Is the Low Volatility Anomaly Universal?

Contributors

Fei Mei Chan
Director
Index Investment Strategy
feimei.chan@spglobal.com

Craig J. Lazzara, CFA
Managing Director
Index Investment Strategy
craig.lazzara@spglobal.com

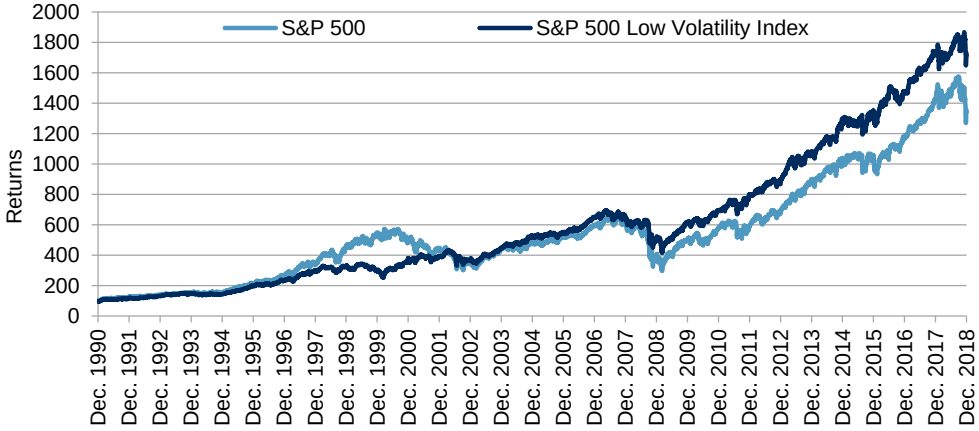
"Las Vegas is busy every day, so we know that not everyone is rational."

- Charles D. Ellis[1]

EXECUTIVE SUMMARY

- Portfolio managers have run defensive equity strategies for decades. Low volatility has become an important factor in the 10 years since the 2008 financial crisis.
- The low volatility anomaly challenges the conventional wisdom about risk and return—low volatility stocks, by definition, exhibit lower risk, but they have also outperformed their benchmarks over time. This phenomenon is observed universally across the globe.
- Low volatility strategies also exhibit a distinctive pattern of returns that is observable across capitalization tranches and geographic regions. They offer *protection* in down markets and *participation* in up markets.
- Low volatility's performance benefits from an asymmetry. Return dispersion tends to be above average when low volatility outperforms, and below average when low volatility underperforms.

Exhibit 1: Relative Performance of the S&P 500® Low Volatility Index versus the S&P 500



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. 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] Baker, Kent H. and Victor Ricciardi, "Understanding Behavioral Aspects of Financial Planning and Investing," Journal of Financial Planning.

INTRODUCTION

Low volatility investing gained immense popularity in the last decade.

Low volatility investing gained immense popularity in the last decade. A proliferation of passive investment vehicles based on this concept attracted more than $70 billion in assets globally as of the end of February 2019.[2]

The low volatility phenomenon is not, however, a new concept; academics first wrote about it more than four decades ago.[3] Low volatility strategies are familiar in the investment world; portfolio managers have sought volatility reduction, explicitly or otherwise, for as long as there have been portfolio managers.

In the U.S., the S&P 500 Low Volatility Index was the first index vehicle to exploit this phenomenon systematically.[4] Since 1991, the index has outperformed the S&P 500 (see Exhibit 1); more importantly, it has done so at a substantially *lower* level of volatility. Furthermore, the phenomenon is found in all markets segments and regions we have observed.

It is not, however, a new concept; academics first wrote about it more than four decades ago.

LOWER RISK…BUT HIGHER RETURNS?

There are different ways to construct a low volatility portfolio, giving portfolios different characteristics and results.[5] One common assumption of these methodologies is that **low volatility is a factor of return**, in the same sense that small size or cheap valuation are regarded as factors of return.[6] This is a counterintuitive—indeed, anomalous—assumption, since it seems to contradict what "everyone knows" about risk and return. Anyone who studies finance learns early on that risk and reward go hand in hand and that with higher expected returns come higher risks. Therefore, low volatility portfolios, which are by definition less risky than the market average, should underperform.

There are different ways to construct a low volatility portfolio, giving portfolios different characteristics and results.

Against this logical theory we have only some inconvenient facts. The outperformance shown in Exhibit 1 was accompanied by volatility levels that, as Exhibit 2 shows, were consistently lower than those of the S&P 500. Over the 28-year period, the S&P 500 Low Volatility Index gained 10.7% compared to the S&P 500's 9.8%, with a 23% *lower* standard deviation. Other examples abound. It's no wonder that academics regard

[2] Figure includes only products that are strictly classified as low or minimum volatility and does not include multi-factor products that include low or minimum volatility. Data from Morningstar and S&P DJI.

[3] 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; see also: Fama, Eugene F. and James D. MacBeth, "Risk, Return, and Equilibrium: Empirical Tests," *The Journal of Political Economy*, Vol. 81, No. 3. (May–June, 1973), pp. 607–636.

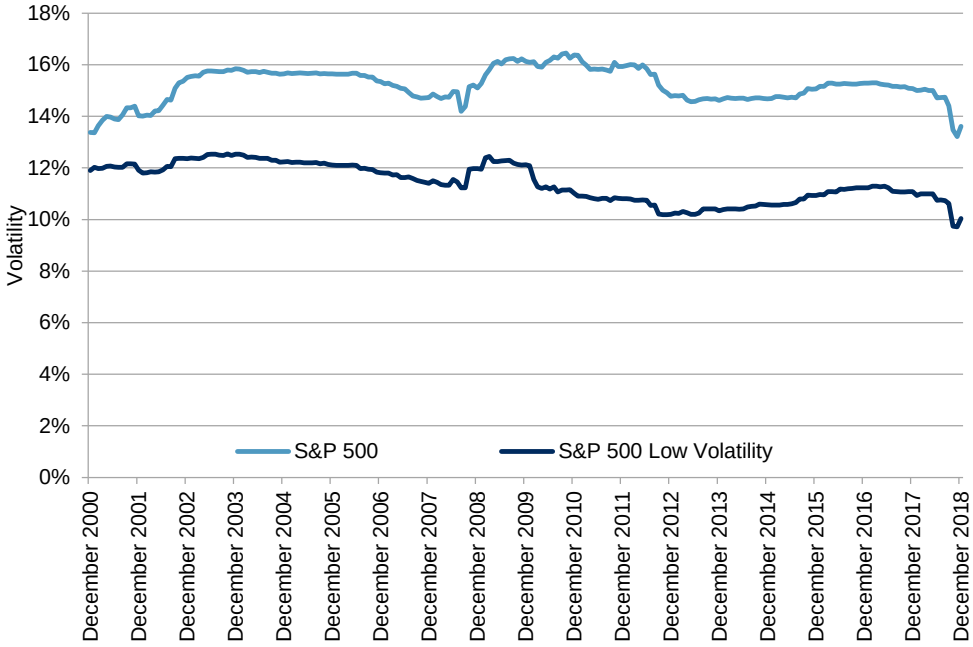
[4] The index comprises the 100 least volatile stocks in the S&P 500, as measured by their historical standard deviation. For complete methodology see S&P Low Volatility Index Methodology.

[5] See Soe, Aye M., "Inside Low Volatility Indices," S&P Dow Jones Indices, January 2017.

[6] Think of a "factor" as an attribute with which excess returns are associated. See Fama, Eugene F. and Kenneth R. French, "Common risk factors in the returns on stocks and bonds," *Journal of Financial Economics* 33 (February 1993), pp 3-56.

"the long-term outperformance of low-risk portfolios [as] **perhaps the greatest anomaly in finance**."[7]

Exhibit 2: The S&P 500 Low Volatility Index Has Been Consistently Less Volatile than the S&P 500



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. 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 methodology underlying the S&P 500 Low Volatility Index is simple. It requires the conviction that low volatility persists.

PERSISTENCE

The methodology underlying the S&P 500 Low Volatility Index is almost painfully simple. Based on the standard deviation of the trailing 252 daily returns, we identify the 100 least volatile stocks in the S&P 500 and weight them inversely to their volatility. The index is rebalanced quarterly; no quadratic formulae need apply. We sometimes refer to this as a "rankings-based" approach to low volatility, since index inclusions are driven strictly by a stock's volatility ranking compared to those of its peers.

This simple procedure does not require the construction of risk models or the artful use of complicated optimization routines. What it does require, however, is the conviction that **low volatility persists**. Otherwise said, the methodology assumes that stocks that have been in the lowest quintile of volatility for the past year will continue to be of below-average volatility for at least the next quarter.

Is this assumption correct? The most obvious evidence has already been unveiled in Exhibit 2. When the S&P 500's volatility rises (as in 2002 or 2008), the S&P 500 Low Volatility Index has also tended to be more

[7] Baker, Malcolm, Brendan Bradley, and Jeffrey Wurgler, "Benchmarks as Limits to Arbitrage: Understanding the Low-Volatility Anomaly," Financial Analysts Journal 67 (2011), pp 40-54 (emphasis added).

volatile, but its volatility has been *consistently lower* than that of the S&P 500. In other words, the **evidence that low volatility persists, at least in the short to medium term, is strong**.

Exhibit 3 is another way to substantiate the rankings-based approach to accessing low volatility. The matrix shows the percentage of stocks in the S&P 500 that overlapped in specific volatility quintiles over two consecutive years. Sixty-five percent of the stocks in the least volatile quintile in year one continued in the least volatile quintile in year two. Nearly all of the stocks (88% = 65% + 23%) in the least volatile quintile had below average volatility in the following year. These data lend credence to the view that low volatility persists, at least in the short to medium term.

Our data lend credence to the view that low volatility persists, at least in the short to medium term.

Exhibit 3: Volatility Tends to Persist and a Majority of Stocks with the Highest (or Lowest) Volatility in One Year Remained So in the Subsequent Year

QUINTILE		VOLATILITY QUINTILE, SUBSEQUENT YEAR (%)				
		1	2	3	4	5
VOLATILITY QUINTILE, PREVIOUS YEAR	1	65	23	8	2	2
	2	22	41	26	9	2
	3	7	24	35	27	7
	4	3	9	24	38	26
	5	2	4	9	23	63

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. 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.

PERFORMANCE PATTERNS

In essence, low volatility strategies temper the performance of the market.

It's instructive to observe how low volatility performs in different market environments.[8] In essence, low volatility strategies temper the performance of the market. This means that in rising markets, a low volatility index should lag its benchmark; in falling markets, low volatility should decline less than the benchmark. Exhibit 4 illustrates this succinctly. Monthly returns of the S&P 500 from 1991 through 2018 are plotted against the monthly return difference between the S&P 500 Low Volatility Index and the S&P 500. Performance differentials for the low volatility index exhibit a strong inverse relationship with the performance of the S&P 500.

[8] We've long argued that it's vital to understand how index performance can be contingent on the market environment. See Lazzara, Craig J., "The Limits of History," S&P Dow Jones Indices, February 2013.

Exhibit 4: Relative Performance of Low Volatility Has a Strong Inverse Relationship with the Performance of the Benchmark

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. 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.

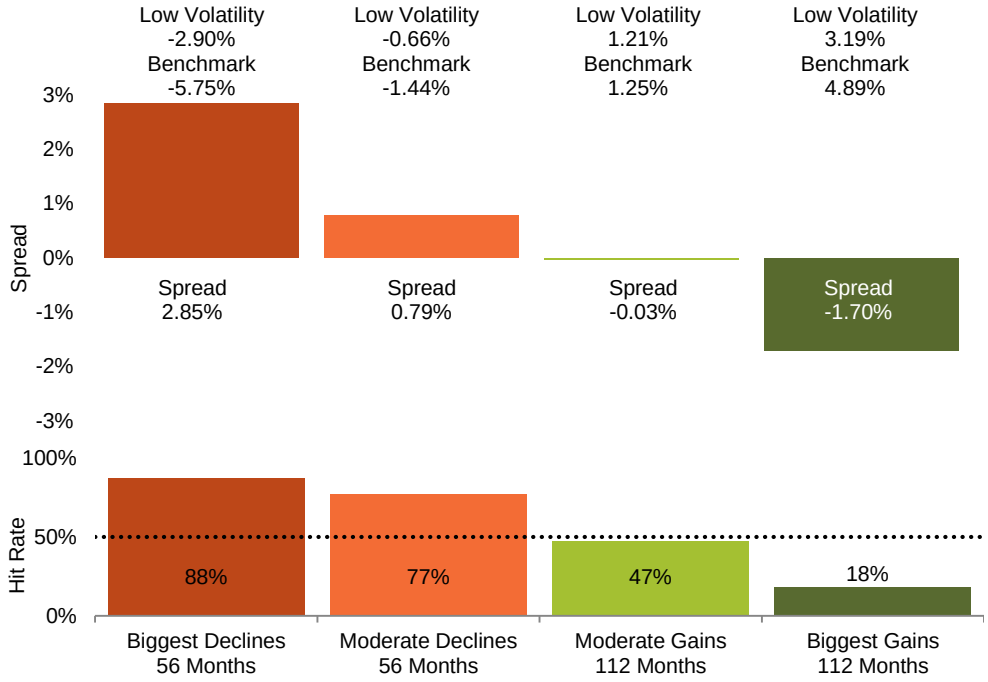
In the 56 months during which the S&P 500 declined the most, the S&P 500 Low Volatility Index outperformed by an average of 2.85%.

Exhibit 5 gathers the months from Exhibit 4 into four buckets. There were a total of 336 months in the period; the S&P 500 declined in 112 and rose in 224. We divided both the positive and negative months in half, which gives us an appreciation for the *magnitude* of market moves, as well as their *direction*.

In the 112 best months, the index underperformed by an average of -1.70%.

For example, in the 56 months during which the S&P 500 declined the most, the S&P 500 Low Volatility Index outperformed by an average of 2.85%. Moreover, its hit rate was 88%—meaning that it outperformed the S&P 500 in 49 months, 88% of the total. Moving along the chart in Exhibit 5, the spread between the S&P 500 Low Volatility Index and the S&P 500 diminishes, and the hit rates decline as well. In the 112 best months, the S&P 500 Low Volatility Index underperformed 82% of the time, by an average of -1.70%. Results are analogous in the smaller negative and smaller positive months.

Exhibit 5: Low Volatility Strategies Tend to Offer Protection in Down Markets but Won't Participate Fully in Up Markets



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.46%, moderate declines were months when the benchmark returned between -2.46% and 0%, moderate gains were months when the benchmark returned between 0% and 2.45%, and biggest gains were months when the benchmark gained more than 2.45%. 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.

Low volatility strategies allow for market participation during good times while also providing protection in bad times.

We can therefore conclude that the low volatility strategy attenuates the market's return, in both directions. The S&P 500 Low Volatility Index tended to rise less than the market when the market was up, and tended to decline less than the market when the market was down—and that's why its overall volatility was lower than that of the S&P 500. Low volatility strategies allow for market *participation* during good times while also providing *protection* in bad times.

UNIVERSALITY

If the low volatility story ended there, it would be an interesting strategy for U.S. portfolio managers, but not much more. However, there is more to the story; applying the methodology originally developed for the S&P 500 produces similar results in a range of other markets. The critical elements of this methodology are simple:

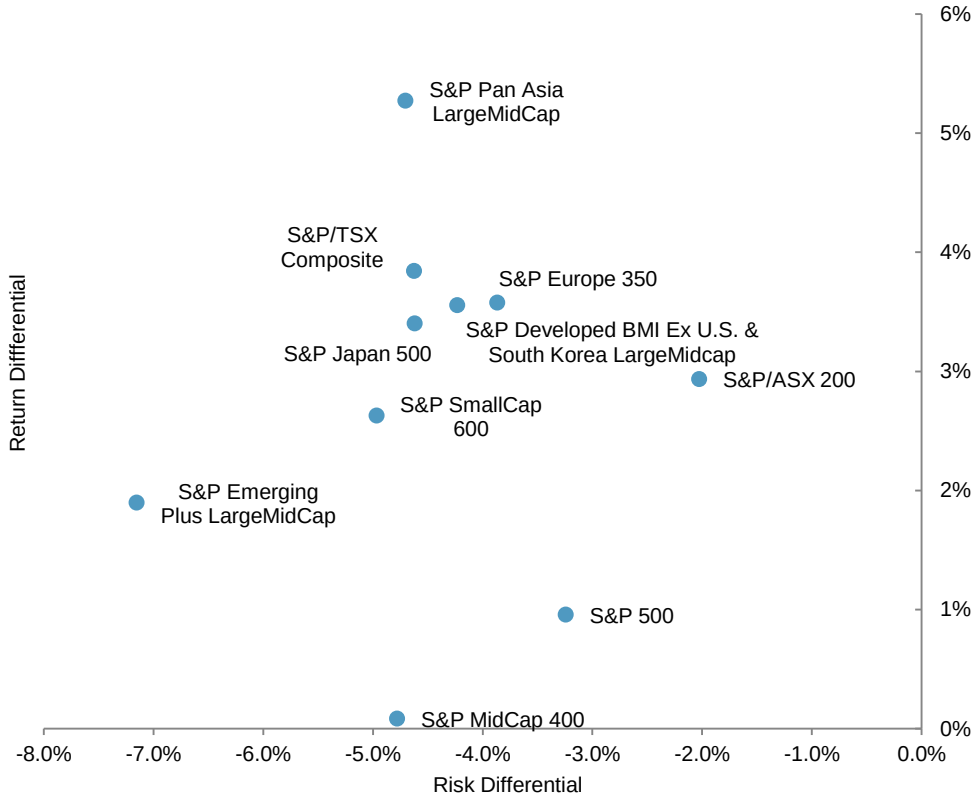
- Measure volatility with daily returns over a one-year period;
- Select approximately one-fifth of the stocks in the benchmark index as constituents of the low volatility index;
- Weight the constituents inverse to their volatility; and
- Rebalance quarterly.

As in the U.S., all regional low volatility indices make the critical assumption that low volatility persists.

Exhibit 6 demonstrates that for mid- and small-cap U.S. stocks, as well as for a range of international markets, this methodology has produced substantial reductions in volatility relative to the applicable benchmark index. Without exception, it also generated superior returns.

Exhibit 6: Universally, Low Volatility Strategies Have Outperformed Respective Asset Class Benchmarks with Lower Risk

In Pan Asia, the low volatility strategy worked almost identically to its S&P 500-based counterpart



Source: S&P Dow Jones Indices LLC. Data through Dec. 31, 2018. Data start date varies for each index (see Appendix A). Standard deviations are computed by annualizing the standard deviation of monthly returns. 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.

It's particularly important, when comparing low volatility strategies from different regions, to be aware of the differential impact of each market environment. For example, Exhibit 6 shows us that low volatility outperformed in Pan Asia by a much greater amount than in the U.S., but that could be because the Asian markets did not perform as well during our test period as the U.S. market (recall from Exhibit 5 that low volatility indices tend to outperform in weak markets and underperform in strong ones).

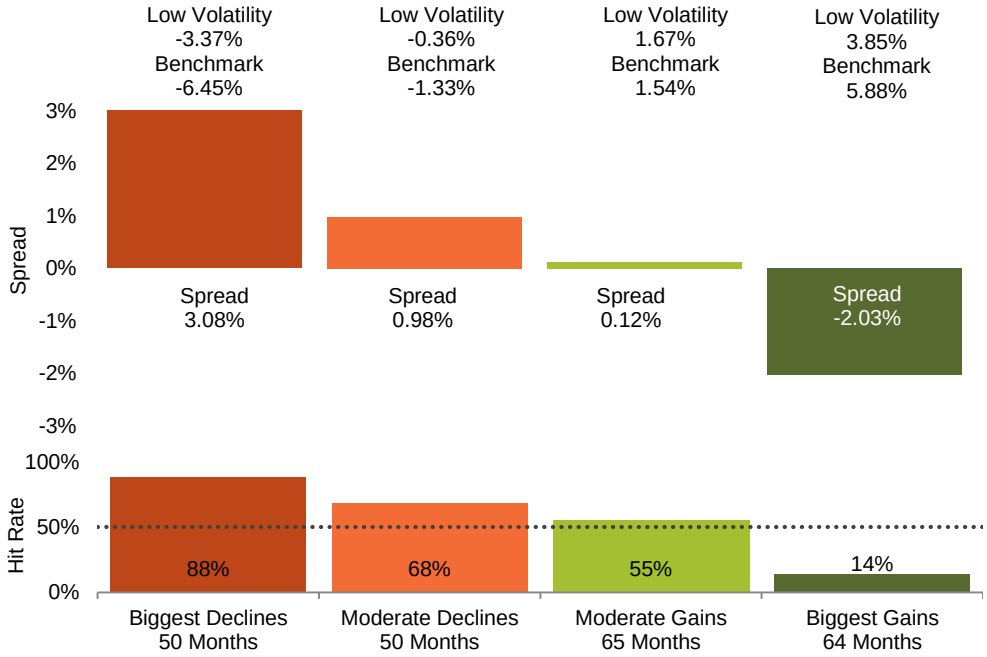
To improve our understanding of low volatility's performance in the Pan Asia region, we constructed Exhibit 7, which shows the impact of the

market environment on low volatility. Comparing Exhibits 5 and 7 shows that in Pan Asia, the low volatility strategy worked almost identically to its S&P 500-based counterpart. As market conditions improved, the low volatility strategy tended to underperform. In weak markets, the low volatility strategy tended to outperform. The same pattern can be observed in other markets (see Appendix B).

Exhibit 7: Low Volatility Strategies Exhibit a Distinct Pattern of Returns that Is Observable across All Asset Classes – Pan Asia

Wherever we've looked, simple, rankings-based low volatility strategies have attenuated the volatility of their benchmark indices…

…typically while recording higher levels of total return



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.95%, moderate declines were months when the benchmark returned between -2.95% and 0%, moderate gains were months when the benchmark returned between 0% and 2.97%, and biggest gains were months when the benchmark gained more than 2.97%. 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.

In summary, wherever we've looked, simple, rankings-based low volatility strategies have attenuated the volatility of their benchmark indices, typically while recording higher levels of total return. Whatever one might say about the low volatility anomaly, it is clearly not unique to large-capitalization U.S. stocks.

Low volatility lost slightly more often than it won, but it won by a larger spread when it outperformed than it lost when it underperformed.

PARTITIONING LOW VOLATILITY'S OUTPERFORMANCE

An investment strategy's success can be measured by both frequency and magnitude: how often it outperforms, and by how much. In data for the U.S., for example, the S&P 500 Low Volatility Index outperformed the S&P 500 in 49% of the months in our data set. When it outperformed, the average monthly outperformance was 1.98%, while the average underperformance in months when low volatility lagged the S&P 500 was 1.83%. In a performance sense, in other words, low volatility lost slightly

more often than it won, but it won by a larger spread when it outperformed than it lost when it underperformed.

The concept of *dispersion* can illuminate this asymmetry.[9] Dispersion measures the degree to which stock returns in a given market differ from one another. The higher the dispersion is, the greater will be the difference between the returns of a capitalization-weighted index and the returns of a factor index such as low volatility.[10] **The periods in which low volatility has tended to outperform have been periods of above-average dispersion**. Similarly, the periods in which low volatility has underperformed have been periods of below-average dispersion.[11]

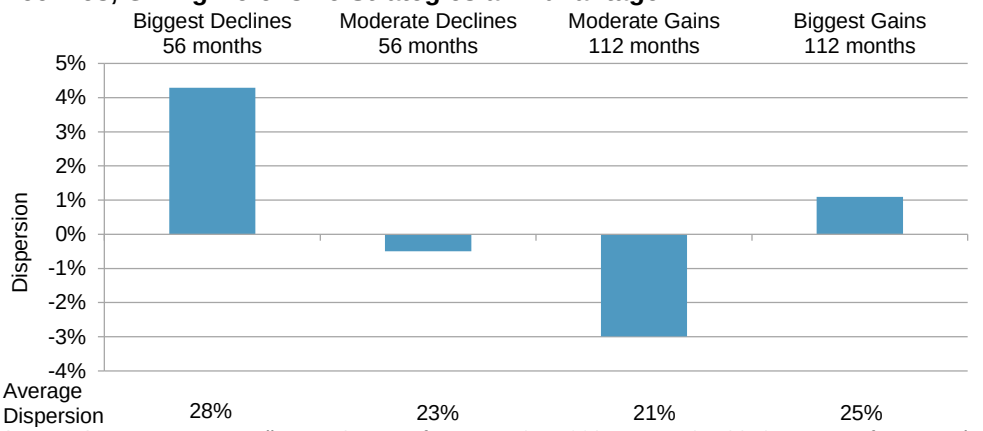
The periods in which low volatility has tended to outperform have been periods of above-average dispersion.

This effect is not coincidental. As we've seen, low volatility (and other defensive indices) tend to outperform in weak stock markets. Weak stock markets tend to occur in times of relatively high volatility. And high volatility is typically associated with high dispersion.[12]

From 1991 through 2018, average monthly dispersion for the S&P 500 was 23.6%. Exhibit 8 shows that in the months of the S&P 500's worst performance, dispersion was 4% greater than average. Put simply, **the months when low volatility strategies were most likely to outperform tended to be months when the payoff for being right was above average; the months when low volatility was likely to underperform tended to be months when the penalty for being wrong was below average**.

Similarly, the periods in which low volatility has underperformed have been periods of below-average dispersion.

Exhibit 8: Dispersion Was Highest in the Months of the Biggest Market Declines, Giving Defensive Strategies an Advantage



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. 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.

[9] Edwards, Tim and Craig J. Lazzara, "Dispersion: Measuring Market Opportunity," S&P Dow Jones Indices, December 2013.

[10] Chan, Fei Mei and Craig J. Lazzara, "Gauging Differential Returns," S&P Dow Jones Indices, January 2014. A similar observation applies to active management. See Lazzara, Craig, "The Value of Skill," March 20, 2015.

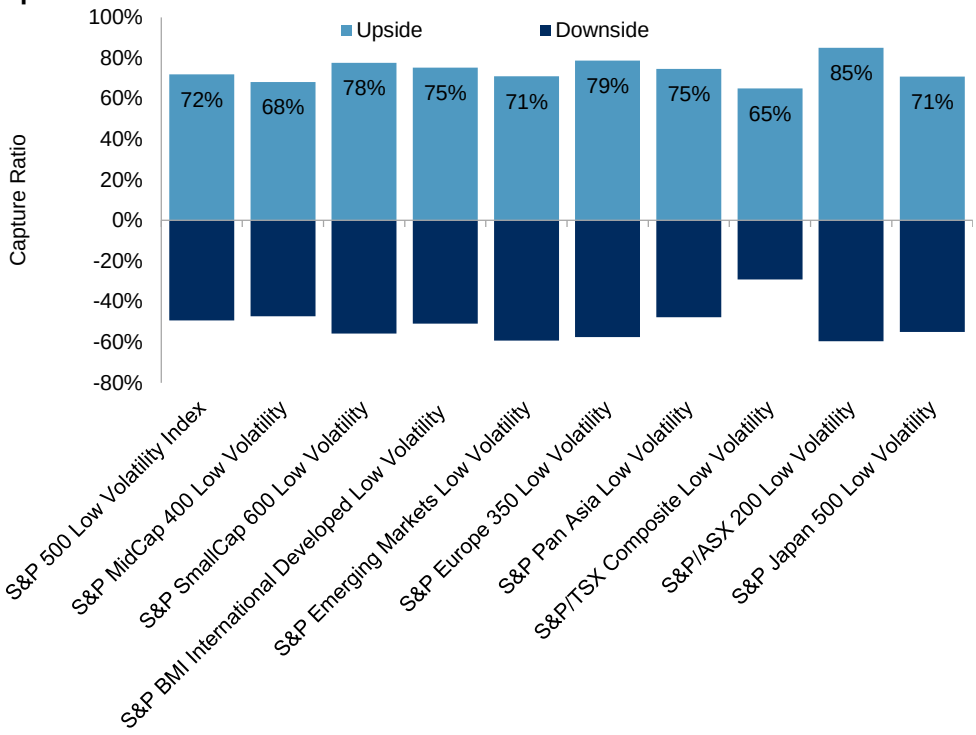
[11] Chan, Fei Mei and Craig J. Lazzara, "The Best Offense: When Defensive Strategies Win," March 2015.

[12] Edwards, Tim and Craig J. Lazzara, "The Landscape of Risk," S&P Dow Jones Indices, December 2014.

It is tautological that any defensive index, low volatility included, will mitigate the market's moves in both directions. Capture ratios (computed as the ratio of low volatility performance to benchmark performance) should always be less than 1.00. The advantage of low volatility is that the upside capture ratio is characteristically greater than the downside capture, as illustrated in Exhibit 9.

The advantage of low volatility is that the upside capture ratio is characteristically greater than the downside capture.

Exhibit 9: In All Markets Observed, Low Volatility Captured More of the Upside than the Downside



Source: S&P Dow Jones Indices LLC. Data through Dec. 31, 2018. Index start date varies for each asset class (see Appendix A). Standard deviations are computed by annualizing the standard deviation of monthly returns. 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.

This is not a lucky coincidence—it follows directly from the way in which dispersion interacts with the market's direction.

This is not a lucky coincidence—it follows directly from the way in which dispersion interacts with the market's direction. When the market is down, low volatility tends to outperform, and dispersion tends to be high. The gap between the performance of low volatility and the benchmark is therefore relatively large, leading to low capture ratios. When the market is up, low volatility tends to underperform, but dispersion tends to be low. The gap between the performance of low volatility and the benchmark is therefore relatively small, producing higher capture ratios.

RATIONALIZING THE LOW VOLATILITY ANOMALY

There are a number of (non-mutually exclusive) explanations for the existence of a low volatility effect or anomaly. We highlight two, both of

which explain why market participants might be inclined to overpay for high volatility stocks.[13]

One explanation is *leverage aversion*. The Capital Asset Pricing Model (CAPM) argues that a stock's return should be proportionate to its systematic risk, or beta. Early empirical tests found that this formulation worked well for stocks with betas below 1.00, but not for higher beta stocks.[14] One explanation for this is that the CAPM assumes that all investors should own the market portfolio; if they want more risk than the market offers, they should own the market portfolio with leverage. In practice, transaction costs and regulatory restraints inhibit the use of leverage. An investor targeting a beta of 1.20 is unlikely to hold the S&P 500 with 20% leverage—instead he'll buy a portfolio of stocks with a beta averaging 1.20. This creates excess demand for high beta, high volatility stocks, elevating their prices above intrinsic value. A strategy that systematically avoids such stocks is therefore likely to benefit.

Leverage aversion and "preference for lotteries are two explanations that explain why market participants might overpay for high volatility stocks.

A second explanation comes from the realm of *behavioral finance,* specifically from the cognitive bias that behavioral economists call the "preference for lotteries." Their argument is that no rational person would ever buy a lottery ticket, since the expected return of such a purchase is negative. But we know that billions of lottery tickets are sold all over the world every day. Why do so many people behave in a way that classical economics regards as completely irrational? The behavioral argument is that some people are willing to risk a known amount of money in exchange for the possibility, however slim, of a gigantic payoff.

If this happens in a game of chance, how does it apply to financial markets? What's the analogy to a lottery ticket in the stock market? The stock market's lottery tickets are the stocks of highly volatile companies. Ultimately, they may not amount to much, but one of them could be the next Apple. Some investors are willing to pay for the chance of an improbable—but very large—reward.

This tendency, which also amounts to buying volatility for volatility's sake, drives the price of lottery-like stocks above their fair value. This means that **a portfolio that systematically excludes the most-volatile stocks**—exactly what rankings-based low volatility indices do—**is more likely to outperform over time, globally**.

CONCLUSION

The low volatility anomaly is an observable phenomenon across market segments and regions. Low volatility indices have outperformed their capitalization-weighted benchmarks over time with lower risk. Even more

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

[14] Jensen, Black, and Scholes, *op. cit.*

remarkably, without exception, low volatility indices exhibit a distinct pattern of returns when compared to their benchmarks. They all attenuate the performance of the broader market, losing less when markets decline and gaining less when markets rise. Because of this dynamic, low volatility indices are poised to take advantage of an important market characteristic; they outperform in periods of relatively high dispersion. Otherwise said, **low volatility strategies tend to be right when the payoff for being right is most advantageous**.

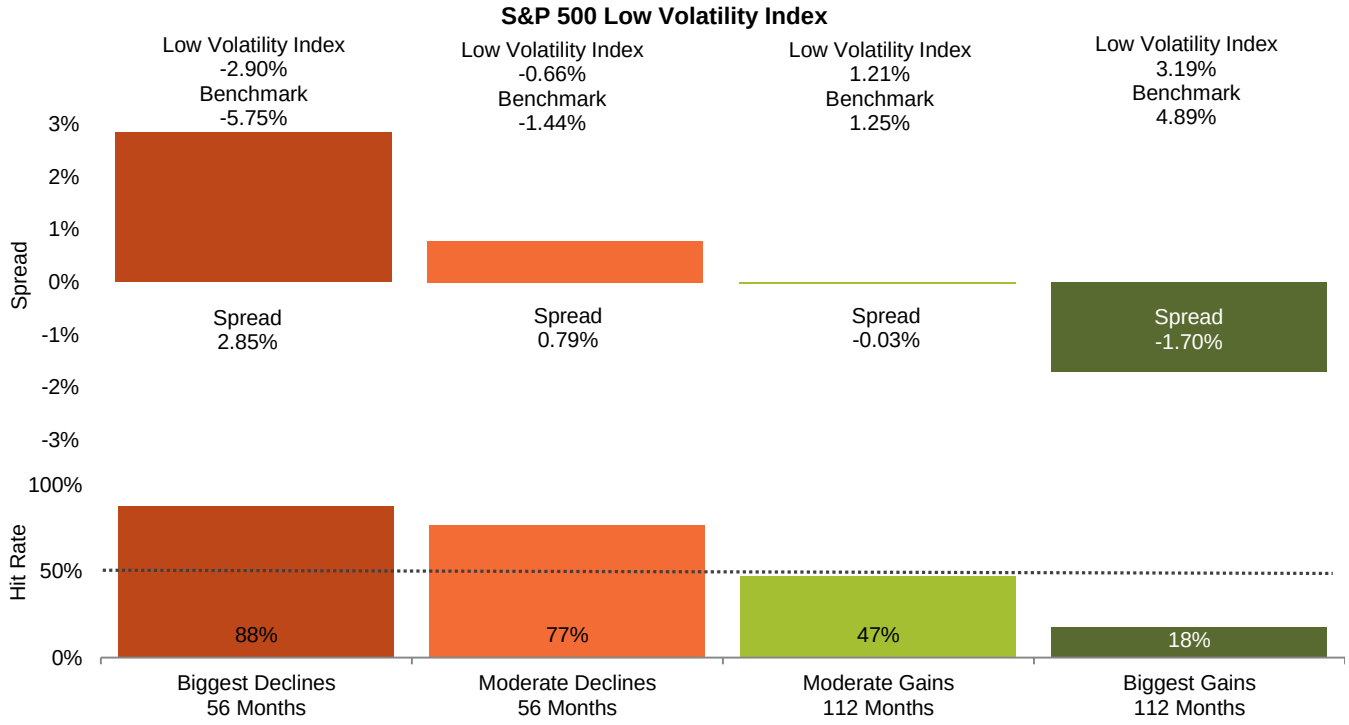
APPENDIX A: LOW VOLATILITY INDICES

Exhibit 6: Low Volatility Indices

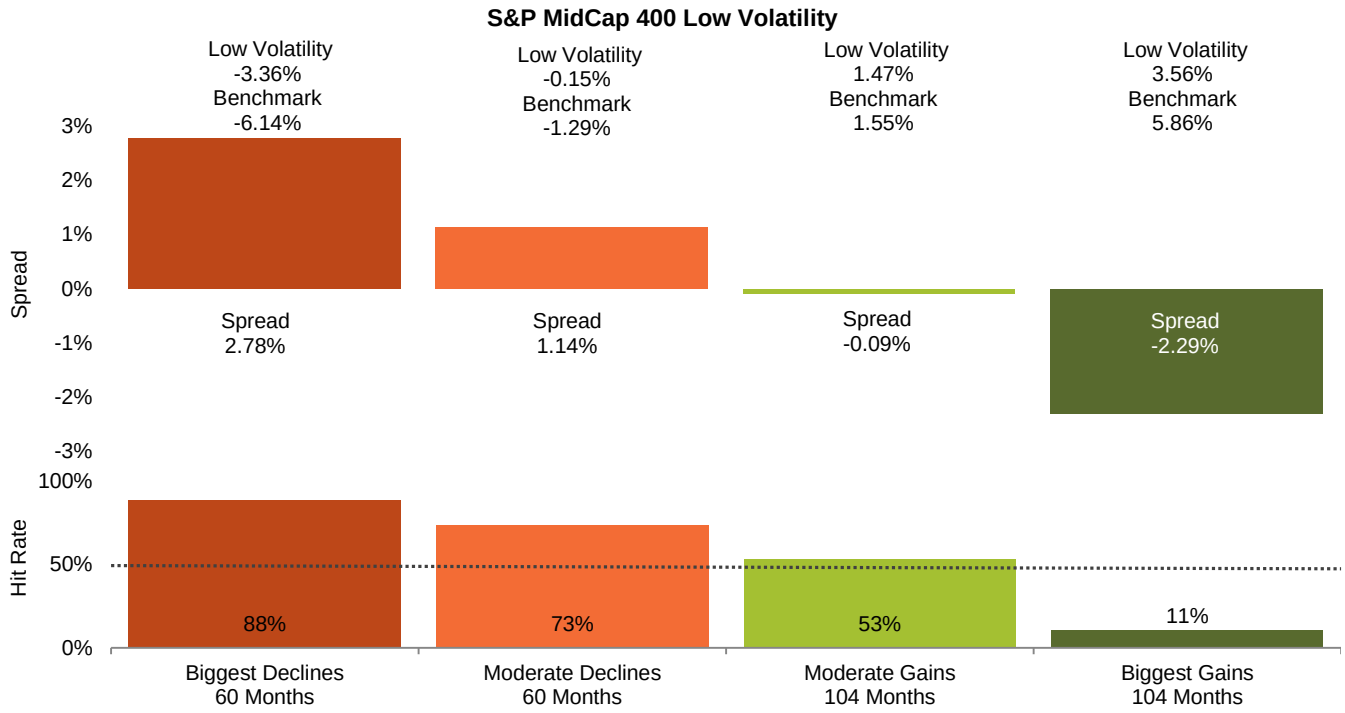
LOW VOLATILITY INDEX	NUMBER OF STOCKS	FIRST VALUE DATE	BENCHMARK INDEX	NUMBER OF STOCKS
S&P 500 Low Volatility	100	Dec. 31, 1990	S&P 500	500
S&P MidCap 400 Low Volatility	80	Aug. 16, 1991	S&P MidCap 400	400
S&P SmallCap 600 Low Volatility	120	Feb. 17, 1995	S&P SmallCap 600	600
S&P BMI International Developed Low Volatility	200	June 28, 1991	S&P Developed Ex-U.S. & Korea LargeMidCap	1210
S&P EPAC Ex-Korea Low Volatility	200	May 25, 2015	S&P EPAC Ex-Korea LargeMidCap	1108
S&P BMI Emerging Markets Low Volatility	200	Sept. 30, 1997	S&P Emerging Plus LargeMidCap	1173
S&P Europe 350 Low Volatility	100	March 31, 1998	S&P Europe 350	350
S&P Pan Asia Low Volatility	50	Nov. 30, 1999	S&P Pan Asia LargeMidCap	1464
S&P/ASX 200 Low Volatility Index	40	June 16, 2000	S&P/ASX 200	200
S&P/TSX Composite Low Volatility	50	March 31, 1997	S&P/TSX Composite	241
S&P Japan 500 Low Volatility	100	March 19, 1993	S&P Japan 500	500

Source: S&P Dow Jones Indices LLC. Data as of Dec. 31, 2018. Table is provided for illustrative purposes.

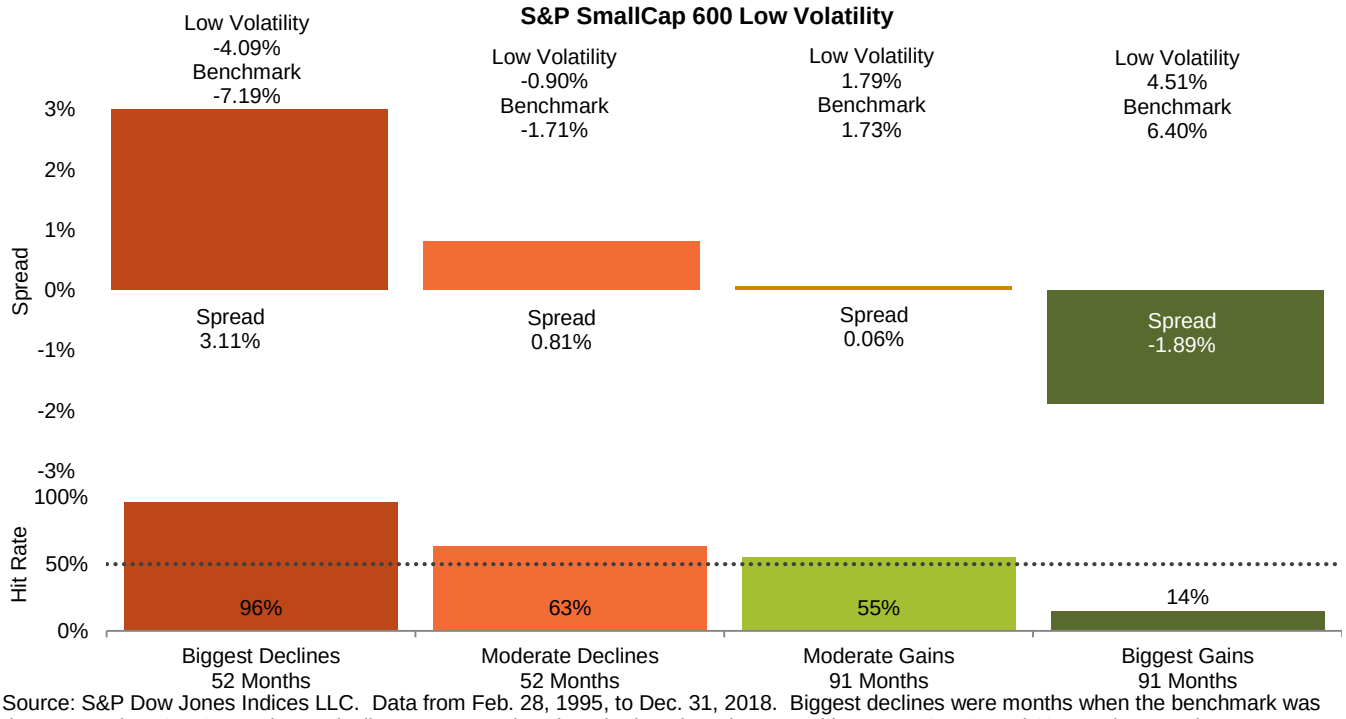
APPENDIX B: AVERAGE MONTHLY PERFORMANCE IN DIFFERENT MARKET ENVIRONMENTS



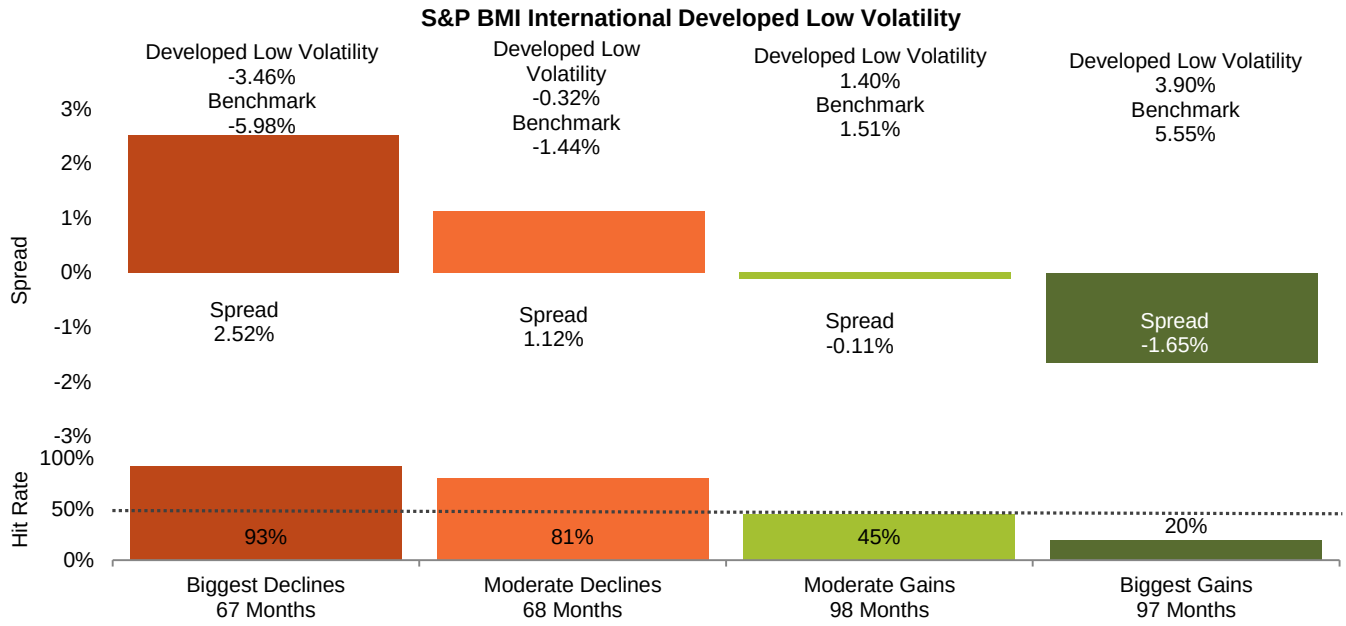
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.46%, moderate declines were months when the benchmark returned between -2.46% and 0%, moderate gains were months when the benchmark returned between 0% and 2.45%, and biggest gains were months when the benchmark gained more than 2.45%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



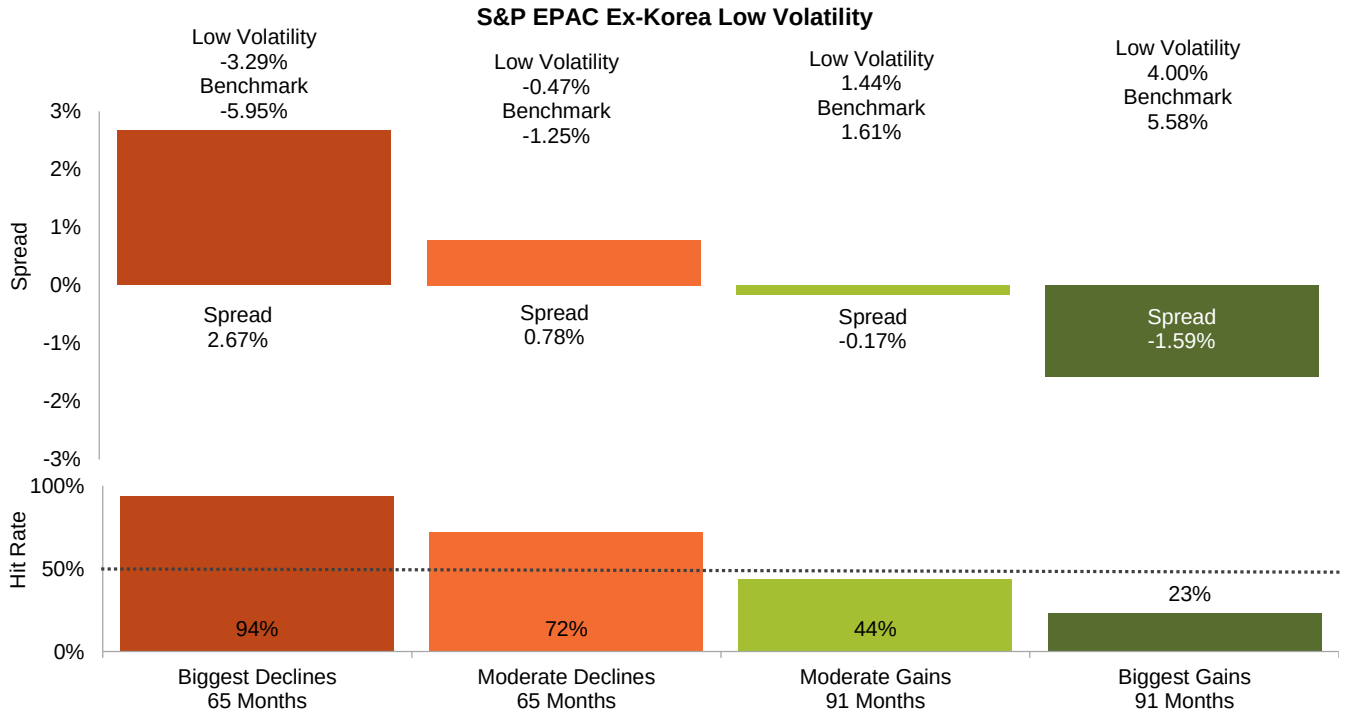
Source: S&P Dow Jones Indices LLC. Data from Aug. 30, 1991, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.85%, moderate declines were months when the benchmark returned between -2.85% and 0%, moderate gains were months when the benchmark returned between 0% and 3.11%, and biggest gains were months when the benchmark gained more than 3.11%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



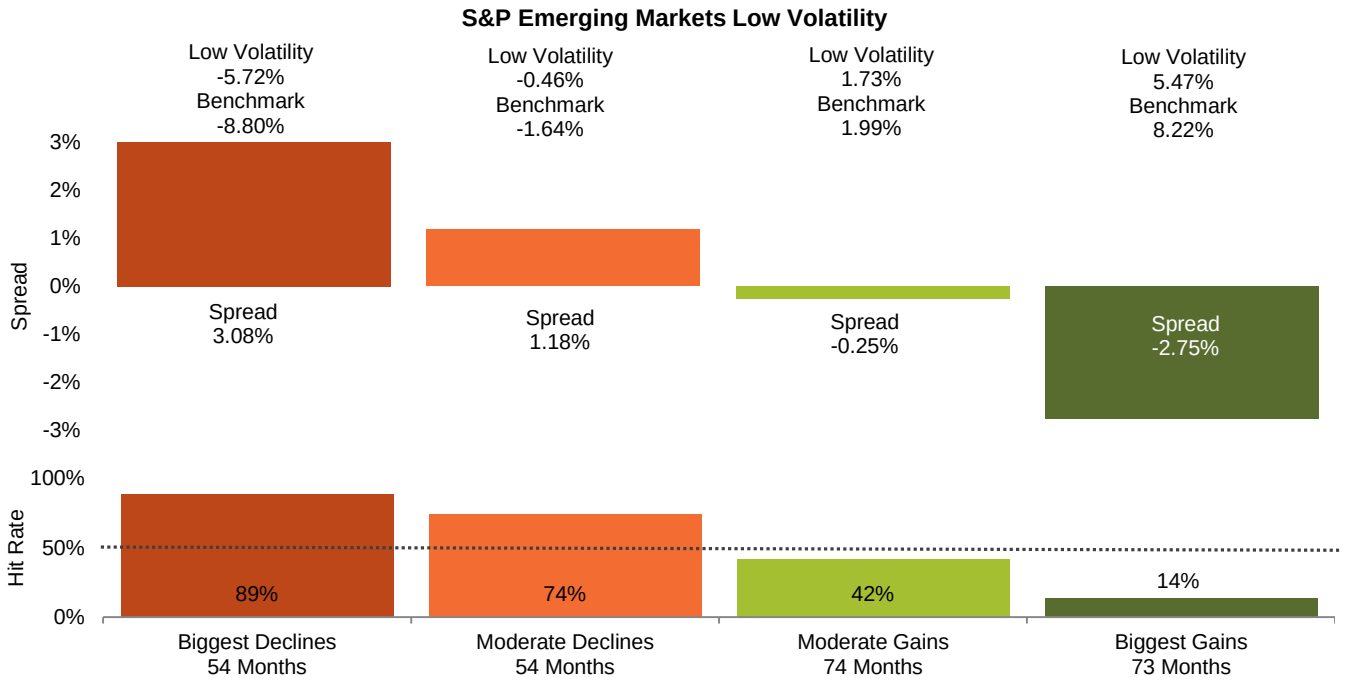
Source: S&P Dow Jones Indices LLC. Data from Feb. 28, 1995, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 3.41%, moderate declines were months when the benchmark returned between -3.41% and 0%, moderate gains were months when the benchmark returned between 0% and 3.54%, and biggest gains were months when the benchmark gained more than 3.54%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



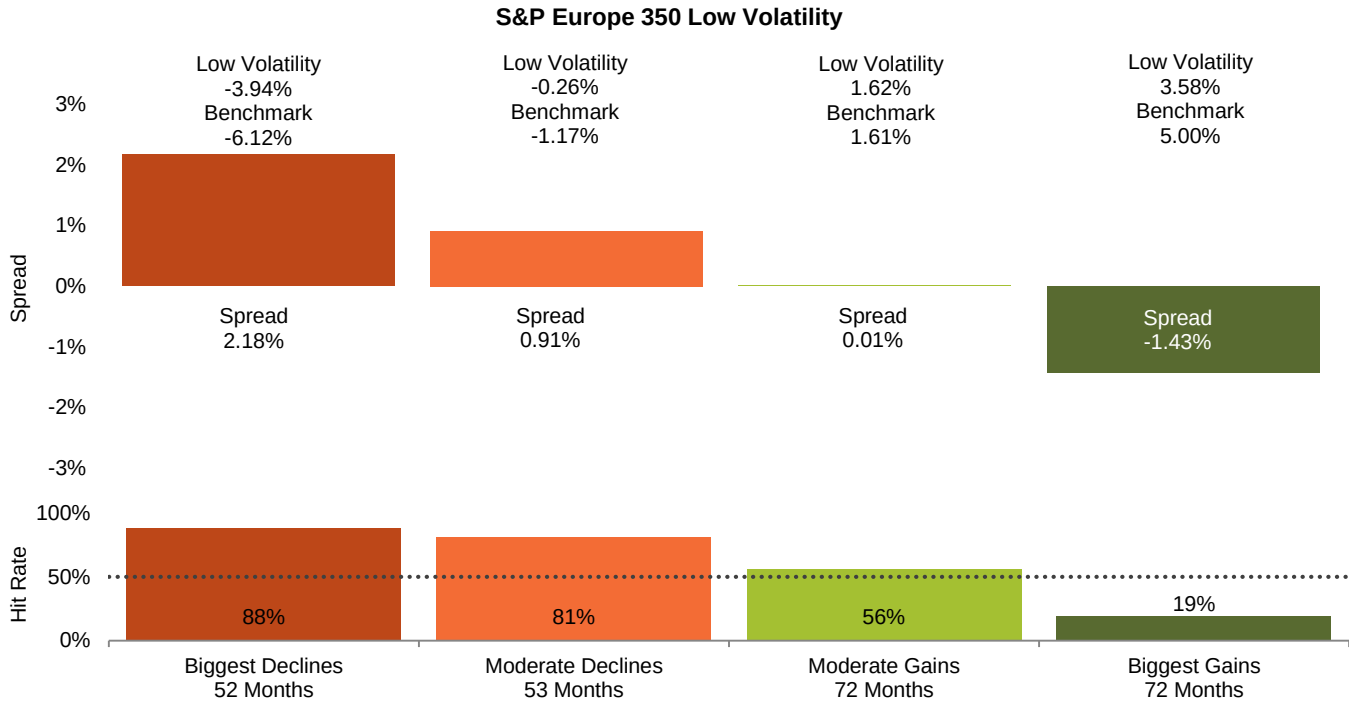
Source: S&P Dow Jones Indices LLC. Data from June 28, 1991, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.80%, moderate declines were months when the benchmark returned between -2.80% and 0%, moderate gains were months when the benchmark returned between 0% and 3.06%, and biggest gains were months when the benchmark gained more than 3.06%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



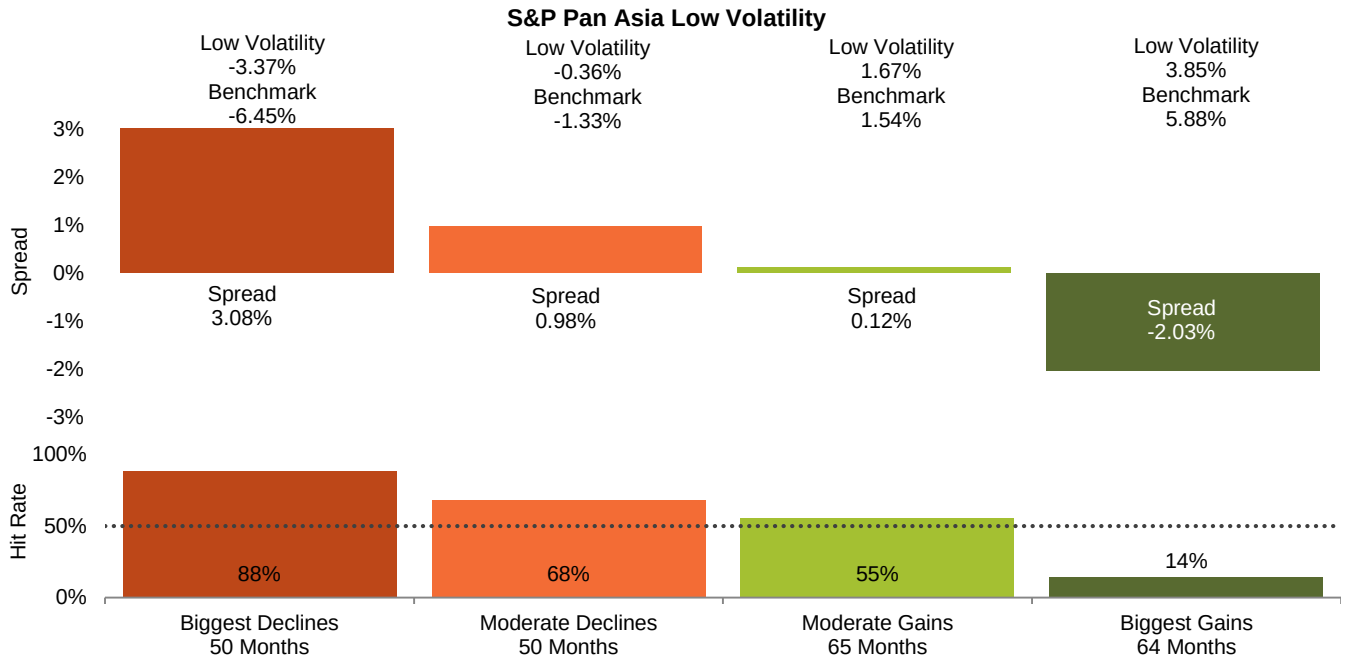
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1992, through Dec. 31, 2018. Biggest declines were months when the benchmark was down more than -2.50%, moderate declines were months when the benchmark returned between -2.50% and 0%, moderate gains were months when the benchmark returned between 0% and 3.04%, and biggest gains were months when the benchmark gained more than 3.04%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



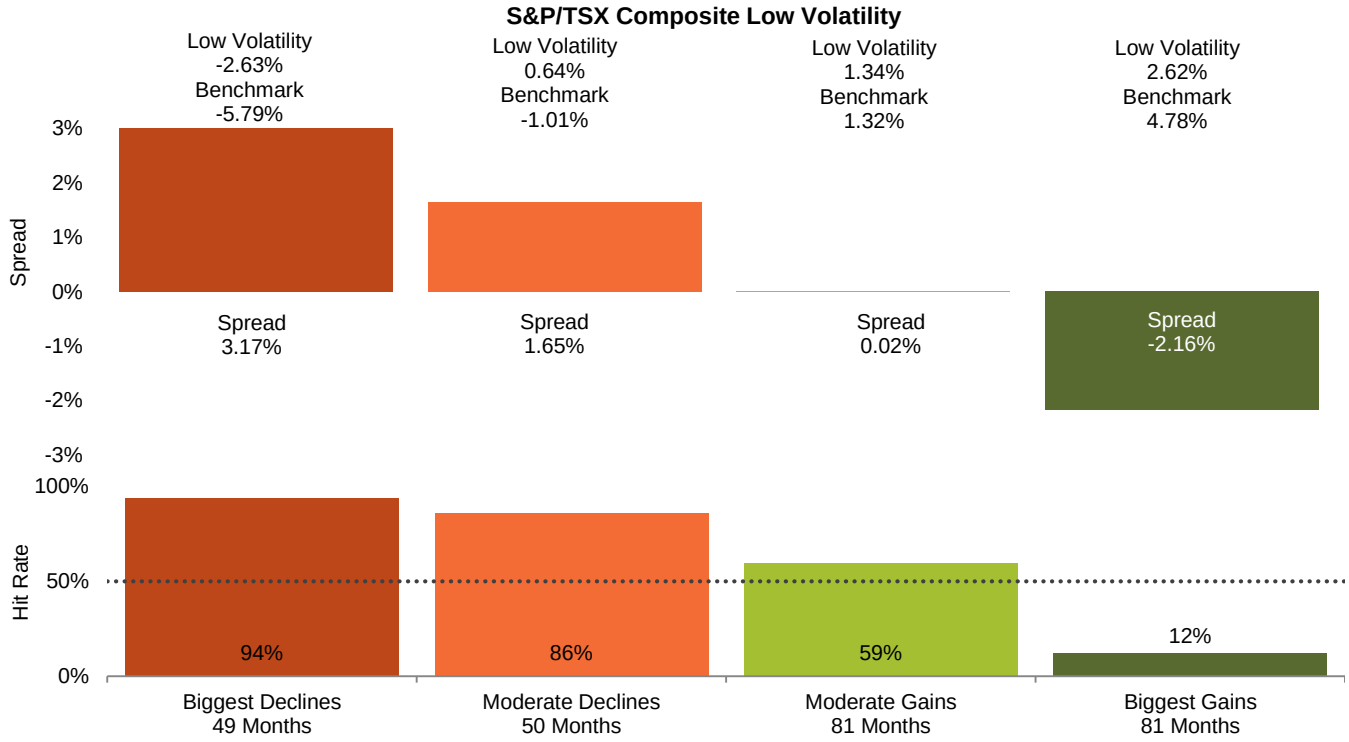
Source: S&P Dow Jones Indices LLC. Data from Sept. 30, 1997, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 3.30%, moderate declines were months when the benchmark returned between -3.30% and 0%, moderate gains were months when the benchmark returned between 0% and 4.21%, and biggest gains were months when the benchmark gained more than 4.21%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



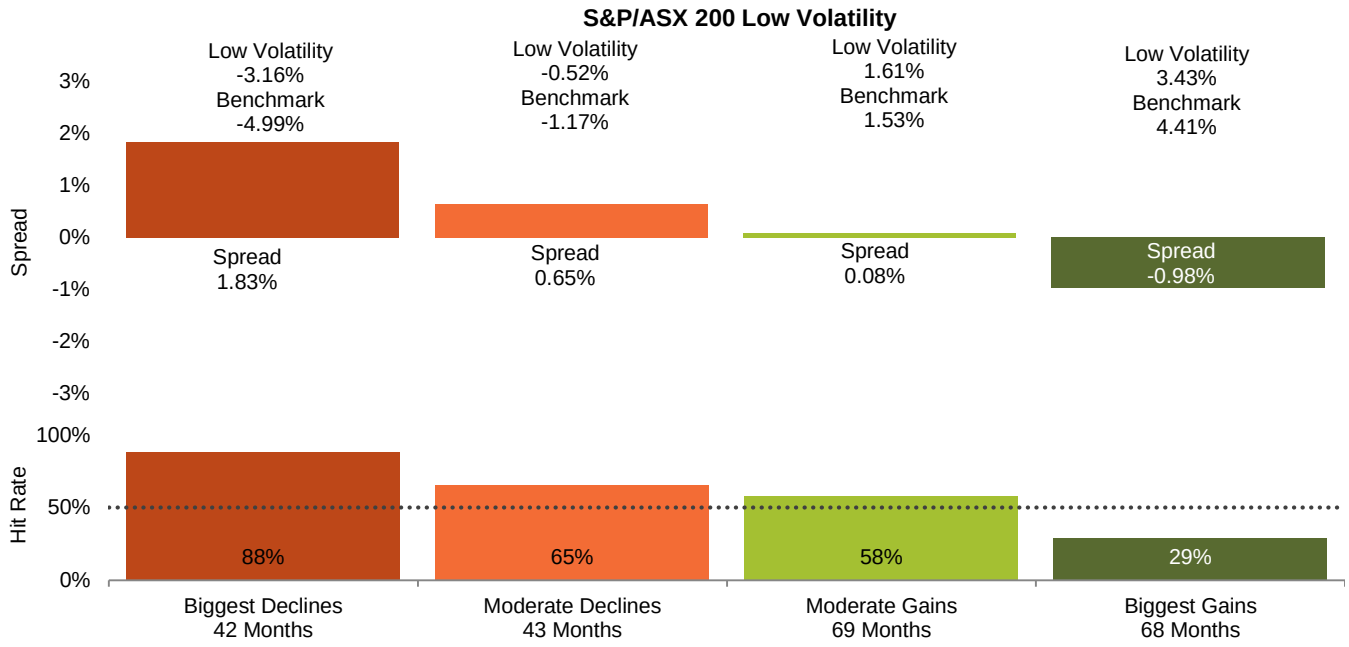
Source: S&P Dow Jones Indices LLC. Data from March 20, 1998, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.47%, moderate declines were months when the benchmark returned between -2.47% and 0%, moderate gains were months when the benchmark returned between 0% and 2.73%, and biggest gains were months when the benchmark gained more than 2.73%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



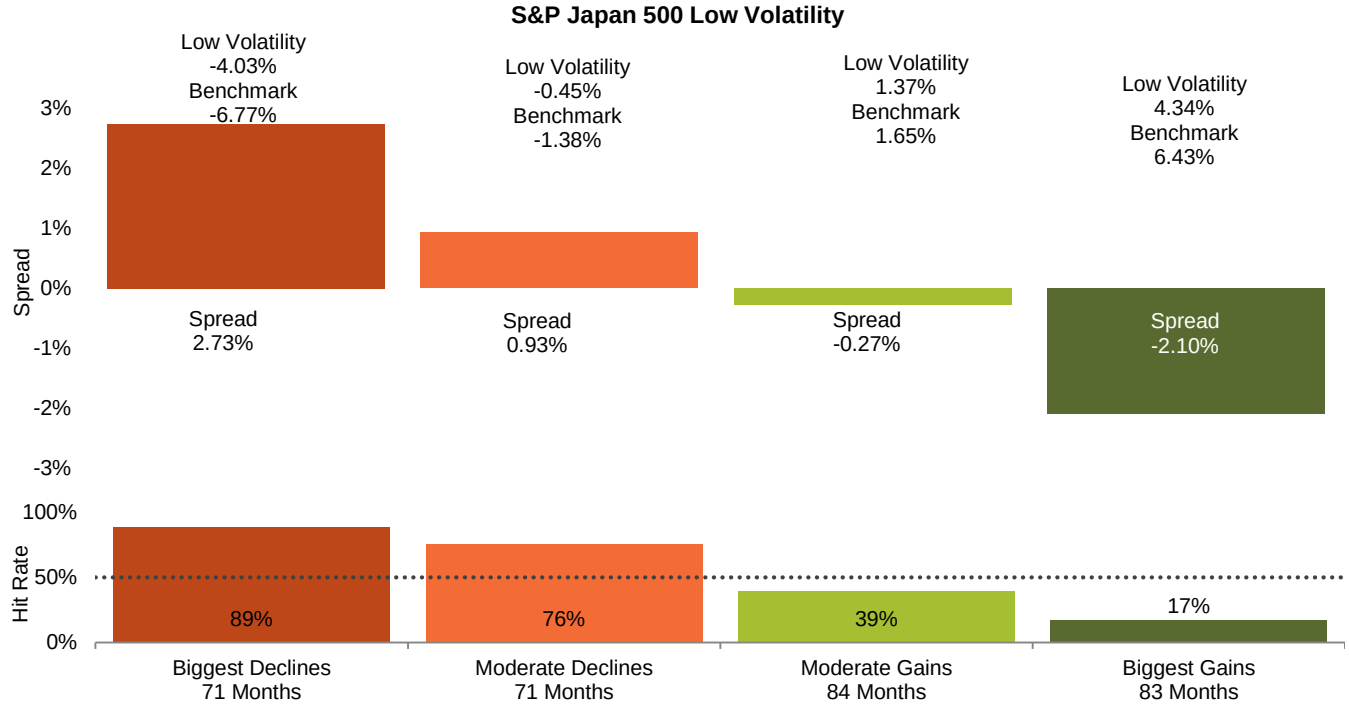
Source: S&P Dow Jones Indices LLC. Data from Nov. 19, 1999, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.95%, moderate declines were months when the benchmark returned between -2.95% and 0%, moderate gains were months when the benchmark returned between 0% and 2.97%, and biggest gains were months when the benchmark gained more than 2.97%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



Source: S&P Dow Jones Indices LLC. Data from March 21, 1997, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.35%, moderate declines were months when the benchmark returned between -2.35% and 0%, moderate gains were months when the benchmark returned between 0% and 2.57%, and biggest gains were months when the benchmark gained more than 2.57%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



Source: S&P Dow Jones Indices LLC. Data from June 16, 2000, to Dec. 31, 2018. Biggest declines were months when the benchmark was down more than 2.21%, moderate declines were months when the benchmark returned between -2.21% and 0%, moderate gains were months when the benchmark returned between 0% and 2.90%, and biggest gains were months when the benchmark gained more than 2.90%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.



Source: S&P Dow Jones Indices LLC. Data from March 31, 1993, to Dec. 28, 2018. Biggest declines were months when the benchmark was down more than 3.36%, moderate declines were months when the benchmark returned between -3.36% and 0%, moderate gains were months when the benchmark returned between 0% and 3.57%, and biggest gains were months when the benchmark gained more than 3.57%. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect 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.

S&P DJI RESEARCH CONTRIBUTORS		
Sunjiv Mainie, CFA, CQF	Global Head	sunjiv.mainie@spglobal.com
Jake Vukelic	Business Manager	jake.vukelic@spglobal.com
GLOBAL RESEARCH & DESIGN		
AMERICAS		
Aye M. Soe, CFA	Americas Head	aye.soe@spglobal.com
Cristopher Anguiano, FRM	Analyst	cristopher.anguiano@spglobal.com
Phillip Brzenk, CFA	Senior Director	phillip.brzenk@spglobal.com
Smita Chirputkar	Director	smita.chirputkar@spglobal.com
Rachel Du	Senior Analyst	rachel.du@spglobal.com
Bill Hao	Director	wenli.hao@spglobal.com
Qing Li	Director	qing.li@spglobal.com
Berlinda Liu, CFA	Director	berlinda.liu@spglobal.com
Hamish Preston	Associate Director	hamish.preston@spglobal.com
Maria Sanchez	Associate Director	maria.sanchez@spglobal.com
Kunal Sharma	Senior Analyst	kunal.sharma@spglobal.com
Kelly Tang, CFA	Director	kelly.tang@spglobal.com
Hong Xie, CFA	Senior Director	hong.xie@spglobal.com
APAC		
Priscilla Luk	APAC Head	priscilla.luk@spglobal.com
Arpit Gupta	Senior Analyst	arpit.gupta1@spglobal.com
Akash Jain	Associate Director	akash.jain@spglobal.com
Anurag Kumar	Senior Analyst	anurag.kumar@spglobal.com
Xiaoya Qu	Senior Analyst	xiaoya.qu@spglobal.com
Yan Sun	Senior Analyst	yan.sun@spglobal.com
Liyu Zeng, CFA	Director	liyu.zeng@spglobal.com
EMEA		
Sunjiv Mainie, CFA, CQF	EMEA Head	sunjiv.mainie@spglobal.com
Leonardo Cabrer, PhD	Senior Analyst	leonardo.cabrer@spglobal.com
Andrew Cairns	Senior Analyst	andrew.cairns@spglobal.com
Andrew Innes	Associate Director	andrew.innes@spglobal.com
Jingwen Shi	Analyst	jingwen.shi@spglobal.com
INDEX INVESTMENT STRATEGY		
Craig J. Lazzara, CFA	Global Head	craig.lazzara@spglobal.com
Chris Bennett, CFA	Director	chris.bennett@spglobal.com
Fei Mei Chan	Director	feimei.chan@spglobal.com
Tim Edwards, PhD	Managing Director	tim.edwards@spglobal.com
Anu R. Ganti, CFA	Director	anu.ganti@spglobal.com
Sherifa Issifu	Analyst	sherifa.issifu@spglobal.com
Howard Silverblatt	Senior Index Analyst	howard.silverblatt@spglobal.com

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 MidCap 400 Low Volatility Index and S&P SmallCap 600 Low Volatility Index were launched September 24, 2012. The S&P BMI International Developed Low Volatility Index and S&P BMI Emerging Markets Low Volatility Index were launched December 5, 2011. The S&P Europe 350 Low Volatility Index was launched July 09, 2012. The S&P/ASX 200 Low Volatility Index was launched October 17, 2017. 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 Developed Ex-U.S. & Korea LargeMidcap was launched February 13, 2009. The S&P Emerging Plus LargeMidCap was launched December 31, 2003. The S&P Europe 350 was launched October 07, 1998. The S&P Japan 500 was launched December 19, 2006. The S&P EPAC Ex-Korea Low Volatility Index was launched May 25, 2015. The S&P EPAC Ex-Korea LargeMidCap was launched on December 7, 2015. 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.

The Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices LLC maintains the Index and calculates the Index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US $10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US $1,650), the net return would be 8.35% (or US $8,350) for the year. Over a three year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US $5,375, and a cumulative net return of 27.2% (or US $27,200).

GENERAL DISCLAIMER