfolio has achieved its objective over the period examined. However, we also wanted to see if these characteristics drive performance in ways that we expect. Table 5 compares the excess returns of the three defensive portfolios since September 2003, as well as the contributions to those excess returns. Country and industry effects were fairly small over this time frame, as is often the case in an attribution run over long periods. For Min Var and ERC, the factor exposure is the largest contributor, while it is negligible for LVF.

Table 5: Attribution Summary – Sept 2003 to Oct 2018

Returns (%)

	FTSE Developed	Min Var	ERC	LVF
Benchmark	9.24	---	---	---
Defensive Portfolio		11.44	9.91	9.64
Excess Return		2.20	0.67	0.40
Contribution to Excess Return (%)				
Country		-0.14	-0.41	0.13
Industry		0.41	0.06	0.25
Factor		1.99	1.14	0.01
Residual		-0.06	-0.11	0.01

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

Table 6 shows attribution details for the factors. From this we can deduce the direction of the average payoff from each factor, with Value having a negative payoff over the period, and the other four factors producing the expected positive payoff.

Active exposures and contributions are quite small for Value, Momentum, and Quality. The Size factor has had the largest impact for Min Var and ERC, both of which had a large active Size exposure. LVF on the other hand, had a negative Size exposure (reflecting its large-cap tendency, as shown earlier) and so had a negative contribution from Size.

The average active exposures to Volatility align with the time-series in Exhibit 1. LVF shows the highest exposure and, thus, the highest contribution from Volatility, while ERC shows a slightly negative exposure and contribution from this factor.

All three portfolios have posted excess returns, but contributors differed

Table 6: Factor detail attribution summary − Sept 2003 to Oct 2018

Factor	Average Active Exposure			Contribution		
	Min Var	ERC	LVF	Min Var	ERC	LVF
Value	0.01	0.03	0.01	-0.04	-0.01	-0.03
Momentum	-0.03	-0.04	-0.02	-0.36	-0.11	-0.23
Size	1.23	0.71	-0.13	2.14	1.22	-0.20
Quality	0.13	0.06	0.08	0.13	0.06	0.01
Volatility	0.21	-0.01	0.38	0.16	-0.03	0.40

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

Drawdown episodes

The statistics examined so far are averages over long periods of time. A more granular perspective can be gained by examining periods of significant broad market downturns.[4] The table below shows returns for each defensive portfolio and the share of the benchmark (the FTSE Developed) drawdown they exhibited. This analysis reinforces our previous conclusion that Min Var offers significant protection in down markets.

Table 7: Drawdown episodes

	Returns (%)				Share of Drawdown		
	FTSE Developed	Min Var	ERC	LVF	Min Var	ERC	LVF
Nov 2007−Mar 2008 Global Financial Crisis	-12.7	-10.3	-11.8	-11.2	81%	93%	88%
Jun 2008−Feb 2009 Lehman Collapse	-49.0	-36.1	-44.1	-45.1	74%	90%	92%
Mar 2011−Dec 2011 European Credit Crisis	-13.9	-5.5	-12.2	-8.2	40%	88%	59%
Aug 2015−Jan 2016 China Growth Scare	-13.5	-8.6	-13.1	-11.6	63%	97%	85%

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

A close look at these episodes is instructive because it highlights the effects of differences in portfolio construction. A detailed performance attribution summary for these episodes is provided in the Appendix on page 26. For example, the first episode coincides with the global financial crisis sell-offs from November 2007 to March 2008, when all three defensive portfolios provided relatively small reductions in volatility. Although they all benefited from industry diversification

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[4] We looked at rolling six-month returns and found episodes when the benchmark was down more than 10% and then adjusted the period to include all of the negative months around that episode.

(for example, underweights to Technology and overweights to Utilities), Min Var and LVF held up better than ERC. This was mainly because of their positive exposure to the (low) Volatility factor, whereas ERC had negative exposure.

In the second episode (the Lehman collapse), ERC was helped by its country diversification (for example, the overweight to Japan, which performed relatively well during that period). However, once again, ERC was underexposed to (low) Volatility, whereas Min Var and LVF were overweight. Moreover, exposures to (small) Size, which also performed well during part of this period, helped Min Var and ERC, but hurt LVF.

In the 2011 downdraft, Min Var and LVF benefited considerably from their Volatility exposures but ERC had only a slightly positive active weight to the factor. ERC was also hurt by its sizable overweight to Japan and underweight to the US. Similar to the previous episode, Min Var's exposure to Size and Volatility contributed considerable downside protection during that episode, as well as to ERC's more modest drawdowns.

During the 2015 episode, ERC once again benefited from its underexposure to (low) Volatility. Size, on the other hand, benefited Min Var and ERC but hurt LVF. Again, ERC held large active weights in Japan and the US, which detracted from performance.

These outcomes underscore the point that the different construction methodologies of each index can produce very different exposures that, in turn, result in very different performance patterns.

7. Balancing considerations

Min Var

The objective of the Min Var approach is to reduce the portfolio volatility through optimization with constraints to ensure diversification. The optimization results in a highly diversified portfolio and volatility is significantly reduced despite the constraints. The optimization naturally results in positive active exposures to (small) Size and (low) Volatility factors, while it has the side-effect of a relatively low level of capacity.

ERC

The objective of ERC is risk diversification. As we have shown, the ERC portfolio construction methodology results in a diversified portfolio, as evidence by its large Effective Ns. By balancing risk across large-cap stocks that have similar risk profiles, ERC is underweight the mega-caps and overweight the smaller large caps, giving it an active (small) Size exposure, which has been beneficial to performance over the period examined. However, other factor exposures are negligible and do not contribute significantly to performance.

Low Volatility Factor

The LVF approach seeks to take advantage of the low volatility anomaly by increasing exposure to the low-volatility factor. As such, it is the only approach of the three that tilts away from the benchmark, and so has considerable capacity. However, because the low Volatility factor is highly correlated with large-cap stocks, the portfolio ends up with less (small) Size exposure and is more concentrated than the benchmark. Of course, the Size exposure can be specifically controlled in the factor Tilt framework.

One difference with the LVF approach is that investors can set specific parameters for its factor exposures. In other words, while Min Var provides the lowest volatility (given constraints) and ERC offers the most risk-balanced portfolio, LVF's exposure to Volatility can be adjusted depending on the investment risk/return objectives. Table 8 shows statistics for five different LVF portfolios as Volatility exposures (or tilts) increase,[5] which is accompanied by a small increase in active Size exposure. However, the extra exposure comes at a cost of increased concentration and lower capacity.

All three approaches fulfilled their main objective but it's important to understand the reasons why

Table 8: Low Volatility Factor active exposures, with variable tilts

	Benchmark	Tilt 1	Tilt 2	Tilt 3	Tilt 4	Tilt 5
Active Volatility Exposure	--	0.37	0.52	0.62	0.69	0.75
Active Size Exposure	--	-0.13	-0.19	-0.23	-0.25	-0.27
Diversification	374.9	265.1	214.5	182.1	158.8	140.9
Capacity	100.0	84.2	71.6	62.1	54.7	48.8

Source: FTSE Russell. Data from September 2003 to October 2018. LVF results based on back-tested data. Data based on the FTSE Developed Index Universe. Please see end for important legal disclosures.

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[5] This is done by increasing the exponent: 1, 2, 3, 4, 5.

At moderate levels of factor exposure, the LVF portfolio is well diversified and there is a nearly linear relationship between excess return and tracking error, which generates a stable information ratio as tracking error increases. In this case, the IR is given but investors can choose the level of active risk they want. However, there is a limit to how much exposure a portfolio can obtain to any specific factor without becoming overly concentrated and overwhelmed by idiosyncratic outcomes. Portfolios targeting higher exposures would also be difficult to implement.

Table 9: Low Volatility factor performance, with variable tilts

	Tilt 1	Tilt 2	Tilt 3	Tilt 4	Tilt 5
Geometric Excess Return % p.a.	0.66	0.92	1.05	1.15	1.22
Tracking Error % p.a.	2.30	3.42	4.20	4.80	5.29
Information Ratio (IR)	0.29	0.27	0.25	0.24	0.23

Source: FTSE Russell. Data from September 2003 to October 2018. Past performance is no guarantee of future results. Data based on the FTSE Developed Index Universe. Min Var, ERC and LVF results based on back-tested data. Please see the end for important legal disclosures.

Conclusion

Defensive strategies can play an important role in a portfolio. Frequently, however, there is confusion about exactly what that role should be. It is important for investors to think frankly and specifically about their portfolio goals and risk tolerances. In this report, we examined three popular defensive strategies: Low Volatility Factor, Minimum Variance and Equal Risk Contribution.

We showed that despite some similarities, the strategies have very different objectives, which have resulted in very different index construction methodologies. While our analysis shows that each portfolio has met its primary objectives, it also revealed some secondary effects that investors need to consider.

In particular, although LVF meets the objective of return enhancement because of its exposure to the (low) Volatility factor, it does so only by tilting into low-volatility stocks. From this standpoint, LVF can be considered a standard factor investment approach and may be best combined with other return-enhancing factors along with appropriate diversification control. In particular, in a multi-factor index context, FTSE Russell's Tilt framework can achieve any desired Size exposure if that is also an objective.

While ERC also achieves its objective of diversification, its main drawback is that it does not accomplish much more than that. It has little exposure to the other return-enhancing factors. And, even though its diversification helps to reduce volatility marginally, its volatility reduction and downside protection are modest.

Table 10: Strategy benefits and drawbacks

	LVF	Min Var	ERC
Primary benefit	Return enhancement	Volatility reduction	Diversification
Secondary benefits		Diversification and return enhancement	
Secondary drawbacks	Concentration	Lower capacity	

Source: FTSE Russell based on past performance. Please see the end for important legal disclosures.

Min Var, on the other hand, has achieved its primary objective of volatility reduction while also enjoying the benefits of increased diversification and significant exposure to the return-enhancing Volatility factor, as well as the (small) Size factor. Furthermore, Min Var's objective of reducing portfolio volatility sits squarely in the category of defensive strategies in that it protects the portfolio from adverse market shocks.

References

[1] Implementation considerations for factor investing. FTSE Russell. March 2018.

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[3] Low Volatility or Minimum Variance. FTSE Russell. September 2015.

[4] Black, F. "Capital Market Equilibrium with Restricted Borrowing." Journal of Business, Vol. 45, No. 3, pp 444-455, 1972.

[5] Haugen, R., and J. Heins. "On the Evidence Supporting the Existence of Risk Premiums in the Capital Market", Wisconsin Working Paper, 1972.
(SRN: https://ssrn.com/abstract=1783797)

[6] Ground Rules: FTSE Global Minimum Variance Index Series. January 2018.

[7] Ground Rules: FTSE Global Equal Risk Contribution Index Series. June 2017.

[8] Ground Rules: FTSE Global Factor Index Series. November 2018.

[9] FTSE Research White Paper. FTSE Global Equal Risk Contribution Index Series.

Appendix. Performance attribution; contribution to excess return, by episode.

	Nov 2007−Mar 2008			Jun 2008−2009			Mar 2011-Dec2011			Aug 2015−Jan2016		
	Min Var	ERC	LVF	Min Var	ERC	LVF	Min Var	ERC	LVF	Min Var	ERC	LVF
Value	0.01	0.02	-0.06	0.06	-0.05	-0.16	-0.10	-0.01	-0.08	0.03	-0.07	0.00
Momentum	-0.15	-0.05	-0.03	-0.70	-0.43	-0.23	-0.35	-0.55	-0.08	0.01	0.00	-0.17
Size	0.01	0.01	-0.01	6.47	3.65	-0.86	1.28	0.71	-0.14	0.93	0.53	-0.11
Quality	0.09	0.07	-0.02	0.82	0.24	0.29	0.81	0.49	0.40	0.02	0.00	0.05
Volatility	0.67	-0.24	1.81	2.15	-1.73	6.41	3.09	0.07	5.13	0.40	-1.06	2.37
Total Factors	**0.63**	**-0.20**	**1.68**	**8.79**	**1.68**	**5.46**	**4.73**	**0.70**	**5.23**	**1.40**	**-0.59**	**2.13**
Oil & Gas	-0.28	-0.19	0.05	-0.10	-0.19	0.01	0.14	0.13	-0.01	0.15	0.06	0.01
Basic Materials	-0.25	-0.06	-0.08	0.48	0.16	0.30	0.12	0.01	0.12	0.01	-0.07	0.07
Industrials	0.00	-0.01	0.00	-0.02	-0.32	0.06	0.06	-0.02	0.03	0.02	0.01	0.00
Consumer Goods	0.22	0.06	0.07	0.08	0.02	0.03	0.17	0.09	0.09	0.09	0.03	0.03
Health Care	0.00	0.00	0.00	1.33	0.28	0.43	0.43	0.07	0.25	0.15	0.14	-0.02
Consumer Services	0.09	0.05	0.00	0.74	0.43	0.05	0.35	0.17	0.04	0.04	0.01	0.00
Telecommunications	0.06	0.05	0.01	-0.09	-0.05	0.09	0.02	0.01	0.02	0.00	0.01	0.02
Utilities	0.25	0.16	0.06	0.13	0.13	0.04	-0.02	0.01	-0.01	0.27	0.17	0.04
Financials	0.23	0.10	-0.05	1.77	0.95	0.45	0.28	0.19	0.19	0.04	0.02	0.03
Technology	0.11	0.09	0.10	-0.28	-0.32	-0.18	-0.06	-0.02	-0.01	-0.22	-0.20	-0.07
Total Industry	**0.42**	**0.26**	**0.16**	**4.04**	**1.08**	**1.29**	**1.50**	**0.63**	**0.71**	**0.55**	**0.20**	**0.12**
AU	-0.23	-0.23	-0.06	-0.08	-0.19	-0.02	0.02	0.00	0.00	-0.06	-0.14	-0.03
BELG	0.01	0.01	0.00	-0.13	-0.08	-0.02	0.00	0.00	0.00	0.00	0.00	-0.01
CAN	0.01	0.00	0.00	0.00	0.02	0.01	-0.08	0.00	0.00	0.07	-0.04	-0.06
CHN	-0.01	-0.05	0.04	0.05	0.06	-0.04	-0.01	-0.01	0.00	0.00	0.00	0.00
DEN	0.00	0.00	0.00	-0.01	0.00	0.01	-0.03	0.02	0.00	0.00	0.00	0.00
FIN	0.03	0.02	0.02	0.10	0.06	0.05	0.06	0.01	0.01	-0.01	0.01	-0.02
FRA	0.08	0.05	0.01	0.15	0.11	-0.02	0.37	0.27	-0.04	0.02	0.00	0.01
GER	0.01	0.01	0.00	0.10	0.06	0.00	0.19	0.14	0.05	0.03	0.01	0.01
GRC	-0.01	0.00	0.00	-0.16	-0.02	0.02	-0.14	0.00	0.02	0.01	0.00	0.01
HK	-0.41	-0.27	0.01	0.74	0.53	-0.04	-0.06	-0.10	0.01	-0.17	-0.16	0.01
IRE	-0.01	0.00	0.00	0.01	-0.01	0.02	0.02	0.00	-0.01	0.02	0.01	0.00
ISR	0.00	0.00	0.00	0.16	0.13	0.00	-0.22	-0.10	-0.01	0.12	0.06	0.00
ITA	0.01	0.02	-0.02	-0.08	0.03	-0.07	0.13	0.06	-0.01	-0.01	0.00	0.00
JA	0.34	0.38	-0.11	1.18	2.73	-0.53	-0.13	-0.50	0.01	0.32	0.48	-0.16
KOR	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.19	-0.07	0.39	0.35	-0.04
NETH	-0.01	0.00	0.00	0.12	0.08	0.02	0.05	0.04	0.01	0.02	0.00	0.00
NOR	0.01	0.00	0.00	0.10	-0.02	0.03	-0.02	0.00	-0.01	0.02	-0.01	0.00
NZ	-0.06	-0.02	0.00	-0.21	-0.04	0.00	0.01	0.00	0.00	0.12	0.01	0.00
OEST	-0.02	-0.01	0.00	-0.15	-0.04	0.02	0.00	-0.01	0.02	0.00	0.00	0.00
POL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PTL	-0.02	-0.01	0.00	-0.15	-0.04	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00
SI	-0.06	-0.03	0.00	-0.10	-0.06	0.01	-0.04	-0.01	0.00	-0.39	-0.32	-0.02
SP	-0.04	-0.03	0.02	0.09	0.07	-0.05	0.13	0.08	-0.01	0.08	0.00	0.03
SWED	0.05	0.00	0.01	0.09	-0.01	0.01	0.08	0.02	0.01	0.06	-0.02	0.00
SWIT	-0.05	-0.04	0.01	0.02	0.00	0.01	0.04	0.06	-0.02	0.00	0.04	-0.02
UK	0.40	0.31	-0.10	0.40	0.32	-0.07	-0.03	-0.03	0.00	0.33	0.18	-0.04
USA	-0.01	-0.14	0.05	0.21	-0.03	0.13	-0.40	-0.63	0.11	-0.18	-0.33	0.06
Total Country	**0.02**	**-0.03**	**-0.13**	**2.46**	**3.65**	**-0.55**	**0.26**	**-0.50**	**0.08**	**0.80**	**0.14**	**-0.28**
Total	**1.08**	**0.03**	**1.72**	**15.30**	**6.41**	**6.19**	**6.49**	**0.84**	**6.02**	**2.75**	**-0.26**	**1.97**

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