S&P Dow Jones Indices

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Inside Low Volatility Indices

Since their launch in mid-2011, low volatility and minimum volatility indices have been written about extensively in financial literature, and their index-linked investment vehicles have grown to track a significant amount of assets. The widespread adoption of the strategies by retail and institutional market participants to gain exposure to the low volatility factor indicates that low-risk investing is here to stay. Against that backdrop, it is important that market participants understand the fundamental differences between the two established forms of low-risk index construction: rankings based versus optimization based.

As a leading provider of factor indices, S&P Dow Jones Indices (S&P DJI) publishes both forms of low volatility indices for the domestic large-cap universe, as represented by the S&P 500. While both indices have historically outperformed the underlying S&P 500 universe with lower realized volatility over a long-term investment horizon[1], the two have little else in common. We note that there are meaningful differences regarding their risk/return profiles, sector composition, and factor exposures, and we highlight these differences using the S&P 500 Low Volatility Index and the S&P 500 Minimum Volatility Index to represent the two types of low volatility strategies. As such, this paper is meant to serve as a practical guide for market participants who are looking to understand the impact of index construction differences.

Index Mechanics

Numerous academic studies and previous research from S&P DJI have established that over a long-term investment horizon, both low volatility methodology types were effective at reducing overall portfolio volatility. However, there are significant differences in how the two strategies are constructed. Exhibit 1 shows the construction behind the two indices.

[1] The historical performance shown for the S&P 500 Low Volatility Index and the S&P 500 Minimum Volatility Index is from Dec. 31, 1990, to Dec. 30, 2016. The S&P 500 Low Volatility Index was launched on April 4, 2011, and the S&P 500 Minimum Volatility Index was launched on Nov. 9, 2012. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 1: Different Approaches to Constructing Low Volatility Indices

CATEGORY	S&P 500 LOW VOLATILITY INDEX	S&P 500 MINIMUM VOLATILITY INDEX
Portfolio Construction	Rankings based on past volatility measure (standard deviation)	Mean variance optimized through the estimation of covariance matrix of stock returns
Complexity	Low	High
Underlying Universe	S&P 500	S&P 500
Stock Weight Constraint	None; however, based on index history, the maximum stock weight rarely breaches 3%	Max weight: the lower of 20 times the stock's weight in the S&P 500 or 2% Min weight: 0.05%
Sector Weight Constraint	None	±5% of the benchmark sector weight
Factor Exposure Constraint	None	±0.25 standard deviation of benchmark exposure to all factors (excluding price volatility)[2]
Number of Securities	100	Floating; average of 108 at rebalancing
Turnover	No constraint; average annual two-way turnover of 60%	Maximum 20% two-way turnover at each rebalance (40% per year); relaxed to 30% in infeasible cases
Rebalancing Frequency	Quarterly	Semiannual

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

Since their inception, the S&P 500 Low Volatility Index and S&P 500 Minimum Volatility Index have achieved higher absolute returns than the S&P 500.

Risk/Return Properties

The main objective of low volatility indices is to deliver higher risk-adjusted returns than a market-cap-weighted broad benchmark over a long-term investment horizon. Since their inception, the S&P 500 Low Volatility Index and S&P 500 Minimum Volatility Index have achieved higher absolute returns than the S&P 500 (see Exhibits 2 and 3). They achieved this relative outperformance while also exhibiting lower volatility; from 1991 to 2016, the S&P 500 Low Volatility Index and the S&P 500 Minimum Volatility Index delivered annualized volatility reductions of approximately 23% and 18%, respectively, against the S&P 500.[3]

The tracking error and information ratio (IR) figures help to give additional insight on the active risk taken on by the low-risk strategies to achieve their stated goals of higher risk-adjusted returns over the benchmark. Compared with the optimized minimum volatility strategy, the rankings-based low volatility index had a higher tracking error to the S&P 500 throughout all time periods (see Exhibit 4). However, when viewed on a stand-alone basis, tracking error figures reveal little about the risk efficiency of a strategy. The IR, calculated by dividing the excess returns by the volatility of those excess returns, evaluates the consistency with which a strategy is able to add value over the benchmark. All else being equal, a strategy with a higher IR is preferable.

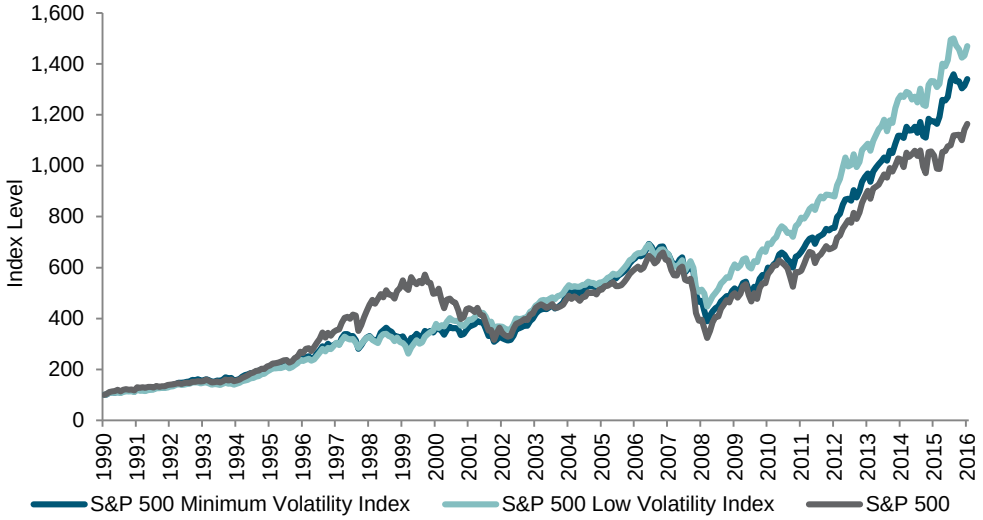
[2] The S&P 500 Minimum Volatility Index is constructed using the Northfield Portfolio Optimizer and the Northfield U.S. Fundamental Equity Risk Model. This is a multi-factor risk model designed to help control the portfolio's exposure to endogenous factors. It is a relaxed capital asset pricing model (CAPM) construct; while acknowledging the importance of beta in measuring the risk of a portfolio, it also acknowledges that certain groups of securities have covariance that are not related to CAPM beta. The model is based on 67 factors: beta, 11 fundamental characteristics, and 55 industry groups.

[3] See Exhibit 4: Risk/Return Profile.

Against that backdrop, when viewed over the near- to mid-term horizons, the optimized low-risk strategy has a higher IR. However, when measured over the longer-term investment horizons (20 years and since inception), the low volatility strategy has a higher IR. Given that a benchmark's IR is zero and we can observe that both indices have positive IRs, the active risk taken by both strategies can be justified by the active return achieved.

When viewed over the near- to mid-term horizons, the optimized low-risk strategy has a higher IR.

Exhibit 2: Cumulative Returns



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Index performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 3: Calendar Year Returns

YEAR	S&P 500 MINIMUM VOLATILITY INDEX (%)	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)	YEAR	S&P 500 MINIMUM VOLATILITY INDEX (%)	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)
1991	22.5	21.7	30.5	2004	21.3	17.7	10.9
1992	11.8	9.3	7.6	2005	5.5	2.2	4.9
1993	15.2	10.9	10.1	2006	19.1	19.7	15.8
1994	1.0	-2.6	1.3	2007	2.4	0.6	5.5
1995	31.1	38.2	37.6	2008	-28.0	-21.4	-37.0
1996	15.8	17.5	23.0	2009	10.6	19.2	26.5
1997	25.1	30.4	33.4	2010	15.7	13.4	15.1
1998	9.3	8.1	28.6	2011	10.2	14.8	2.1
1999	-0.4	-7.8	21.0	2012	14.3	10.3	16.0
2000	8.8	25.0	-9.1	2013	28.1	23.6	32.4
2001	2.5	4.4	-11.9	2014	15.3	17.5	13.7
2002	-12.2	-7.2	-22.1	2015	5.0	4.3	1.4
2003	29.3	22.8	28.7	2016	14.2	10.4	12.0

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Index performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 4: Risk/Return Profiles

PERIOD	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX	S&P 500
ANNUALIZED RETURN (%)			
1-Year	14.16	10.37	11.96
3-Year	11.41	10.60	8.87
5-Year	15.15	13.02	14.66
10-Year	7.73	8.50	6.95
15-Year	9.01	9.13	6.69
20-Year	8.93	9.63	7.68
26-Year	10.50	10.89	9.90
ANNUALIZED VOLATILITY (%)			
3-Year	8.86	9.50	10.74
5-Year	8.49	9.21	10.37
10-Year	12.15	11.23	15.28
15-Year	11.47	10.30	14.35
20-Year	12.30	11.50	15.29
26-Year	11.77	10.97	14.29
RETURN/RISK			
3-Year	1.29	1.12	0.83
5-Year	1.79	1.41	1.41
10-Year	0.64	0.76	0.45
15-Year	0.78	0.89	0.47
20-Year	0.73	0.84	0.50
26-Year	0.89	0.99	0.69
TRACKING ERROR (%)			
3-Year	5.66	6.98	-
5-Year	5.00	7.37	-
10-Year	6.03	8.18	-
15-Year	5.77	7.86	-
20-Year	7.53	10.52	-
26-Year	6.93	9.47	-
IR (%)			
3-Year	0.45	0.25	-
5-Year	0.10	-0.22	-
10-Year	0.13	0.19	-
15-Year	0.40	0.31	-
20-Year	0.17	0.19	-
26-Year	0.09	0.10	-

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Index performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The findings suggest that low volatility strategies can potentially help market participants avoid large drawdowns.

Exhibit 5 shows the three worst drawdowns of the S&P 500 from Dec. 31, 1990, to Dec. 30, 2016, along with the corresponding returns of the low-risk indices during the same periods. In all three scenarios, the low-risk indices managed drawdown risk better than the broad market, producing lower drawdown levels. The findings suggest that low volatility strategies can potentially help market participants avoid large drawdowns. In all three scenarios, the rankings-based low volatility strategy maintained the lowest drawdown levels, which may not be surprising, given that the S&P 500 Low Volatility Index had a lower beta[4] to the benchmark than its minimum volatility counterpart.

The peak-to-recovery performance gives a clear understanding of the cumulative impact that the downturn had on the S&P 500 versus the low volatility indices.

To fully understand the implications that drawdown has on historical portfolio performance, it is useful to compare the peak-to-recovery performance. In Exhibit 5, the peak-to-recovery period is defined as when the S&P 500 was able to gain back all the losses from the drawdown period (thus approximately 0% return). Given that a low-risk strategy is typically affected less during a downturn, less positive performance is needed to recover losses.

During the financial crisis from 2007 to 2009, both types of low-risk strategies outperformed the S&P 500 during the drawdown and the peak-to-recovery periods. We can also observe the strong outperformance of the low volatility strategies during the tech bust in the early 2000s. The peak-to-recovery performance gives a clear understanding of the cumulative impact that the downturn had on the S&P 500 versus the low volatility indices; the S&P 500 Minimum Volatility Index had an outperformance of over 75% and the S&P 500 Low Volatility Index had an outperformance of over 90%.

Exhibit 5: Three Worst Drawdowns of the S&P 500

CATEGORY	MAXIMUM DRAWDOWN (OCT. 9, 2007-MARCH 9, 2009)	SECOND LARGEST DRAWDOWN (SEPT. 1, 2000-OCT. 9, 2002)	THIRD LARGEST DRAWDOWN (JULY 17, 1998-AUG. 31, 1998)
S&P 500 Return (%)	-55.25	-47.41	-19.19
S&P 500 Minimum Volatility Index Return (%)	-48.83	-17.09	-15.18
Excess Return Versus S&P 500 (%)	6.42	30.32	4.01
S&P 500 Minimum Volatility Index Peak-to-Recovery Return (%)	2.86	75.45	-0.28
S&P 500 Low Volatility Index Return (%)	-39.61	2.39	-10.94
Excess Return Versus S&P 500 (%)	15.64	49.80	8.24
S&P 500 Low Volatility Index Return Peak-to-Recovery Return (%)	21.61	90.72	3.39

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Index performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

[4] The historical rolling 12-month beta from Dec. 31, 1990, to Dec. 30, 2016, to the S&P 500 was 0.77 for the S&P 500 Minimum Volatility Index and 0.64 for the S&P 500 Low Volatility Index.

In our previous research, we have documented the asymmetric risk/return property of low volatility strategies (Soe 2012). Although low volatility strategies tend to outperform their benchmarks with lower risk over the long term, their behavior in different market environments over the short term can vary greatly.

The two low-risk strategies outperformed the benchmark approximately 78% to 82% of the time when market returns were negative.

On average, the low volatility strategies outperformed the benchmark in 50% to 52% of the months studied in our analysis (see Exhibit 6). The strategies tended to outperform less frequently when the market trended upward. This pattern reversed when the market faced headwinds. The two low-risk strategies outperformed the benchmark approximately 78% to 82% of the time when market returns were negative. This asymmetric response to market movements highlights the ability of low volatility strategies to provide downside protection in uncertain times.

The strategies underperformed on average by 0.59% to 0.90% during up-market periods. The results indicate that the low volatility strategies did not participate fully in up markets and lagged benchmark returns. An opposite pattern emerged during down markets, where the strategies outperformed by 1.2% to 1.8%. Taken together with the results shown in Exhibit 6, it can be noted that low volatility strategies possess asymmetric risk/return profiles: they outperform the market more frequently and with larger magnitude when it is down.

Exhibit 6: Hit Rate and Average Monthly Excess Returns

HIT RATE: PERCENTAGE OF MONTHS LOW VOLATILITY STRATEGIES OUTPERFORMED THE BENCHMARK

PERIOD	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX
All Months	51.92	49.68
Up Months	38.24	32.35
Down Months	77.78	82.41

AVERAGE MONTHLY EXCESS RETURN OF LOW VOLATILITY STRATEGIES OVER THE BENCHMARK (%)

PERIOD	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX
All Months	0.018	0.040
Up Months	-0.592	-0.899
Down Months	1.170	1.814

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Index performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Sector Composition

Much has been written about the potential sector composition differences of low volatility indices that stem from their varying index constructions. A rankings-based low volatility approach, such as the one used by the S&P 500 Low Volatility Index, simply selects a specified number of the least-volatile securities at each rebalance, without any constraint on sector weight. On the other hand, a minimum-variance, optimization-based approach, such as the one employed by the S&P 500 Minimum Volatility Index, typically places sector weight constraints on the portfolio. This is due to the fact that in the absence of sector constraints, optimizers can potentially result in unrepresentative portfolios with an extreme concentration in a single stock or sector (Soe 2012).

We can conclude that rankings-based, low-risk strategies tend to exhibit a fair degree of overweight in defensive sectors, such as consumer staples, telecommunication services, and utilities.

Blitz and van Vliet (2011) described the large number of assumptions made (including sector weights) when determining what constraints to use in an optimizer-based minimum variance. Additionally, they pointed out that the turnover constraint in the optimization-based approach creates a path dependency in the portfolios, as the composition in the future depends on the composition in the past. A possible result is that the optimizer may not be able to use the pure optimized sector weights, due to the limit of how much weight can be turned over.

In order to understand the potential sector biases and active sector exposures of low-risk strategies, it is important to first highlight the volatility factor exposure of 10 GICS® sectors of the S&P 500. Exhibit 7 shows the average factor exposure of the large-cap sectors to the volatility factor, using the Northfield U.S. Fundamental Risk Model.[5] Historically, we can see that consumer staples had the lowest average active exposure to the price volatility factor, followed by telecommunications services, health care, and utilities, while information technology had the highest active exposure. Based on the data, we can conclude that rankings-based, low-risk strategies could be expected to exhibit a fair degree of overweight in defensive sectors, such as consumer staples, telecommunication services, and utilities.

[5] Positive values indicate that the sector has positive exposure to the price volatility factor. The higher the value, the more exposure the sector has to price volatility.

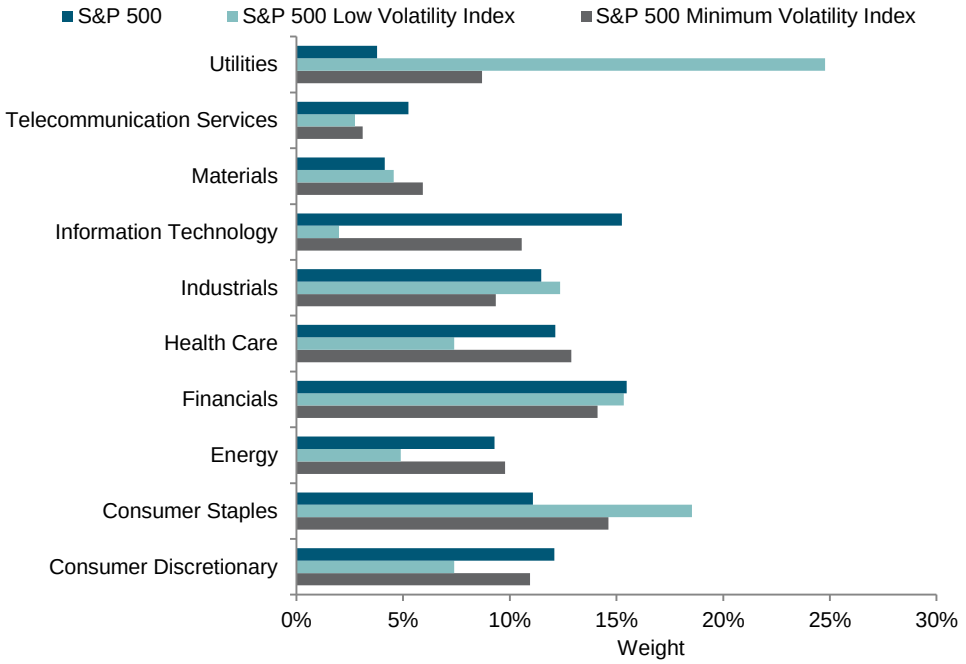
Exhibit 7: Large-Cap U.S. Sectors and Their Average Exposure to Volatility Factor	
SECTOR	**EXPOSURE**
Consumer Staples	-0.360
Telecommunication Services	-0.191
Utilities	-0.139
Energy	-0.118
Industrials	-0.096
Health Care	-0.092
Financials	0.017
Materials	0.045
Consumer Discretionary	0.079
Information Technology	0.404

Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1990, to Dec. 30, 2016. Table is provided for illustrative purposes.

Accordingly, a review of the average historical sector weights across 10 GICS sectors (see Exhibit 8) shows that on average, both low volatility indices are overweight in defensive sectors such as utilities and consumer staples but underweight in cyclical sectors such as information technology and consumer discretionary. In particular, utilities was the largest historical active overweight sector for the rankings-based low volatility index. The significant historical active overweight in utilities may cause concern for market participants who have specific band constraints for active sector bets.

Both low volatility indices are overweight in defensive sectors such as utilities and consumer staples but underweight in cyclical sectors such as information technology and consumer discretionary.

Exhibit 8: Average Historical Sector Weights Comparison



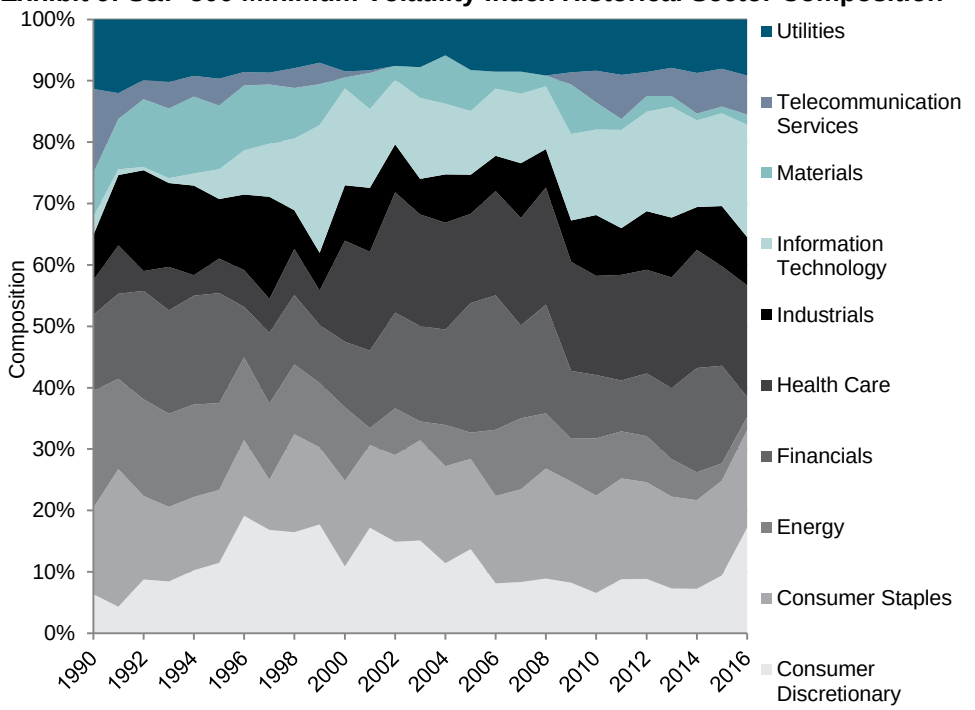
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Chart is provided for illustrative purposes.

Exhibits 9 and 10 show the historical sector compositions of the S&P 500 Minimum Volatility Index and the S&P 500 Low Volatility Index. The charts convey the dynamic selection process for the S&P 500 Low Volatility Index, in which sector weights adjust quickly to market changes. In particular, it is worth noting that the rankings-based approach has been successful in avoiding thematic bubbles, as highlighted by the weight of the information technology sector prior to the tech bubble crash in the early 2000s, as well as the weight of the financials sector leading up to the 2008 financial crisis.[6]

The S&P 500 Minimum Volatility Index maintains a much tighter sector exposure relative to the underlying benchmark by keeping its sector weights within 5% over or under the corresponding sector weights in the S&P 500.

On the other hand, the S&P 500 Minimum Volatility Index maintains a much tighter sector exposure relative to the underlying benchmark by keeping its sector weights within 5% over or under the corresponding sector weights in the S&P 500. Tighter sector constraints mean that the strategy does not take on big active sector bets, bringing the minimum variance portfolio closer to the market-cap-weighted benchmark.

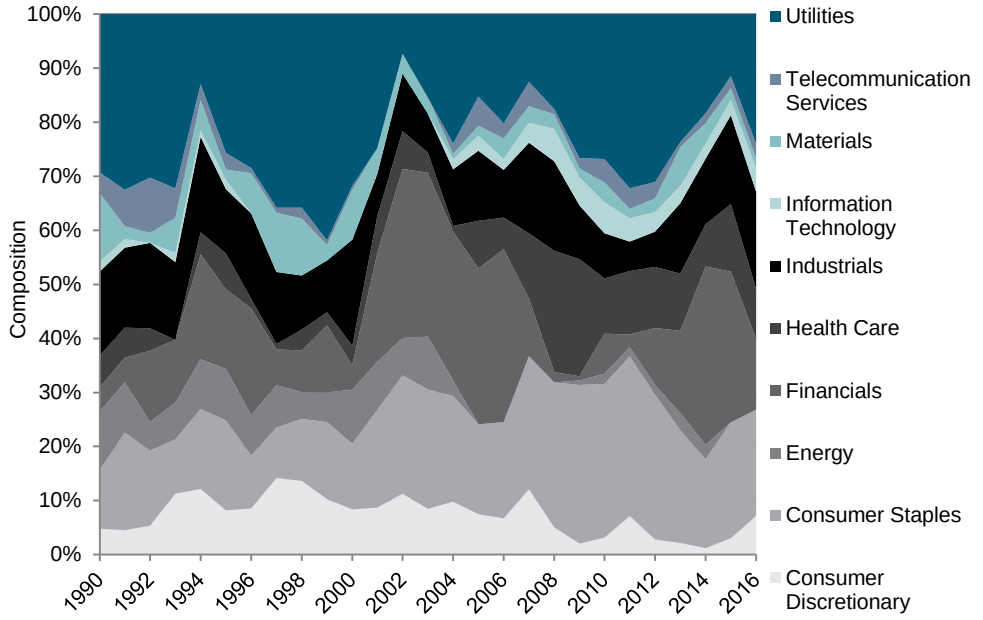
Exhibit 9: S&P 500 Minimum Volatility Index Historical Sector Composition



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Chart is provided for illustrative purposes.

[6] Sector analysis shows that the S&P 500 Low Volatility Index maintained zero or minimal weight in the information technology sector. In contrast, the S&P 500 had as much as 28.5% in the sector at the peak of the bubble. Similarly, in the months prior to the collapse of Lehman Brothers and the credit market crisis of 2008, the S&P 500 Low Volatility Index had considerably lower exposure to the financials sector. As of the July 2008 rebalance, the weight of the financials sector in the S&P 500 Low Volatility Index was 3.5%, compared with the S&P 500's financials sector weight of 15.11%.

Exhibit 10: S&P 500 Low Volatility Index Historical Sector Composition



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 30, 2016. Chart is provided for illustrative purposes.

Performance attribution attempts to explain the sources of a portfolio's performance relative to its benchmark over a specified period of time.

Performance Attribution

Given that the two strategies can differ significantly in their sector composition, we studied whether sector allocation differences contribute to the performance differential between the two strategies. Performance attribution attempts to explain the sources of a portfolio's performance relative to its benchmark over a specified period of time. Using the multi-period Brinson Attribution Model, we broke down the sources of low volatility indices' excess returns relative to the S&P 500.

Using the total returns of all three indices from December 1990 to December 2016, we divided the analysis into three sub periods and reported the average annual effect for each of the three performance attribution components (see Exhibit 11).[7] By evaluating the indices in this framework, we looked to understand whether a particular effect contributes positively or negatively to excess returns.

Both strategies underperformed the benchmark when measured from 1991 to 2000, with the optimization-based strategy faring worse by approximately 88 bps per year on average. We can see that both allocation and selection effects detracted from relative performance for both strategies. It should be noted that the rankings-based strategy had higher sector bets than the

[7] The three components of performance attribution are: allocation effect, selection effect, and interaction effect. The last two effects are often combined and presented together. The allocation effect is the portion of a strategy's excess return attributable to the over- or underweighting of securities in a particular grouping (country, sector, beta, etc.) relative to the benchmark. The selection effect is the portion of a strategy's excess return attributable to selecting different securities within each group from the benchmark. The interaction effect is the portion of a strategy's excess return attributable to combining the allocation effect with the selection effect.

optimization-based strategy during this period. For example, roughly 44% of underperformance came from the sector allocation effect for the rankings-based strategy, whereas the figure is around 28% for the S&P 500 Minimum Volatility Index.

From 2001 to 2010, both strategies outperformed the benchmark readily, with the majority of excess returns coming from selection effect.

For the most recent sub-period ending Dec. 30, 2016, both indices outperformed the benchmark; however, the optimization-based strategy did better than the rankings-based strategy, with allocation and selection effect contributing to the relative outperformance. On the other hand, sector allocation decisions seemed to have a negative impact on S&P 500 Low Volatility Index returns, with the excess returns coming exclusively from the stock selection effect.

Exhibit 11: Performance Attribution

TIME PERIOD	INDEX	AVERAGE ANNUAL ALLOCATION EFFECT	AVERAGE ANNUAL SELECTION + INTERACTION EFFECT	AVERAGE ANNUAL TOTAL EFFECT
1990-2000	S&P 500 Minimum Volatility Index	-1.14	-2.98	-4.12
	S&P 500 Low Volatility Index	-1.43	-1.81	-3.24
2001-2010	S&P 500 Minimum Volatility Index	0.72	2.28	3.00
	S&P 500 Low Volatility Index	0.25	3.35	3.60
2011-2016	S&P 500 Minimum Volatility Index	0.33	1.64	1.97
	S&P 500 Low Volatility Index	-0.30	1.34	1.04

Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1990, to Dec. 30, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

While the two strategies may align directionally with regard to their relative under- or outperformance to the benchmark, they take on different sector and security bets to achieve the end results.

Results from the performance attribution analysis highlight differences in sources of excess returns for the two types of low-risk strategies. While the two strategies may align directionally with regard to their relative under- or outperformance to the benchmark, they take on different sector and security bets to achieve the end results.

Risk Decomposition – Factor Risk Versus Asset-Specific Risk

As demonstrated earlier, the low volatility indices exhibited lower realized total risk than the benchmark during our measurement period. For risk management and risk budgeting purposes, it is important that market participants understand the type of risk each low volatility strategy is taking to achieve lower realized risk than the benchmark, as differences in risk composition have implications for the sources of returns.

In this section, we estimated the risk allocation of the indices by decomposing the total risk of each strategy into systematic (factor) risk and unsystematic (asset-specific) risk. Using the Northfield U.S. Fundamental Equity Risk Model, we computed the average monthly factor contribution to the ex-ante total risk of each strategy from Dec. 31, 1990, through Dec. 30, 2016.

Exhibits 12 and 13 depict systematic and unsystematic risk percentages of total risk throughout time on a monthly basis. The differences in risk composition between the two strategies, for both systematic risk as well as asset-specific risk, are statistically significant at a 95% confidence level.[8]

On average, both indices have shown a similar degree of systematic risk throughout time, with 86.5% and 83.3% total risk stemming from systematic risk for the S&P 500 Low Volatility Index and the S&P 500 Minimum Volatility Index, respectively. We further broke down average factor risk contribution to total risk into market and fundamental factors (see Exhibit 14). The contributions of those factors to the risk of each index paint a contrasting picture in the type of factor bets taken by the two strategies.

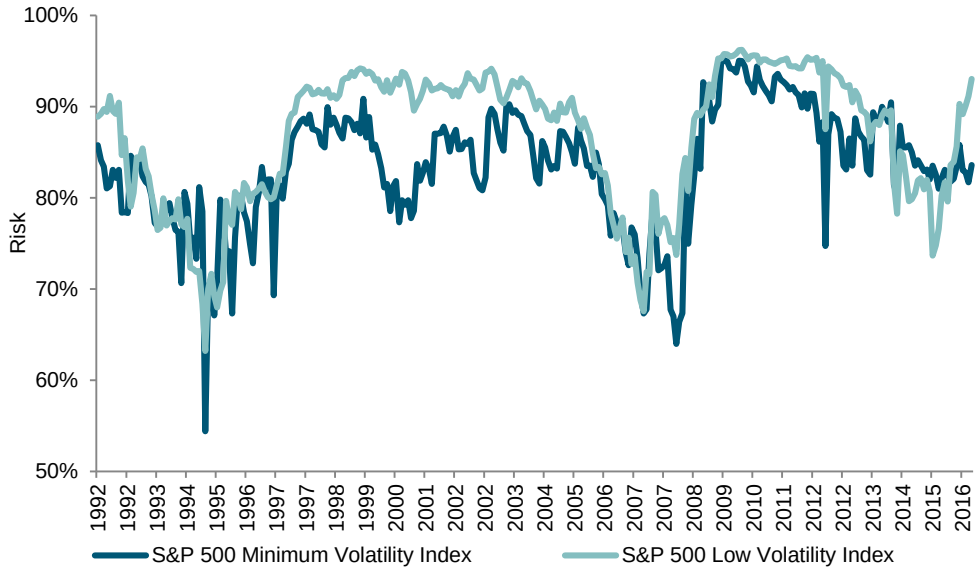
The contributions of those factors to the risk of each index paint a contrasting picture in the type of factor bets taken by the two strategies.

Market risk is the biggest contributor to total risk for both low-risk strategies. However, the optimized low volatility strategy takes on a bigger market factor bet, with approximately 51.3% of the total risk coming from that factor alone, compared with 44.4% for the rankings-based strategy. Similarly, Kang (2012) found that non-optimized low-risk strategies exhibited higher active risk and lower market beta compared with a minimum volatility strategy. This finding can be expected, as minimum volatility strategies have active constraints on factors and other risk exposures, unlike rankings-based strategies, resulting in higher exposure to market risk (Soe 2012).

After the market factor, size is the second-biggest contributor to total risk for the minimum volatility strategy. For the rankings-based, low-risk strategy, industry factors together serve as the second biggest contributors to total risk. This finding is not surprising, as the rankings-based low volatility strategy does not impose constraints on active sector weights. As we noted in the previous section, the strategy frequently deviates significantly from the sector weights of the underlying market-cap-weighted benchmark.

[8] There was a t-stat of 6.249 for systematic risk and a t-stat of -6.249 for unsystematic risk.

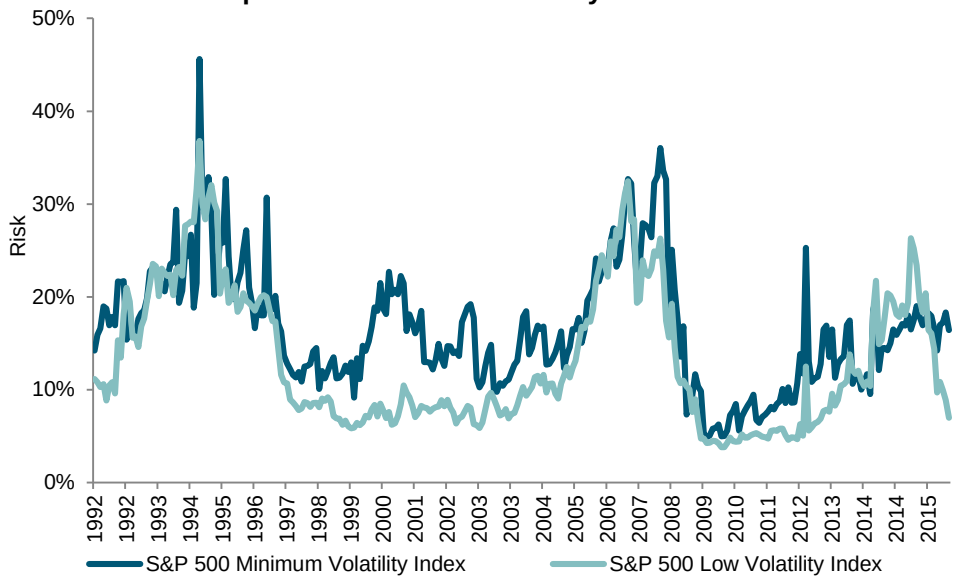
Exhibit 12: Systematic Risk of Low Volatility Indices



Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1992 to Dec. 30, 2016, on a monthly basis. Chart is provided for illustrative purposes.

After the market factor, size is the second biggest contributor to total risk for the minimum volatility strategy.

Exhibit 13: Stock-Specific Risk of Low Volatility Indices



Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1992 to Dec. 30, 2016, on a monthly basis. Chart is provided for illustrative purposes.

Exhibit 14: Average Factor Contribution to Total Risk (Variance)

FACTOR GROUP	FACTOR	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX
Average Stock Specific Risk (%)		16.67	13.49
Average Factor Risk (%)		83.33	86.51
AVERAGE FACTOR CONTRIBUTION TO TOTAL RISK (%)			
Market	Beta	51.28	44.40
Size	Log of Market Cap	10.16	7.06
Volatility	Price Volatility	2.30	9.16
Yield	Dividend Yield	1.28	4.97
Value	Earnings/Price	0.41	1.11
	Book/Price	1.19	1.84
	Revenue/Price	0.96	0.25
Leverage	Debt/Equity	1.41	0.92
Earnings Growth	EPS Growth Rate	0.39	0.81
Earnings Stability	Earnings Variability	1.24	0.44
Momentum	Relative Strength	3.84	2.31
Liquidity	Trading Activity	0.17	1.60
Industry	Industry	8.71	11.62

Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1990, to Dec. 30, 2016, on a monthly basis. Table is provided for illustrative purposes.

Understanding what active factor exposures were taken by low-risk strategies relative to the benchmark helps market participants understand return drivers and evaluate whether factor exposures taken by the strategies are compensated adequately.

Active Factor Exposure and Factor Impact Breakdown

As we noted in the previous section, variations in risk composition stemming from index construction differences have implications on the sources of portfolio returns. Understanding what active factor exposures were taken by low-risk strategies relative to the benchmark helps market participants understand return drivers and evaluate whether factor exposures taken by the strategies are compensated adequately.

In this section, we compared the average monthly exposures of the two low-risk strategies to the S&P 500 and computed the average and cumulative impact of active exposures on returns of the strategies. We used the Northfield U.S. Fundamental Risk Model for the analysis. Exhibit 15 shows that both low-risk strategies, on average, had sizable negative exposures to the price volatility factor. It should be noted that the rankings-based strategy had higher negative active exposure to the volatility factor than the optimized strategy. Both strategies also had significant exposure to small size, as shown by their negative exposure to market cap. The finding is to be expected, as both low-risk strategies deviate from the market-cap-weighting mechanism. Market participants should be aware that large-cap, low-risk strategies, despite built out of a liquid large cap universe, can have strong tilt towards size due to their weighting mechanisms.

Exhibit 16 shows the average monthly impact for each of the factors. Factor impact is calculated as the return of the factor times the factor exposure. Within the domestic large-cap equity space, volatility was the worst-performing factor during the measurement period. On average, both low volatility indices showed negative active exposure to the volatility factor, leading to strong positive active returns versus the benchmark.

We can see that following market (beta) and momentum (relative strength), dividend yield has been the third-best performing factor for the S&P 500. Both types of low volatility indices have exhibited sizable positive exposure to the dividend yield factor, leading to positive excess returns versus the benchmark. A prior study by S&P DJI[9] also confirmed the contribution of the dividend yield factor in driving the return of low volatility strategies.

Both types of low volatility indices have exhibited sizable positive exposure to the dividend yield factor, leading to positive excess returns versus the benchmark.

Exhibit 15: Average Monthly Active Factor Exposures

FACTOR GROUP	FACTOR	AVERAGE FACTOR EXPOSURES			AVERAGE ACTIVE EXPOSURES	
		S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX	S&P 500	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX
Beta		**0.715**	**0.742**	**1.043**	**-0.328**	**-0.301**
Fundamental		**0.525**	**0.654**	**1.081**	**-0.556**	**-0.427**
Size	Log of Market Cap	1.418	1.499	2.294	-0.877	-0.795
Volatility	Price Volatility	-0.719	-0.916	-0.497	-0.223	-0.420
Yield	Dividend Yield	0.409	0.594	0.128	0.281	0.466
Value	Earnings/ Price	0.175	0.319	0.109	0.066	0.210
	Book/Price	-0.257	-0.169	-0.387	0.129	0.218
	Revenue/ Price	-0.039	-0.135	-0.206	0.167	0.071
Leverage	Debt/ Equity	0.230	0.363	0.187	0.043	0.175
Earnings Growth	Eps Growth Rate	-0.255	-0.290	-0.088	-0.167	-0.202
Earnings Stability	Earnings Variability	-0.136	-0.198	-0.292	0.156	0.093
Momentum	Relative Strength	-0.097	-0.094	-0.031	-0.066	-0.063
Liquidity	Trading Activity	-0.203	-0.317	-0.136	-0.066	-0.181
Industry		**NM***	**NM***	**NM***	**NM***	**NM***

Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1990, to Dec. 30, 2016, on a monthly basis. Table is provided for illustrative purposes. *NM indicates not meaningful.

[9] See "What Is In Your Smart Beta Portfolio."

Exhibit 16: Average Factor Returns and Factor Impact

FACTOR GROUP	FACTOR	AVERAGE FACTOR RETURN (%)	AVERAGE FACTOR IMPACT (%)		COMPOUNDED FACTOR IMPACT (%)	
			S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX	S&P 500 MINIMUM VOLATILITY INDEX	S&P 500 LOW VOLATILITY INDEX
Beta		**0.725**	**-0.234**	**-0.221**	**-667.329**	**-679.614**
Fundamental		**0.305**	**0.123**	**0.232**	**463.761**	**885.347**
Size	Log of Market Cap	-0.065	0.014	0.035	83.766	188.596
Volatility	Price Volatility	-0.322	0.068	0.132	276.385	527.180
Yield	Dividend Yield	0.203	0.065	0.098	215.775	316.418
Value	Earnings/ Price	0.137	0.019	0.047	56.261	134.158
	Book/Price	-0.023	0.018	0.011	56.093	27.234
	Revenue/ Price	0.104	0.024	0.020	59.888	46.284
Leverage	Debt/Equity	-0.065	0.000	-0.004	-0.840	-14.886
Earnings Growth	Eps Growth Rate	0.009	0.015	0.004	38.600	-2.930
Earnings Stability	Earnings Variability	-0.109	-0.015	-0.007	-27.959	6.518
Momentum	Relative Strength	0.393	-0.085	-0.100	-299.642	-328.346
Liquidity	Trading Activity	0.043	0.002	-0.005	5.435	-14.878
Industry		**NM***	**0.020**	**0.028**	**101.120**	**142.862**

Source: S&P Dow Jones Indices LLC and Northfield Information Services. Data from Dec. 31, 1990, to Dec. 30, 2016, on a monthly basis. Table is provided for illustrative purposes. *NM indicates not meaningful.

Due to the way that they are constructed, the two strategies have the potential to be meaningfully different in their sector composition, active risk exposures, and risk decomposition.

CONCLUSION

While rankings-based and optimized low volatility indices share a common objective—to deliver higher risk-adjusted returns than the broad market over a long-term investment horizon—their similarity ends there. Due to the way that they are constructed, the two strategies have the potential to be meaningfully different in their sector composition, active risk exposures, and risk decomposition.

Minimum volatility strategies have tighter constraints on active sector weights, rarely resulting in sector compositions that deviate significantly from the underlying benchmark. On the other hand, the rankings-based low volatility index tends to overweight defensive sectors, especially utilities.

In terms of factor exposures, both strategies benefitted greatly from having negative active exposure to the price volatility factor, which was the worst-performing factor during the measurement period. However, each index has different active exposures to other factors that market participants may want to consider. Risk decomposition analysis shows that after accounting for the market factor, size serves as the second-largest contributor to total risk for optimized low-risk strategies, whereas the industry factor was the second-largest contributor for the rankings-based strategy.

The differences in sector weights, risk exposure, and risk composition for the low-risk strategies suggest that market participants should conduct thorough due diligence on sources of returns and evaluate whether active risks taken are compensated or not.

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PERFORMANCE DISCLOSURE

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Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

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