S&P Dow Jones Indices

A Division of S&P Global

Research

S&P 500® Low Volatility Index: Five Decades of History

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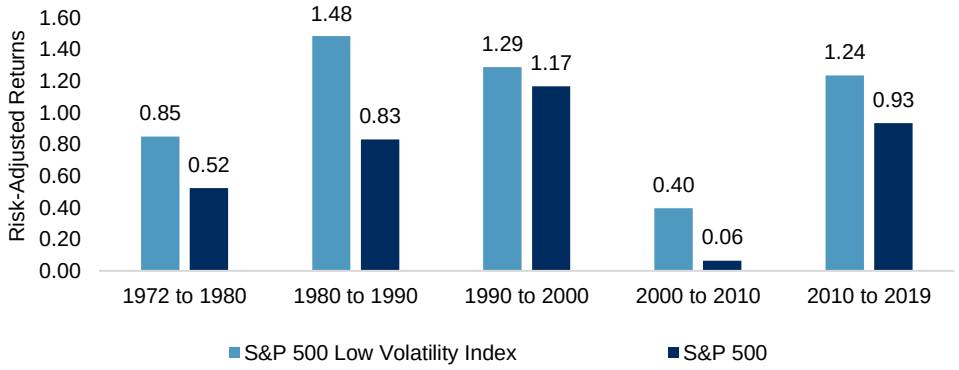
EXECUTIVE SUMMARY

S&P Dow Jones Indices (S&P DJI) publishes a series of low volatility indices, offering market participants a perspective on the returns of lower volatility equities and forming the basis for index-linked products globally.[1] Low volatility indices have typically outperformed their underlying broad market benchmarks on both an absolute and a risk-adjusted basis.[2] S&P DJI recently extended the returns history for one of the widely followed low volatility benchmarks—the S&P 500 Low Volatility Index—back to February 1972.[3] Using the additional two decades of return information, this paper:

- Offers a longer-term perspective on the ability of low volatility indices to combine downside protection and upside participation;
- Assesses the relative importance of equity market movements and interest rates in explaining the low volatility index's performance; and
- Demonstrates the potential applications of low volatility indices.

Exhibit 1 shows the risk-adjusted returns for the S&P 500 Low Volatility Index and the S&P 500 in each decade since 1972.

Exhibit 1: S&P 500 Low Volatility Index Had Higher Risk-Adjusted Returns



Source: S&P Dow Jones Indices LLC. Chart based on daily data between Feb. 18, 1972, and Dec. 31, 2019. Risk-adjusted returns based on the ratio of annualized returns to annualized volatility. 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.

[1] Please see Appendix A for an overview of the low volatility indices offered by S&P Dow Jones Indices.

[2] Chan, Fei Mei and Craig J. Lazzara, "Is the Low Volatility Anomaly Universal?," S&P Dow Jones Indices, April 2019.

[3] Previously, the returns data began in November 1990.

INTRODUCTION

Higher-risk investments should offer higher returns than less risky alternatives, all else equal.

The cornerstone of investing is the notion that the expected return of an asset should compensate for the associated risk(s) of that asset. In other words, higher-risk investments should offer higher returns than less risky alternatives, all else equal.

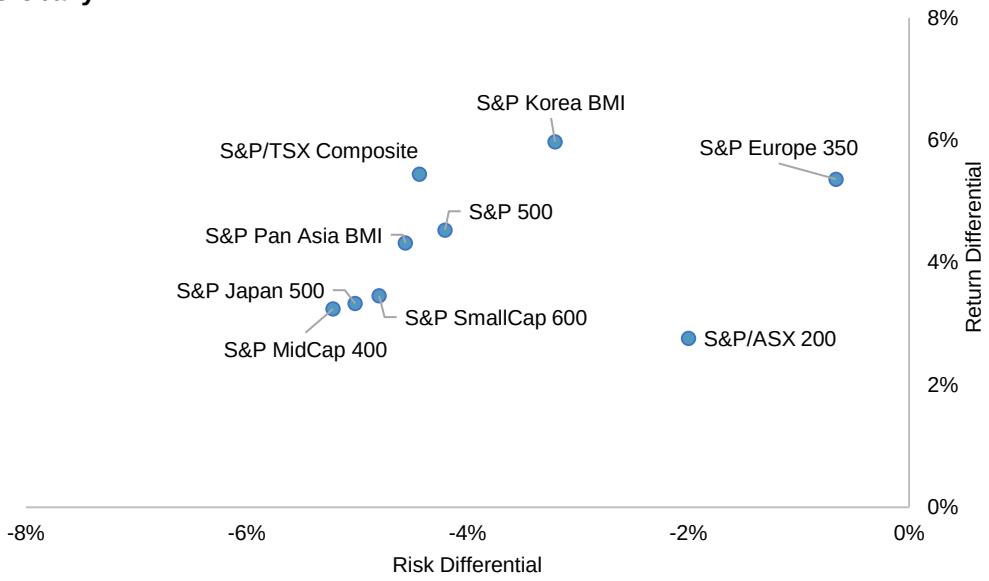
However, flying in the face of the theory, there is a bulk of evidence—accumulated since the 1970s[4]—that demonstrates less volatile stocks have outperformed on a risk-adjusted basis. Our own research shows that the "low volatility anomaly" is universal: this observation applies over multiple time horizons, geographies, and market segments.[5]

However, less volatile stocks have outperformed on a risk-adjusted basis.

S&P DJI's low volatility indices track the performance of a specified number of the least volatile stocks from a given universe. For example, the S&P 500 Low Volatility Index—launched in 2011—selects the 100 least volatile constituents of the S&P 500 at each quarterly rebalance. S&P DJI also applies a similar methodology to other regions, serving as low volatility benchmarks across a number of geographies. Exhibit 2 shows that these low volatility indices offered higher returns with less volatility than their parent benchmarks, historically.

S&P DJI's low volatility indices seek to track the performance of a specified number of the least volatile stocks from a given universe.

Exhibit 2: Low Volatility Strategies Offered Higher Returns and Lower Risk, Globally



Source: S&P Dow Jones Indices LLC. Chart based on monthly total return between June 2000 and December 2019. All data in local currency, except for the USD-denominated S&P Pan Asia BMI. 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.

[4] Jensen, Michael C., Fischer Black, and Myron S. Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," Studies in the Theory of Capital Markets, Praeger Publishers Inc., 1972

[5] Chan, Fei Mei and Craig J. Lazzara, "Is the Low Volatility Anomaly Universal?," S&P Dow Jones Indices, April 2019.

The performance of S&P DJI's low volatility indices has been used to better understand their key characteristics and to dispel some common misconceptions.

Additionally, the performance of S&P DJI's low volatility indices—over both hypothetical back-tests and since their respective launch dates—has been used to better understand their key characteristics and to dispel some common misconceptions. For example, we have found that:

1) Low volatility indices are constructed differently—and have distinct risk/return characteristics—compared to *minimum volatility* indices.[6]

2) Low volatility indices benefited from their ability to combine upside participation and downside protection, historically.

3) Low volatility indices typically outperformed when the reward for outperformance was higher, and they usually underperformed when the penalty for underperformance was lower.[7]

4) Equity valuations did not explain the relative performance of lower volatility stocks: there was no discernable relationship between the relative cheapness (or expensiveness) of less volatile stocks and their relative performance.[8]

Low volatility indices benefited from their ability to combine upside participation and downside protection.

5) The performance of low volatility strategies did not depend on the multi-decade (perhaps once-in-a-lifetime) changes in the fixed income environment.[9]

6) Unlike other anomalies, the returns attributed to the "low volatility anomaly" have not disappeared or diminished since its discovery.[10]

7) Active managers have found it difficult—and almost impossible over longer horizons—to outperform the S&P 500 Low Volatility Index.[11]

Active managers have found it difficult to outperform the S&P 500 Low Volatility Index.

The above observations are based on data covering the past three decades. While such a sample is certainly long enough to draw meaningful conclusions about the characteristics of low volatility indices, the recent history extension to the S&P 500 Low Volatility Index offers an opportunity to provide a longer-term perspective. We begin with a brief recap of how low volatility indices are calculated.

[6] Soe, Aye and Phillip Brzenk, "Inside Low Volatility Indices," S&P Dow Jones Indices, January 2017.

[7] Chan, Fei Mei and Craig J. Lazzara, " The Best Offense: When Defensive Strategies Win," S&P Dow Jones Indices, March 2015.

[8] Chan, Fei Mei and Craig J. Lazzara, "The Valuation of Low Volatility," S&P Dow Jones Indices, November 2016.

[9] Edwards, Tim, Craig J. Lazzara, and Hamish Preston, "Low Volatility: A Practitioner's Guide," S&P Dow Jones Indices, June 2018.

[10] Edwards, Tim, Craig J. Lazzara, and Hamish Preston, "The Persistence of Smart Beta," S&P Dow Jones Indices, October 2015.

[11] Soe, Aye and Berlinda Liu, "Volatility Test: Defensive Factor Indices versus Actively Managed Funds," S&P Dow Jones Indices, May 2019.

S&P DJI'S LOW VOLATILITY INDEX DESIGN

S&P DJI's low volatility indices typically rebalance on a quarterly basis.

S&P DJI's low volatility indices first measure the trailing 12-month volatility of each member of the respective universe. The least volatile *n* constituents are then selected to be part of the low volatility index, with each eligible stock weighted inversely proportional to its volatility. While the rebalance frequency varies across different markets, S&P DJI's low volatility indices typically rebalance on a quarterly basis.[12] For example, the S&P 500 Low Volatility Index selects the 100 least volatile S&P 500 stocks at each quarterly rebalance.

The merit of using historical volatility to identify those stocks that will likely be among the least volatile group in the future relies on the persistence of volatility rankings. In order to examine the persistence in volatility rankings, we first identify year-end S&P 500 constituents between 1972 and 2019 that remained in the index for two consecutive years. We then sort these stocks into quintiles based on their trailing 12-month realized volatilities (the least volatile 20% of stocks that year, up to the most volatile 20% of stocks).

The merit of using historical volatility to identify those stocks that will be among the least volatile group in the future relies on the persistence of volatility rankings.

Exhibit 3 shows the resulting transition matrices: one matrix for the period covering 1973 to 1990 (extended history), and the other for the two-year periods ending between 1991 and 2019.

Exhibit 3: S&P 500 Constituent Volatility Quintile Transition Matrix

		QUINTILE IN SUBSEQUENT RANKING (1973-1990)				
		1	2	3	4	5
INITIAL QUINTILE (1973-1990)	1	62%	21%	9%	4%	3%
	2	24%	34%	26%	11%	5%
	3	9%	29%	32%	22%	8%
	4	2%	12%	24%	40%	22%
	5	2%	4%	9%	24%	62%
		QUINTILE IN SUBSEQUENT RANKING (1991-2019)				
		1	2	3	4	5
INITIAL QUINTILE (1991-2019)	1	64%	21%	8%	2%	1%
	2	24%	38%	23%	10%	2%
	3	7%	27%	34%	23%	6%
	4	2%	9%	26%	39%	20%
	5	0%	1%	6%	23%	67%

Source: S&P Dow Jones Indices LLC, Factset. Data from December 1972 to December 2019. 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.

[12] See S&P DJI's Low Volatility Indices Methodology for more information.

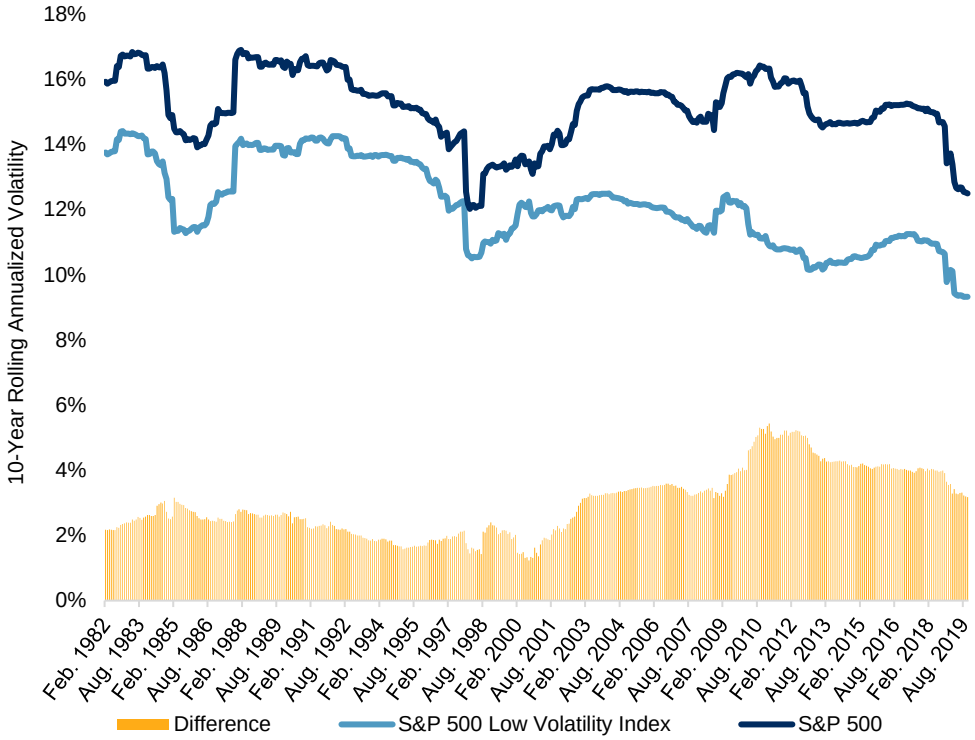
The ranking-based low volatility methodology was effective in identifying S&P 500 constituents that were subsequently less volatile.

Exhibit 3 supports the idea of using trailing volatilities in order to identify those stocks that will likely be less volatile in the future: **the persistence of volatility rankings is evident over the one-year time horizon, both in the earlier and later periods.** For example, 62% of the least volatile stocks (quintile 1) between 1972 and 1990 remained in the least volatile bucket one year later. While such persistence was most prominent for both the least and most volatile constituents (quintiles 1 and 5), it extended to all buckets: values along the leading diagonals in both matrices (representing stocks that maintained a similar volatility ranking year to year) were the highest in each row.[13]

Exhibit 4 shows that the ranking-based low volatility methodology was effective in identifying S&P 500 constituents that were subsequently less volatile: the trailing 10-year annualized volatility of the S&P 500 Low Volatility Index was always lower than that of the S&P 500, with an average monthly difference of 2.99%. These results are similar to previously reported figures covering the period after December 1990.[14]

The trailing 10-year annualized volatility of the S&P 500 Low Volatility Index was always lower than that of the S&P 500.

Exhibit 4: Using Trailing Volatility Was Usually Effective in Identifying Constituents That Were Subsequently Less Volatile



Source: S&P Dow Jones Indices LLC. Chart based on monthly total returns between Feb. 29, 1972, and Dec. 31, 2019. 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.

[13] See Edwards, Tim, Craig J. Lazzara, and Hamish Preston, "Low Volatility: A Practitioner's Guide," S&P Dow Jones Indices, June 2018.

[14] Exhibit 4 assumes that the low volatility index rebalances at the end of January, April, July, and October each year. Hypothetical low volatility index weights from the beginning of each three-month period are used to compute the index-weighted price volatility over the next three months. All volatility figures are annualized.

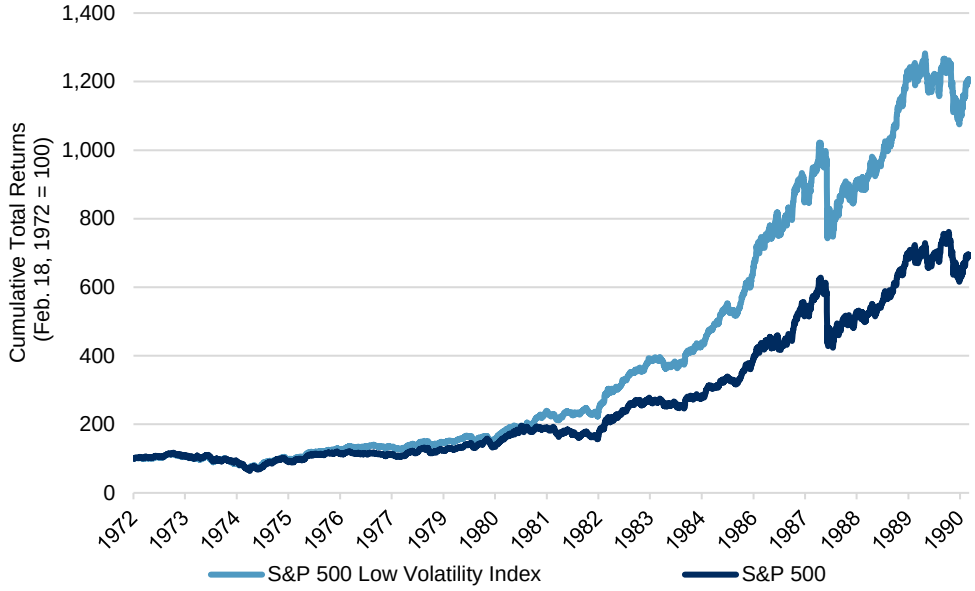
We now turn our attention to confirming similarities in the S&P 500 Low Volatility Index's risk/return characteristics and return patterns over the different periods.

RISK/RETURN CHARACTERISTICS

Low volatility indices typically outperformed their parent benchmarks on both an absolute return and risk-adjusted basis.

As previously mentioned, low volatility indices typically outperformed their parent benchmarks on both an absolute return and risk-adjusted basis. Exhibits 5 and 6 highlight the performance pattern between February 1972 and December 1990. Not only were the low volatility index's cumulative total returns higher, but the combination of higher returns and lower volatility helped it to post higher risk-adjusted returns than the benchmark.

Exhibit 5: Cumulative Outperformance over the S&P 500



The combination of higher returns and lower volatility helped the S&P 500 Low Volatility Index to post higher risk-adjusted returns than the benchmark.

Source: S&P Dow Jones Indices LLC. Chart based on daily data between Feb. 18, 1972, and Dec. 31, 1990. 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 6: Outperformance Was Evident across Both Periods

	PERIOD 1: FEB. 1972-DEC. 1990			PERIOD 2: DEC. 1990-DEC. 2019			BOTH PERIODS		
	RETURN (%)	RISK (%)	RETURN /RISK	RETURN (%)	RISK (%)	RETURN/ RISK	RETURN (%)	RISK (%)	RETURN/ RISK
S&P 500 Low Volatility Index	14.07	11.65	1.21	10.88	12.84	0.85	12.14	12.36	0.98
S&P 500	10.78	15.54	0.69	10.19	17.48	0.58	10.43	16.72	0.62

Source: S&P Dow Jones Indices LLC. Table based on daily data between Feb. 18, 1972, and Dec. 31, 2019. Risk-adjusted returns based on the ratio of annualized returns to annualized volatility. 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 7 shows that the outperformance of the low volatility index was not simply the result of sizeable outperformance at the beginning of the period compounded over time. Indeed, the S&P 500 Low Volatility Index outperformed the U.S. equity benchmark in the majority of calendar year periods between 1972 and 1990, with outperformance most prominent during some of the most negative years for the S&P 500.

The outperformance of the low volatility index was not simply the result of sizeable outperformance at the beginning of the period compounded over time.

Exhibit 7: Calendar Year Total Return Comparisons

YEAR	S&P 500 RETURN (%)	S&P 500 LOW VOLATILITY RETURN (%)	DIFFERENCE (%)
1972*	14.92	12.33	-2.59
1973	-14.80	-15.08	-0.28
1974	-26.58	-20.63	5.95
1975	37.15	40.78	3.63
1976	23.96	28.73	4.76
1977	-7.26	-1.25	6.01
1978	6.51	4.03	-2.48
1979	18.49	14.30	-4.18
1980	32.38	23.13	-9.25
1981	-5.00	18.42	23.42
1982	21.47	28.77	7.30
1983	22.48	28.12	5.64
1984	6.20	13.50	7.29
1985	31.56	39.80	8.24
1986	18.51	29.40	10.90
1987	5.64	1.67	-3.97
1988	16.31	18.88	2.58
1989	31.53	31.76	0.23
1990	-3.10	-4.76	-1.65
1991	30.47	21.71	-8.76
1992	7.62	9.34	1.72
1993	10.08	10.92	0.84
1994	1.32	-2.60	-3.92
1995	37.58	38.17	0.59
1996	22.96	17.50	-5.46
1997	33.36	30.40	-2.96
1998	28.58	8.07	-20.51
1999	21.04	-7.76	-28.80
2000	-9.10	25.03	34.14
2001	-11.89	4.37	16.26
2002	-22.10	-7.16	14.94

Source: S&P Dow Jones Indices LLC. Table based on daily data between Feb. 18, 1972, and Dec. 31, 2019. 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.
* Data starts on Feb. 18, 1972.

The S&P 500 Low Volatility Index outperformed the U.S. equity benchmark in the majority of calendar year periods.

Outperformance of the S&P 500 Low Volatility Index was most prominent during some of the most negative years for the S&P 500.

Exhibit 7: Calendar Year Total Return Comparisons (cont.)

YEAR	S&P 500 RETURN (%)	S&P 500 LOW VOLATILITY RETURN (%)	DIFFERENCE (%)
2003	28.68	22.75	-5.93
2004	10.88	17.69	6.80
2005	4.91	2.20	-2.71
2006	15.79	19.69	3.90
2007	5.49	0.58	-4.91
2008	-37.00	-21.41	15.59
2009	26.46	19.22	-7.24
2010	15.06	13.36	-1.70
2011	2.11	14.78	12.67
2012	16.00	10.30	-5.70
2013	32.39	23.59	-8.80
2014	13.69	17.49	3.80
2015	1.38	4.34	2.95
2016	11.96	10.37	-1.59
2017	21.83	17.41	-4.42
2018	-4.38	0.27	4.65
2019	31.49	28.26	-3.23

Source: S&P Dow Jones Indices LLC. Table based on daily data between Feb. 18, 1972, and Dec. 31, 2019. 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.

MARKET CRASHES ANALYSIS

To understand the performance of the S&P 500 Low Volatility Index during turbulent market environments, we analyze the three largest drawdowns of the S&P 500 in two periods. 1972-1990 (period 1) saw the stagflation/oil crisis (1973-1974), Black Monday (1987), and Fed tightening (1980-1982) downturn events, while 1991-2019 (period 2) saw the Global Financial Crisis (2007-2009), Tech Bust (2000-2002), and Trade Tensions (2018). While each scenario had different circumstances and causes, they demonstrate further evidence of the low volatility index's performance traits.

To appreciate the full impact of downturns on a benchmark, it is important to understand the impact of geometric compounding. **If an index declines by 10% in one period, a return *greater* than 10% is required to get back to zero cumulative return—11.11% in this example.** As a result, if the low volatility index loses less than then benchmark during drawdown periods, it does not have as much to recoup in recovery.

Exhibits 8a and 8b gives figures on the three worst drawdowns of the S&P 500 for both periods. Having covered the drawdown events in period 2 in other papers,[15] what follows is additional commentary on each drawdown event in the first period.

[15] Additional notes on drawdown events in the second period can be found in Soe, Aye and Phillip Brzenk, "Inside Low Volatility Indices," S&P Dow Jones Indices, January 2017.

If the low volatility index loses less than then benchmark during drawdown periods, it does not have as much to recoup in recovery.

Exhibit 8a: Three Largest Drawdowns of the S&P 500 (1972-1990)

CATEGORY		LARGEST DRAWDOWN	SECOND-LARGEST DRAWDOWN	THIRD-LARGEST DRAWDOWN
Peak Date		Jan. 11, 1973	Aug. 25, 1987	Nov. 28, 1980
Trough Date		Oct. 3, 1974	Dec. 4, 1987	Aug. 12, 1982
Recovery Date		July 9, 1976	May 15, 1989	Oct. 7, 1982
S&P 500 Return (%)		-44.90	-32.56	-20.18
S&P 500 Low Volatility Index	Return (%)	-39.94	-26.80	15.45
	Excess Return versus S&P 500 (%)	4.96	5.77	35.63
	Peak-to-Recovery Excess Return versus S&P 500 (%)	9.37	8.17	43.63

Source: S&P Dow Jones Indices LLC. Table based on daily total returns data between Feb. 29, 1972, and May 15, 1989. 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 8b: Three Largest Drawdowns of the S&P 500 (1991-2019)

CATEGORY		LARGEST DRAWDOWN	SECOND-LARGEST DRAWDOWN	THIRD-LARGEST DRAWDOWN
Peak Date		Oct. 9, 2007	Sept. 1, 2000	Sept. 20, 2018
Trough Date		March 9, 2009	Oct. 9, 2002	Dec. 24, 2018
Recovery Date		April 2, 2012	Oct. 23, 2006	April 12, 2019
S&P 500 Return (%)		-55.25	-47.41	-19.36
S&P 500 Low Volatility Index	Return (%)	-39.61	2.39	-10.69
	Excess Return versus S&P 500 (%)	15.64	49.80	8.67
	Peak-to-Recovery Excess Return versus S&P 500 (%)	21.61	90.72	7.46

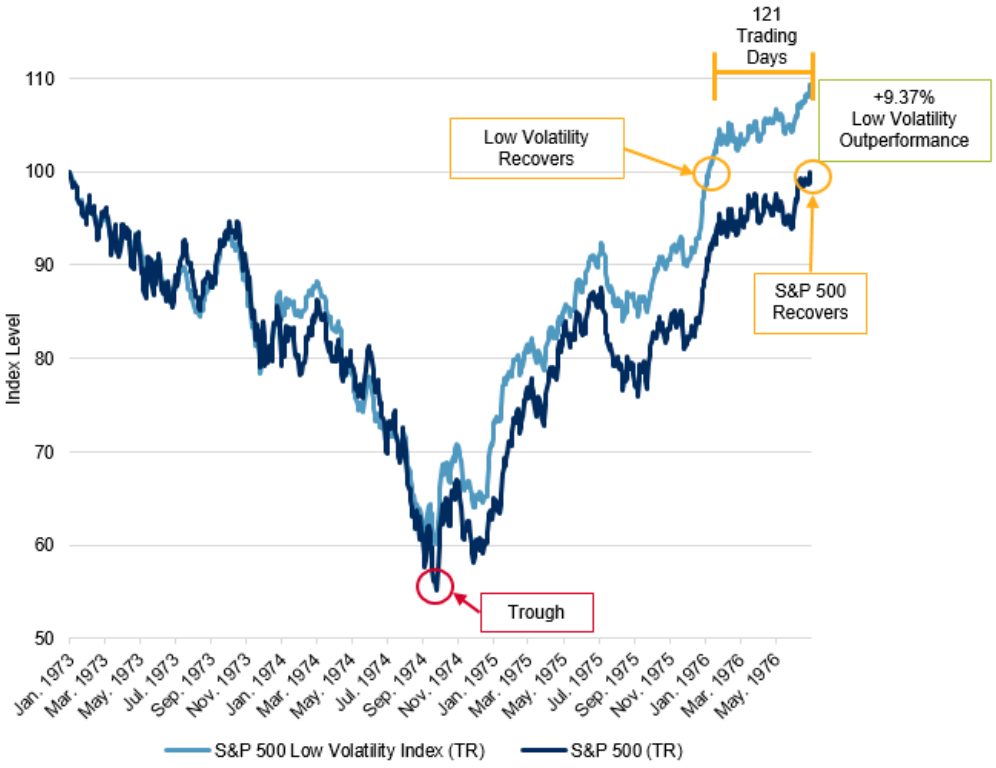
Source: S&P Dow Jones Indices LLC. Table based on daily total returns data between Sept. 1, 2000, and April 12, 2019. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

In the first period, the most significant market downturn occurred in the early 1970s.

In the first period, the most significant market downturn occurred in the early 1970s, coinciding with the U.S. economy reeling from double-digit inflation courtesy of a quadrupling in oil prices. During this period, the S&P 500 declined by 45% over a 21-month period and took three and a half years to return to its previous local peak. In contrast, the low volatility index fell 40% in the drawdown period before reaching its previous local peak a full six months sooner than the U.S. equity benchmark.

The cumulative effect of the low volatility index losing less resulted in total outperformance of more than 9% relative to the S&P 500. Exhibit 9 shows the full period in greater detail.

Exhibit 9: Largest Drawdown Event Timeline



Source: S&P Dow Jones Indices LLC. Chart based on daily total returns data between Jan. 11, 1973, and July 9, 1976. 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.

The cumulative effect of the low volatility index losing less resulted in total outperformance of more than 9% relative to the S&P 500.

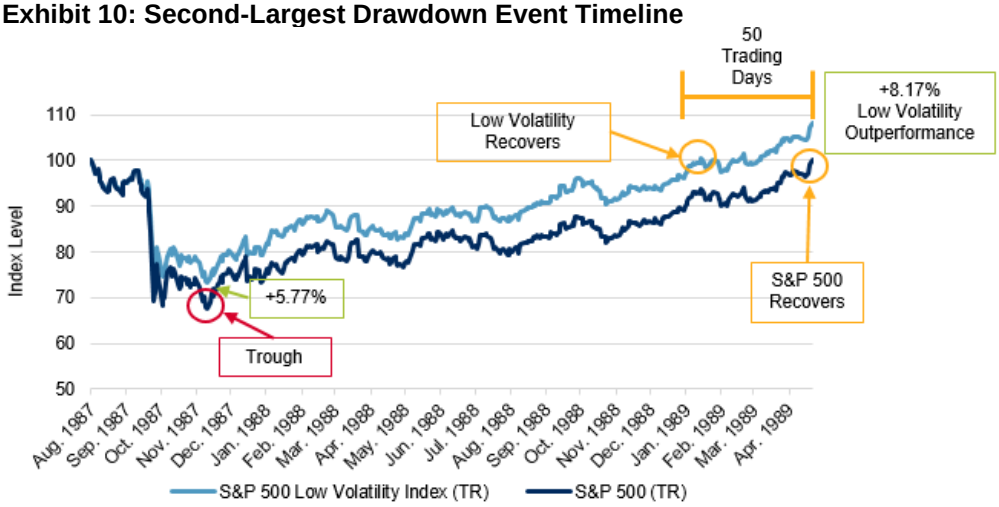
The second-largest drawdown for the S&P 500 came in the late 1980s when the index dropped by over 32.5% in just three months.

The second-largest drawdown for the S&P 500 came in the late 1980s when the index dropped by over 32.5% in just three months: the 17.6% plunge on Oct. 19, 1987—known to many as Black Monday—accounted for over half of the fall. After Black Monday, the index remained at subdued levels for another month and a half, hitting a low on Dec. 4, 1987, before recovering to pre-downturn levels by May 1989.

During the downturn period, the low volatility index declined by 26.8% and recovered a full 50 trading days prior to the S&P 500. By the time the benchmark recovered fully on May 15, 1989, the low volatility index had outperformed by 8.2% (see Exhibit 10).

By the time the benchmark recovered fully on May 15, 1989, the low volatility index had outperformed by 8.2%.

Exhibit 10: Second-Largest Drawdown Event Timeline

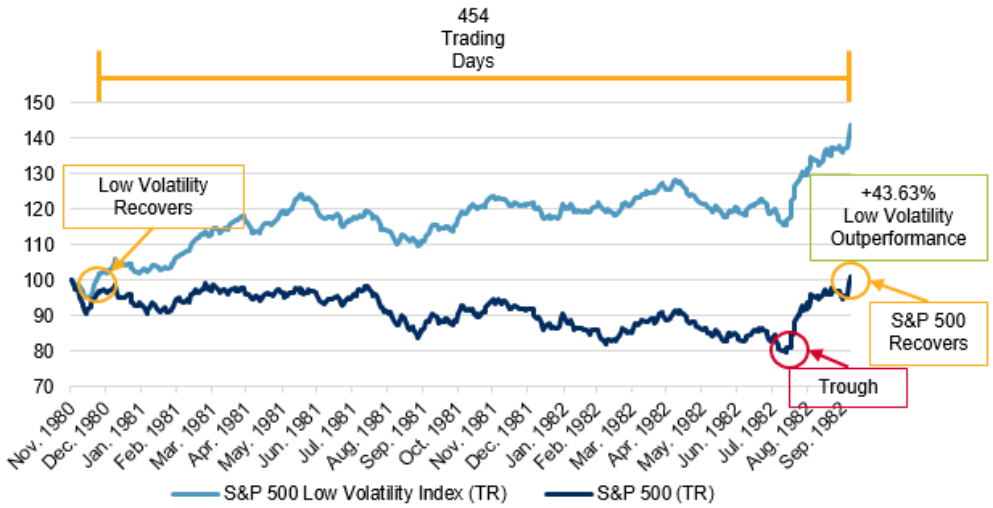


Source: S&P Dow Jones Indices LLC. Chart based on daily total returns data between Aug. 25, 1987, and May 15, 1989. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Finally, the period between 1980 and 1982 was challenging for the S&P 500 as it experienced the third-largest drawdown due to the Fed hiking interest rates in response to surging inflation.[16] Against the backdrop of the prolonged period of market uncertainty, the S&P 500 was in negative territory for almost two years and bottomed out by August 1982 with a decline of 20.18%. Conversely, and in spite of a minimal drawdown in the first month, the low volatility index produced positive returns for most of the period, recovering a full 454 trading days sooner and with a cumulative outperformance of over 43% from peak-to-trough (see Exhibit 11).

The low volatility index produced positive returns for most of the period the S&P 500 was in negative territory.

Exhibit 11: Third-Largest Drawdown Event Timeline



Source: S&P Dow Jones Indices LLC. Chart based on daily total returns data between Nov. 28, 1980, and Aug. 12, 1982. 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.

[16] The Fed funds rate reached 18% in November 1980 before rising to 20% in December 1980.

In later sections, we return to the relationship between interest rates and the low volatility index returns. We note that the low volatility index's outperformance between 1980 and 1982 came amid a period of high—*and rising*—interest rates. Such instances challenge the idea that the historical outperformance of low volatility indices, both in the U.S. and globally, is entirely attributable to a sustained, downward trend in bond yields.

The low volatility index's outperformance between 1980 and 1982 came amid a period of high—and rising—interest rates.

Overall, the S&P 500 Low Volatility Index's relative returns during the three biggest drawdowns illustrate the potential benefit of focusing on less volatile securities within a given universe. In the three scenarios, each with their own causes and effects, the low volatility index declined much less than the broad market.

UPSIDE PARTICIPATION & DOWNSIDE PROTECTION

The risk/return characteristics show that **low volatility indices have a propensity to combine upside participation *and* downside protection**. For example, the S&P 500 Low Volatility Index typically fell by less than the S&P 500, while also participating in equity market gains during rosier times.

The S&P 500 Low Volatility Index's relative returns during the three biggest drawdowns illustrate the potential benefit of focusing on less volatile securities within a given universe.

We illustrate this dynamic using upside and downside "capture ratios". We calculate the capture rations by taking the S&P 500 Low Volatility Index's average return in up or down markets (as determined by whether the S&P 500 rose or fell) and dividing it by the corresponding average S&P 500 return.

Exhibit 12 provides the capture ratios for the low volatility index over several horizons. Regardless of the time horizon, or the period in question, the low volatility index typically captured much of the S&P 500's gains, but only a fraction of its declines. All the downside capture ratios were less than one *and* all the upside capture ratios exceeded their corresponding downside capture ratio.

The S&P 500 Low Volatility Index typically fell by less than the S&P 500, while also participating in equity market gains during rosier times.

Exhibit 12: Low Volatility Capture Ratios across Various Time Horizons

PERIOD DEC. 29, 1972-DEC. 31, 1990	DURING WHICH S&P 500 RISES			DURING WHICH S&P 500 DECLINES		
	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)	UPSIDE CAPTURE (%)	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)	DOWNSIDE CAPTURE (%)
Trading Days (Total = 4551)	0.50	0.71	**0.70**	-0.44	-0.70	**0.63**
Weeks (Total = 940)	1.39	1.72	**0.80**	-1.20	-1.77	**0.68**
Calendar Months (Total = 217)	3.69	4.11	**0.90**	-1.99	-3.07	**0.65**
Calendar Quarters (Total = 73)	8.04	8.04	**1.00**	-4.56	-6.67	**0.68**
Calendar Years (Total = 19)	23.30	20.94	**1.11**	-4.66	-11.35	**0.41**

Source: S&P Dow Jones Indices LLC. Table based on data between Dec. 29, 1972, and Dec. 31, 2019. 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 12: Low Volatility Capture Ratios across Various Time Horizons (cont.)

PERIOD DEC. 31, 1990- DEC. 31, 2019	DURING WHICH S&P 500 RISES			DURING WHICH S&P 500 FALLS		
	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)	UPSIDE CAPTURE (%)	S&P 500 LOW VOLATILITY INDEX (%)	S&P 500 (%)	DOWNSIDE CAPTURE (%)
Trading Days (Total = 7306)	0.48	0.72	**0.67**	-0.47	-0.76	**0.62**
Weeks (Total = 1514)	1.10	1.58	**0.70**	-0.98	-1.64	**0.60**
Calendar Months (Total = 348)	2.23	3.10	**0.72**	-1.70	-3.58	**0.47**
Calendar Quarters (Total = 116)	4.67	6.17	**0.76**	-2.31	-6.87	**0.34**
Calendar Years (Total = 29)	14.49	17.96	**0.81**	0.22	-16.89	**-0.01**

Source: S&P Dow Jones Indices LLC. Table based on data between Dec. 29, 1972, and Dec. 31, 2019. 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 low volatility index appeared to be slightly more sensitive to market movements between December 1972 and December 1990 than in the subsequent period.

Another takeaway from Exhibit 12 is that the low volatility index appeared to be slightly more sensitive to market movements between December 1972 and December 1990 than in the subsequent period: the capture ratios in the earlier period all exceeded their counterparts in the later period. This may help to explain why the S&P 500 Low Volatility Index posted higher returns and higher volatility in the earlier period than the later period (see Exhibit 6).

The capture ratios help to explain why the S&P 500 outperformed its low volatility index in 1987.

Additionally, the capture ratios help to explain why the S&P 500 outperformed its low volatility index in 1987. Indeed, the U.S. equity benchmark posted its best year-to-date gain through the end of September 1987 (35.79%) and the S&P 500 Low Volatility Index captured around two-thirds of this gain, up 23.15%. And while the low volatility index outperformed in the fourth quarter (-17.44% versus -22.19%, respectively), it was not enough to overcome its prior underperformance.

The propensity to marry upside participation and downside protection is important to understand low volatility indices' pattern of returns.

LOW VOLATILITY PERFORMANCE & DISPERSION

The propensity to marry upside participation and downside protection is important to understand low volatility indices' pattern of returns. But because the S&P 500 rose in the majority (71%) of quarters since the end of 1972, we would typically expect the low volatility index to underperform. Instead, the magnitude of the S&P 500 Low Volatility Index's relative returns helps to explain its historical outperformance.

Exhibit 13 shows the S&P 500 Low Volatility Index's relative returns in different market environments. Specifically, we use the S&P 500's quarterly total returns to define four regimes: large negative (a decline greater than 6%), small negative (a loss of less than 6%), small positive (a gain of less than 6%), and large positive (a gain of more than 6%).

As expected, the S&P 500 Low Volatility Index outperformed more frequently during market declines than when the S&P 500 rose. Crucially,

though, the extent to which the low volatility index outperformed in negative markets (5.38% and 1.74%, respectively) was higher than its typical underperformance during strong equity market gains.

The extent to which the low volatility index outperformed in negative markets was higher than its typical underperformance during strong equity market gains.

Exhibit 13: Low Volatility Typically Outperformed in Down Markets by More Than It Underperformed in Up Markets

CATEGORY	ALL QUARTERS	LARGE NEGATIVE	SMALL NEGATIVE	SMALL POSITIVE	LARGE POSITIVE
# Quarters	188	25	30	67	66
Frequency Low Volatility Outperformed (%)	48.66	88.00	63.33	49.25	25.76
Average S&P 500 Total Return (%)	2.85	-11.93	-2.48	3.03	10.69
Average S&P 500 Low Volatility Index Total Return (%)	3.17	-6.45	-0.74	3.05	8.71
Average Excess Returns (%)	0.32	5.48	1.74	0.02	-1.99

Source: S&P Dow Jones Indices LLC. Table based on quarterly total returns between Dec. 29, 1972, and Dec. 31, 2019. Past performance is no guarantee of future results. Table 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.

Dispersion measures the index-weighted average difference in returns among an index's constituents.

The results in Exhibit 13 speak to a broader trait: **low volatility indices typically outperform when the reward for outperformance is greater and usually underperform when the associated punishment is relatively subdued.**

In order to demonstrate this, we turn to dispersion, which measures the index-weighted average difference in returns among an index's constituents.[17] When dispersion is higher, there is a larger difference in returns between the relative winners and losers in a given market, and there may be a greater reward to correctly identifying constituents that outperform.[18]

When dispersion is higher, there is a larger difference in returns between the relative winners and losers in a given market.

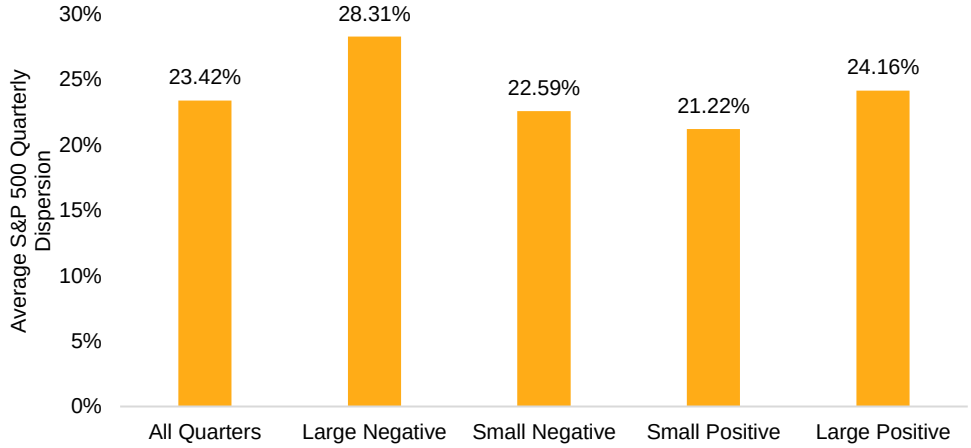
Exhibit 14 shows the average quarterly dispersion among S&P 500 constituents for the same regimes that were used in Exhibit 13. Clearly, dispersion was highest in the large negative quarters. As a result, the S&P 500 Low Volatility Index's propensity to outperform when there was greater reward to doing so helped it to outperform, historically.[19]

[17] For a full overview, see Edwards, Tim and Craig J. Lazzara, "Dispersion: Measuring Market Opportunity," S&P Dow Jones Indices, December 2013.

[18] It should also be noted that there is a greater punishment for selecting the underperforming constituents when dispersion is higher.

[19] This evidence reinforces prior results; see Chan, Fei Mei and Craig J. Lazzara, " The Best Offense: When Defensive Strategies Win," S&P Dow Jones Indices, March 2015.

Exhibit 14: Dispersion Typically Rose in More Volatile Times



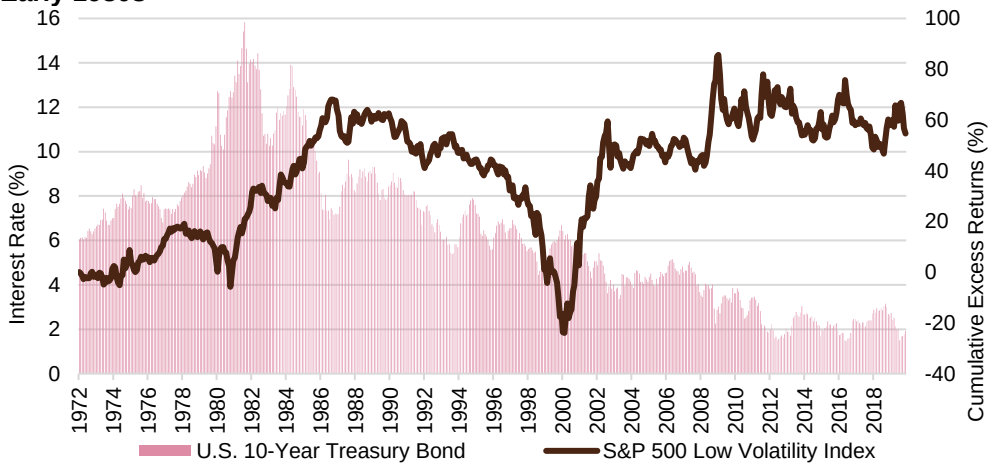
Source: S&P Dow Jones Indices LLC. Chart based on quarterly total returns between Dec. 29, 1972, and Dec. 31, 2019. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

One common critique of low volatility indices is that they have benefited from a multi-decade, perhaps once-in-a-lifetime, downward trend in bond yields.

LOW VOLATILITY: NOT JUST A RATES PLAY

One common critique of low volatility indices is that they have benefited from a multi-decade, perhaps once-in-a-lifetime, downward trend in bond yields (Exhibit 15). Indeed, several studies[20, 21] have shown that low volatility indices tend to have exposure to rising interest rates given the indices have typically overweighted sectors that have bond-like characteristics (such as Utilities and Real Estate) that had higher sensitivity to interest rate movements, historically.

Exhibit 15: U.S. Interest Rates Have Been on a Downward Trend since the Early 1980s



Source: S&P Dow Jones Indices LLC, FRED. Chart based on monthly data between Feb. 29, 1972, and Dec. 31, 2019. 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.

[20] Blitz, D., B. van der Grient, and P. van Vliet. "Interest rate risk in low-volatility strategies." 2014.

[21] Driessen, J., I. Kuiper, and R. Beilo. "Does Interest Rate Exposure Explain the Low-Volatility Anomaly?" 2017.

Given market participants have typically been more concerned about rising interest rates than falling interest rates, we identify periods of material increases in interest rates (1% or more) and report the return of the S&P 500 Low Volatility Index relative to the S&P 500 in those periods. We again group the dates by the extended history (period 1) and original history (period 2). While the date ranges for each are somewhat arbitrary in nature, they do give a sensible break between the relatively high interest rate levels seen in the 1970s and 1980s and the lower rates since then.

The low volatility index typically underperformed when rates rose.

Exhibit 16 shows that the low volatility index typically underperformed when rates rose (13 of 19 observations, by an annualized average of 4.48%). This was especially prominent in period 2, when low volatility underperformed in 9 out of the 10 observations. However, it is possible that the effect of interest rates on low volatility performance is connected or dependent on the state of the equity market.

For example, period 1 saw a mixture of up and down markets, whereas the S&P 500 return was positive for each observation in period 2. Given our analysis shows that we expect the low volatility index to lag the S&P 500 during up markets, and combined with the fact that Treasury yields typically fell (rose) during periods of market turbulence (calmness), the low volatility index's relative returns in Exhibit 16 may simply be a consequence of its expected returns during different market environments.

However, it is possible that the effect of interest rates on low volatility performance is connected and/or dependent on the state of the equity market.

Exhibit 16: Relative Performance in Rising Interest Rate Regimes

PERIOD	DATE RANGE	INTEREST RATE AT BEGINNING (%)	INTEREST RATE INCREASE (%)	S&P 500 LOW VOLATILITY INDEX RETURN (%)	S&P 500 RETURN (%)	EXCESS RETURN (%)	EXCESS RETURN, ANNUALIZED (%)
PERIOD 1: EXTENDED HISTORY (1972-1990)	December 1972-July 1973	6.28	1.15	-10.28	-5.74	-4.54	-6.73
	December 1973-August 1974	6.69	1.42	-20.76	-22.54	1.78	2.38
	September 1977-February 1980	7.28	5.44	16.49	34.08	-17.59	-7.45
	July 1980-September 1981	10.09	5.75	21.07	8.10	12.97	10.24
	December 1981-June 1982	13.13	1.31	-2.46	-10.36	7.90	13.92
	March 1983-May 1984	10.27	3.64	14.55	7.36	7.19	5.71
	September 1986-September 1987	6.95	2.68	19.74	31.38	-11.63	-10.79
	March 1988-August 1988	8.16	1.09	0.21	-0.61	0.82	1.65
	December 1989-April 1990	7.84	1.20	-6.08	-3.16	-2.92	-6.88
PERIOD 2: ORIGINAL HISTORY (1991-2019)	October 1993-November 1994	5.40	2.51	-5.39	2.15	-7.55	-6.50
	January 1996-August 1996	5.58	1.38	5.18	7.45	-2.27	-3.39
	October 1998-January 2000	4.44	2.24	-2.51	39.44	-41.95	-33.50
	November 2001-March 2002	4.30	1.12	14.64	8.91	5.73	14.30
	June 2003-July 2003	3.37	1.12	-0.28	3.06	-3.34	-18.43
	July 2005-June 2006	3.94	1.21	7.76	8.63	-0.87	-0.87
	January 2009-June 2009	2.25	1.28	0.40	3.16	-2.76	-5.45
	September 2010-March 2011	2.47	1.00	15.70	27.78	-12.08	-19.81
	August 2012-August 2013	1.51	1.27	13.20	21.38	-8.18	-7.57
	August 2016-October 2018	1.46	1.69	13.35	26.21	-12.86	-5.94
					Average Excess Return, Annualized (%)		**-4.48**
					Median Excess Return, Annualized (%)		**-5.94**

Source: S&P Dow Jones Indices LLC, FRED. Table based on monthly data between Feb. 29, 1972, and Dec. 31, 2019. 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.

In order to obtain greater insight into the role of yield changes on low volatility portfolios, we review the average monthly excess returns versus the S&P 500 based on changes in the market (up or down) and rates (increase or decrease) in Exhibit 17.

The low volatility index typically underperformed by an average of 1.24% when the market and rates both rose.

Exhibit 17: S&P 500 Low Volatility Index's Relative Returns in Different Environments

PERIOD	RATES INCREASE		RATES DECREASE	
	MARKETS UP	MARKETS DOWN	MARKETS UP	MARKETS DOWN
Period 1 (1972-1990) (%)	-0.94	0.85	-0.06	1.47
Period 2 (1991-2019) (%)	-1.37	1.26	-0.36	2.36
Full History (%)	-1.24	1.03	-0.24	2.04

Source: S&P Dow Jones Indices LLC, FRED. Table based on monthly data between Feb. 29, 1972, and Dec. 31, 2019. 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 low volatility index typically outperformed when rates rose and the market fell.

The analysis demonstrates that the effect of interest rates changes on low volatility performance is conditional on the directional change in the equity market. For example, the low volatility index typically underperformed by an average of 1.24% (full history) when the market and rates both rose. Furthermore, the low volatility index typically outperformed when rates rose and the market fell. Conversely, when rates declined, the low volatility index typically trailed the S&P 500 when the market rose, and it outperformed when the market declined.

While the analysis in this section takes a simplistic approach in trying to understand a complex relationship between interest rates and equities, the data suggests that the existing equity market environment is important to understand any potential impact of interest rate changes on the low volatility index's relative returns.

PRACTICAL APPLICATIONS OF LOW VOLATILITY INDICES

In light of the low volatility indices' characteristics, market participants may be interested in the potential applications of the strategies

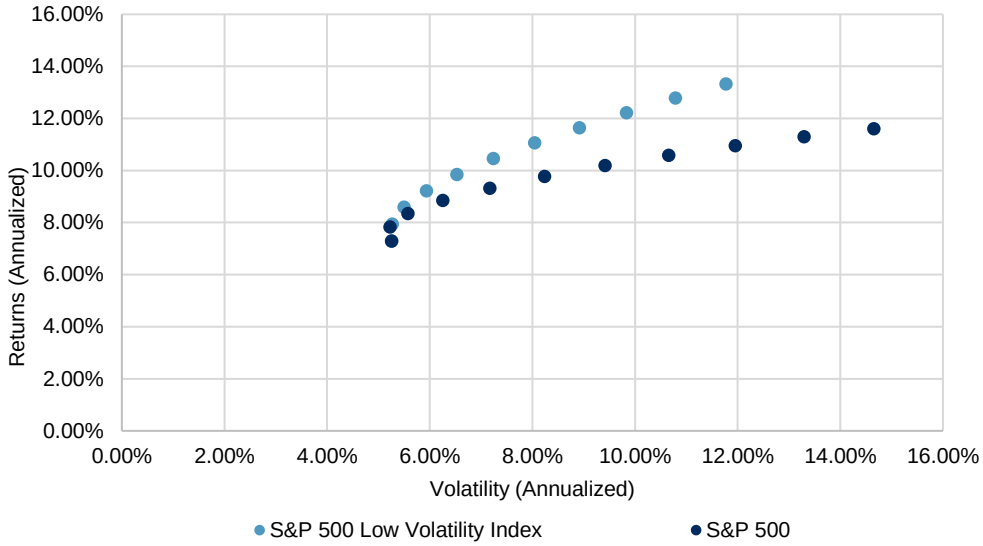
In light of the low volatility indices' characteristics, market participants may be interested in the potential applications of the strategies. Exhibit 18 shows that incorporating low volatility within hypothetical equity/bond portfolios could have improved the risk/return tradeoff for the period between December 1975 and October 2019.

Specifically, Exhibit 18 shows the annualized risk/return figures for hypothetical equity/bond portfolios that rebalance back to their respective target weights at each quarter end. Asset allocations vary from 100% fixed income (left-most dot) to 100% equity (right-most dot), with allocations changing in increments of 10%. The "traditional" portfolios use the S&P 500 for equity market exposure, while their "low volatility" counterparts use the S&P 500 Low Volatility Index. In both cases, the Bloomberg Barclays U.S. Aggregate Index is used for fixed income exposure.

Incorporating the S&P 500 Low Volatility Index improved on the risk-adjusted returns.

Incorporating the S&P 500 Low Volatility Index improved on the risk-adjusted returns: the hypothetical "low volatility" portfolios almost always offered higher returns for the same level of risk compared to their "traditional" counterparts.

Exhibit 18: Incorporating Low Volatility within a Portfolio Improved Returns for Any Level of Volatility



Source: S&P Dow Jones Indices LLC, Factset. Chart based on monthly total returns between December 1975 and December 2019. 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.

Incorporating low volatility could have allowed market participants to increase their equity allocations while maintaining similar portfolio volatility.

Exhibit 18 also shows that, compared to using the S&P 500 for equity exposure, incorporating low volatility could have allowed market participants to increase their equity allocations while maintaining similar portfolio volatility. Exhibit 19 reinforces this fact by comparing two hypothetical equity/bond portfolios: the "traditional" 60/40 portfolio shown above, and a 75/25 "low volatility" portfolio. The hypothetical "low volatility" portfolio offered higher returns and lower volatility than the "traditional" 60/40 portfolio, with lower maximum 12-month drawdowns.

Exhibit 19: Incorporating Low Volatility Could Have Allowed for Higher Equity Exposure

	RETURNS (ANNUALIZED, %)	VOLATILITY (ANNUALIZED, %)	RETURN/ RISK	MAX 12-MONTH DRAWDOWN (%)	TRACKING ERROR (%)	INFORMATION RATIO
Traditional 60/40	10.21	9.41	1.08	29.44	N/A	N/A
Low Volatility 75/25	11.96	9.37	1.28	21.70	5.15	0.34

The Traditional 60/40 and Low Volatility 75/25 portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC, Factset. Table based on monthly total returns between December 1975 and December 2019. 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.

CONCLUSIONS

The S&P 500 Low Volatility Index serves as the basis for benchmarks and investment products and has been the topic of much research.

The S&P 500 Low Volatility Index displayed higher returns and lower volatility than the S&P 500, with a similar combination of upside participation and downside protection.

Recently, S&P Dow Jones Indices extended the history of the index from 1990 to 1972. This paper has demonstrated that many of the characteristics found in the previously available history are also observed in the extended period. For example, the S&P 500 Low Volatility Index displayed higher returns and lower volatility than the S&P 500, with a similar combination of upside participation and downside protection.

Incorporating the low volatility index within a traditional equity/bond portfolio framework could also have improved the associated risk-adjusted returns, and could have allowed for higher equity allocations than would have otherwise been possible.

APPENDIX

Exhibit 20: S&P DJI Low Volatility Indices

LOW VOLATILITY INDEX	BENCHMARKPARENT INDEX	LAUNCH DATE
S&P 500 Low Volatility Index	S&P 500	April 4, 2011
S&P BMI International Developed Low Volatility Index	S&P Developed BMI Ex-U.S. & Korea LargeMidCap	Dec. 5, 2011
S&P BMI Emerging Markets Low Volatility Index	S&P Emerging Plus LargeMidCap	Dec. 5, 2011
S&P 500 Low Volatility Index CAD Hedged	S&P 500	Jan. 24, 2012
S&P Europe 350 Low Volatility Index	S&P Europe 350	July 9, 2012
S&P MidCap 400 Low Volatility Index	S&P MidCap 400	Sept. 24, 2012
S&P SmallCap 600 Low Volatility Index	S&P SmallCap 600	Sept. 24, 2012
S&P Pan Asia Low Volatility Index	S&P Pan Asia Ex-NZ LargeMidCap	Nov. 19, 2012
S&P Korea Low Volatility Index	S&P Korea BMI	May 8, 2013
S&P Nordic Low Volatility Index	S&P Nordic BMI	May 17, 2013
S&P South Africa Low Volatility Index	S&P South Africa Composite	Jan. 29, 2014
S&P Southern Europe Low Volatility Index	S&P Italy BMI, S&P Portugal BMI, S&P Spain BMI	Feb. 28, 2014
S&P Emerging Markets Low Volatility Select Index	S&P Emerging Plus LargeMidCap	Nov. 13, 2014
S&P Eurozone Low Volatility Index	S&P Eurozone BMI	March 30, 2015
S&P Eurozone Low Volatility USD Hedged Index	S&P Eurozone BMI	March 30, 2015
S&P Developed Asia Low Volatility	S&P Asia Pacific LargeMidCap	Aug. 5, 2015
S&P EPAC Ex-Korea Low Volatility	S&P EPAC Ex-Korea LargeMidCap	May 25, 2015
S&P EPAC Ex-Korea Low Volatility USD Hedged Index	S&P EPAC Ex-Korea LargeMidCap	May 25, 2015
S&P Japan 500 Low Volatility Index	S&P Japan 500	June 8, 2015
S&P Japan 500 Low Volatility USD Hedged Index	S&P Japan 500	June 8, 2015
S&P Europe 350 Carbon Efficient Select Low Volatility Index	S&P Europe 350 Carbon Efficient Select Index	Jan. 18, 2016
S&P Global Low Volatility Index	S&P Global LargeMidCap	April 11, 2016
S&P Developed Low Volatility Index	S&P Developed LargeMidCap	April 11, 2016
S&P/ASX 200 Low Volatility Index	S&P/ASX 200	Oct. 17, 2017
S&P China A-Share Low Volatility Index	S&P China A BMI Domestic and S&P China Venture Enterprise indices	July 11, 2018
S&P GCC Composite Low Volatility Index	S&P GCC Composite Index	Jan. 7, 2019
S&P Saudi Arabia Low Volatility Index	S&P Saudi Arabia Index	Jan. 7, 2019
S&P Saudi Arabia Shariah Low Volatility Index	S&P Saudi Arabia Shariah Index	Jan. 7, 2019

Source: S&P Dow Jones Indices LLC. Data as of January 2020. Table is provided for illustrative purposes.

PERFORMANCE DISCLOSURE

The S&P 500 Low Volatility Index was launched April 4, 2011. The S&P Pan Asia Low Volatility Index was launched November 19, 2012. The S&P Korea Low Volatility Index was launched May 8, 2013. The S&P Europe 350 Low Volatility Index was launched July 9, 2012. The S&P/TSX Composite Low Volatility Index was launched April 10, 2012. The S&P Japan 500 Low Volatility Index was launched June 8, 2015. The S&P MidCap 400 Low Volatility Index and the S&P SmallCap 600 Low Volatility Index were launched September 24, 2012. The S&P/ASX 200 Low Volatility Index was launched October 17, 2017. All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. Complete index methodology details are available at www.spdji.com. 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.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live: index values provided for any date or time period prior to the index's Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company's public website or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed "Date of introduction") is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index's public release date.

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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