Low Volatility and High Beta: A Study in Backtest Integrity

"The past is never dead. It's not even past."

– William Faulkner

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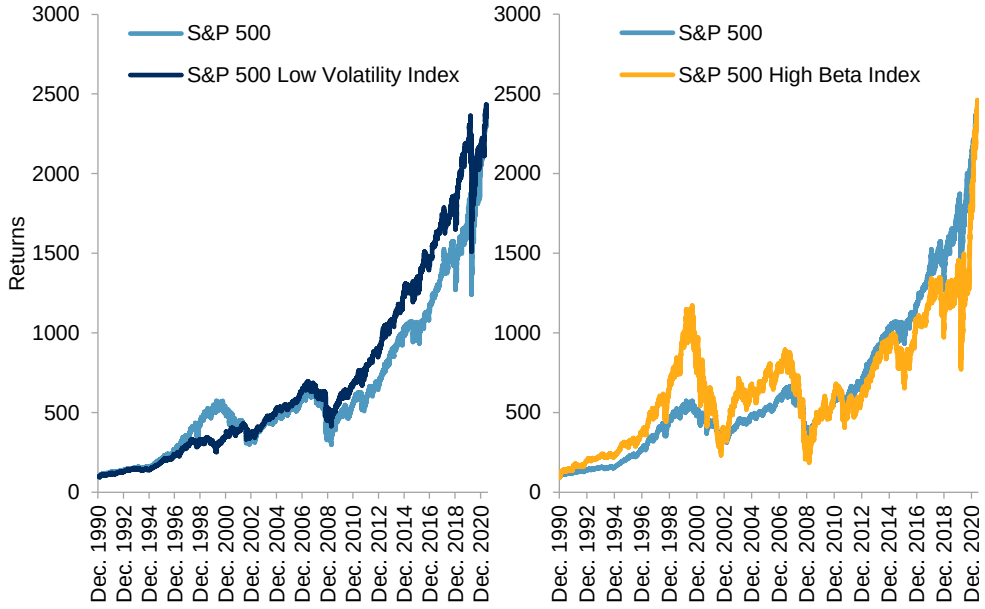
EXECUTIVE SUMMARY

- In April 2011, S&P Dow Jones Indices launched the S&P 500® Low Volatility Index (Low Volatility) and the S&P 500 High Beta Index (High Beta). Their recent 10th "birthday" allows us to compare the backtested performance with which they were introduced with actual live performance.
- Low volatility and high beta strategies are designed to access specific patterns of returns relative to the market. Low volatility should attenuate the market's returns (in both directions), while high beta should amplify them.
- The actual performance of both Low Volatility and High Beta has been consistent with these expectations.

Exhibit 1: Two Strategies Delivered Comparable Returns via Different Paths



Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to June 30, 2021. 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 backtested performance.

INTRODUCTION

The 10 years of live performance will let us make assessments about whether these indices achieved their stated goals…

The 10th anniversary of the launch of the S&P 500 Low Volatility Index[1] and S&P 500 High Beta Index[2] holds more than just commemorative significance. The milestone is also an opportunity to compare the live performance of each index to its backtested history.

Between January 1991 and June 2021, Low Volatility outperformed the S&P 500 with lower risk, while High Beta underperformed with higher risk. Return margins were slim in both cases. But this period is a combination of backtested (January 1991 through March 2011) and live (April 2011 through June 2021) history. Has live performance confirmed what the backtest suggested? The 10+ years of live performance will let us make assessments about whether the indices achieved their stated goals, whether their behavior in the live period was consistent with their behavior in the backtested period, and whether environments in the backtested period and the live period were consistent *with each other*.

GOALS AND ACHIEVEMENTS

…whether their behavior in the live period was consistent with their behavior in the backtested period…

Before comparing track records, it is important to define what success looks like for strategies like low volatility and high beta. Low volatility strategies are designed to attenuate, and high beta strategies to amplify, the market's performance. Those are their explicit goals and the indices, regardless of market environment, should perform consistently with those goals. This means, for example, that in a strongly rising market, Low Volatility should be *expected* to underperform; analogously, in a falling market High Beta should be *expected* to underperform. To an unusual degree, the expected relative performance of both strategies is highly dependent on the market's performance.

…and whether environments in the backtested period and the live period were consistent with each other.

Backtested performance is often, and rightly, viewed with a healthy dose of skepticism. Live history, however, can also be deceiving, especially if it does not reflect the full range of possible market environments.[3] This is particularly true for strategies like low volatility and high beta that explicitly seek to provide a specific risk profile, and therefore result in a pattern of *relative* returns.

Exhibit 2 shows the history of the S&P 500 from January 1991 through June 2021. The vertical green line marks the division between backtest and live periods of the history of Low Volatility and High Beta. An immediate observation is that the two periods present very different market

[1] The S&P 500 Low Volatility Index is designed to reflect the performance of the 100 stocks in the S&P 500 with the lowest historical standard deviation of returns.

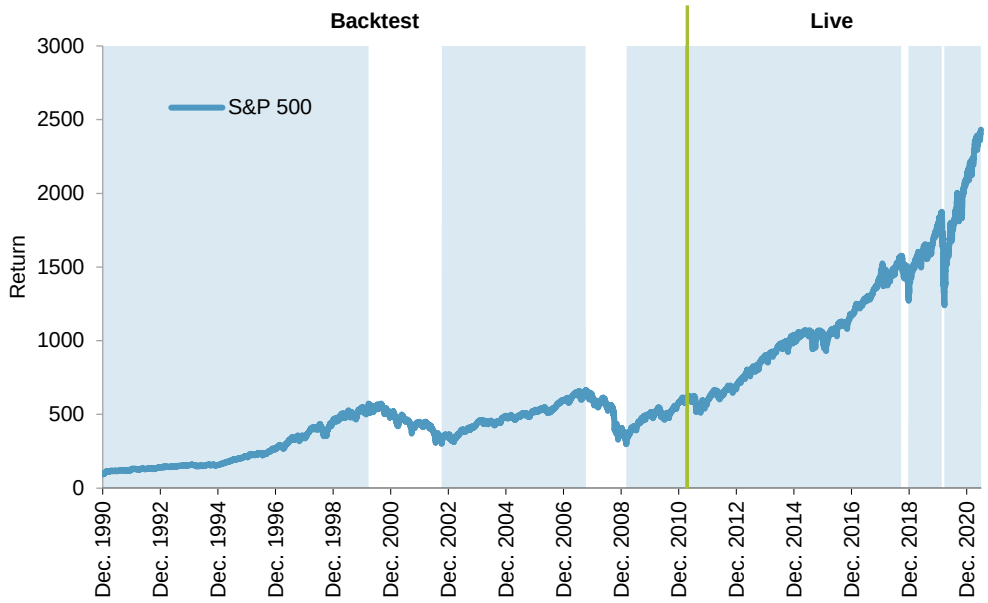
[2] The S&P 500 High Beta Index is designed to reflect the performance of the 100 stocks in the S&P 500 that are most sensitive to changes in market returns.

[3] Lazzara, Craig J., "The Limits of History," S&P Dow Jones Indices , January 2013.

environments. The backtest period encompassed two sustained market drawdowns: the bursting of the technology bubble after 2000 and the global financial crisis of 2007-2009. Both were long-lasting and substantial declines; the S&P 500 lost approximately one-half its value in each period.

Low volatility strategies are designed to attenuate, and high beta strategies to amplify, the market's performance.

Exhibit 2: Performance History of Low Volatility and High Beta Can Be Viewed in Two Parts – Backtested and Live



The backtest period encompassed two sustained market drawdowns.

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to June 30, 2021. Shaded areas represent rising markets; unshaded areas represent declining markets. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

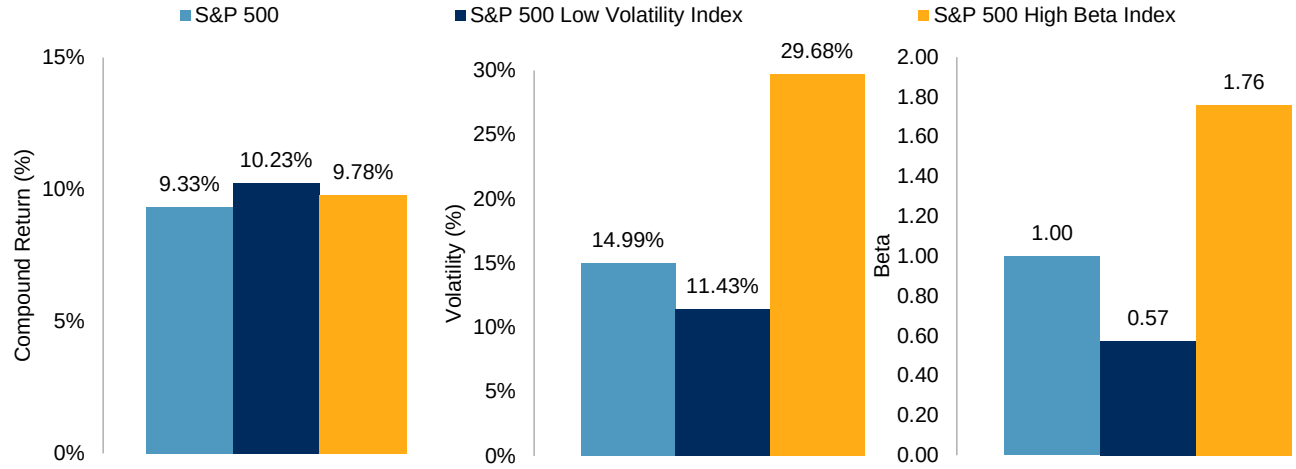
In the backtest period, unsurprisingly, Low Volatility and High Beta delivered on their stated goals. Exhibit 3 shows that the volatility of Low Volatility in the backtest was 11.4%, a 24% reduction compared with the S&P 500's 15.0%. Similarly, the beta of High Beta was 1.76, which qualifies as "high" by anyone's definition.

The S&P 500 gained 9.33% during this period. Low Volatility outperformed the benchmark by 0.90% annually, despite its lower volatility. Academics have cited this surprising combination of lower relative risk with higher relative return as perhaps "the greatest anomaly in finance."[4] High Beta outperformed by 0.44% annually during the backtest period, without challenging anyone's definitions of market efficiency.

In the backtest period, unsurprisingly, low volatility and high beta delivered on their stated goals

[4] Baker, Malcolm, Brendan Bradley, and Jeffrey Wurgler, "Benchmarks as Limits to Arbitrage: Understanding the Low-Volatlity Anomaly," *Financial Analysts Journal*, January/February 2011. Academic work on this anomaly has a long pedigree, starting with 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. The phenomenon has been observed across regions and asset classes. See Chan, Fei Mei and Craig J. Lazzara, "Is the Low Volatility Anomaly Universal?" S&P Dow Jones Indices, April 2019.

Exhibit 3: Both Low Volatility and High Beta Outperformed in the Backtest Period

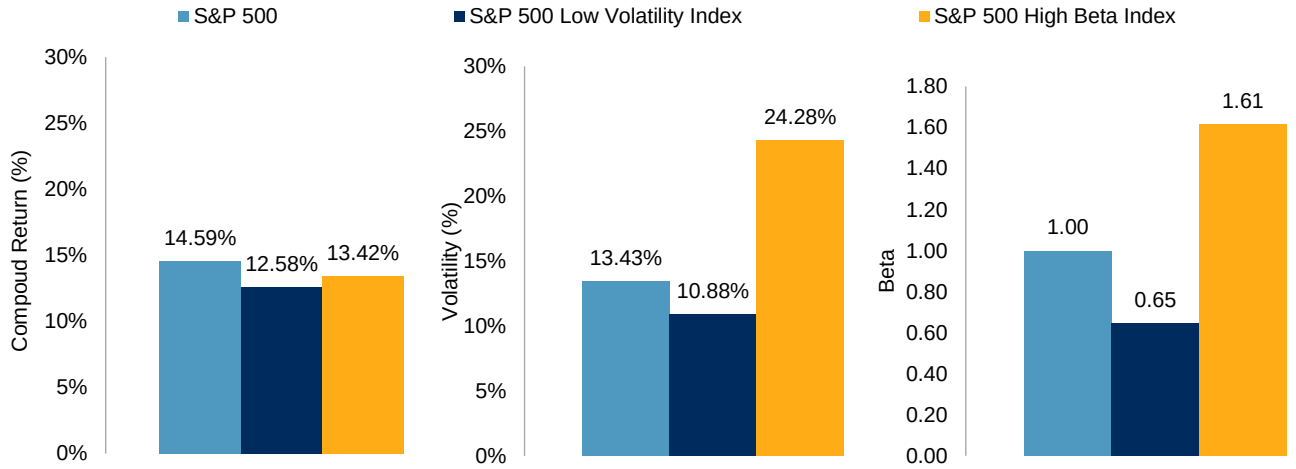


Source: S&P Dow Jones Indices LLC. Data from Dec. 21, 1990, to March 31, 2011. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with backtested performance.

Exhibit 4 presents data for the live performance period; before considering Low Volatility and High Beta, it is important to observe the market environment. In the backtest period, the S&P 500's compound return was 9.33% annually, with 15.0% volatility, for a return/risk ratio of 0.62. In the live period, the S&P 500 rose 14.59%, with 13.4% volatility and a return/risk ratio of 1.09. The live period, in other words, was a *substantially* more favorable environment in which to bear equity risk.

That said, in the live performance period, Low Volatility underperformed the S&P 500 but still achieved its risk reduction goal. High Beta, surprisingly, underperformed with significantly higher risk levels.

Exhibit 4: Both Low Volatility and High Beta Underperformed in the Live Period



Source: S&P Dow Jones Indices LLC. Data from March 31, 2011, to June 30, 2021. 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 backtested performance.

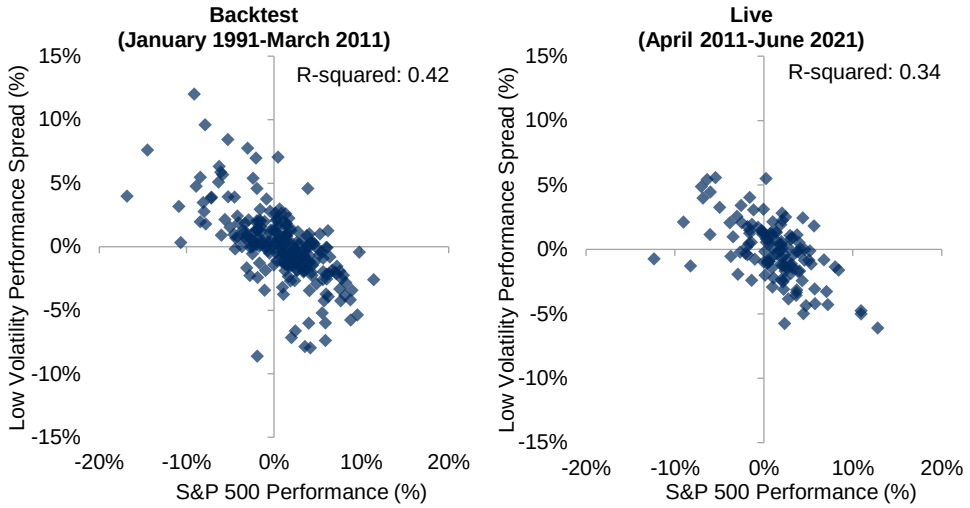
There was clearly a contrast in outcome between the backtest and live windows. This raises the obvious question of whether the two strategies *behaved* differently in the two periods.

BREAKING DOWN PERFORMANCE PATTERNS

A plot of the relative performance of the low volatility index against the S&P 500 should slope downward, with the reverse expected of the high beta index.

In rising markets, a low volatility index should lag its benchmark; in falling markets, it should decline less. A plot of the relative performance of Low Volatility against the performance of the S&P 500 should slope downward, with the reverse expected of High Beta. In Exhibit 5, we have separated the backtest and live periods for both indices. The relationships for Low Volatility and High Beta exhibited the same patterns in both periods.

Exhibit 5a: Relative Performance of Low Volatility Had a Strong Inverse Relationship with the Performance of the Benchmark, Regardless of Market Environment



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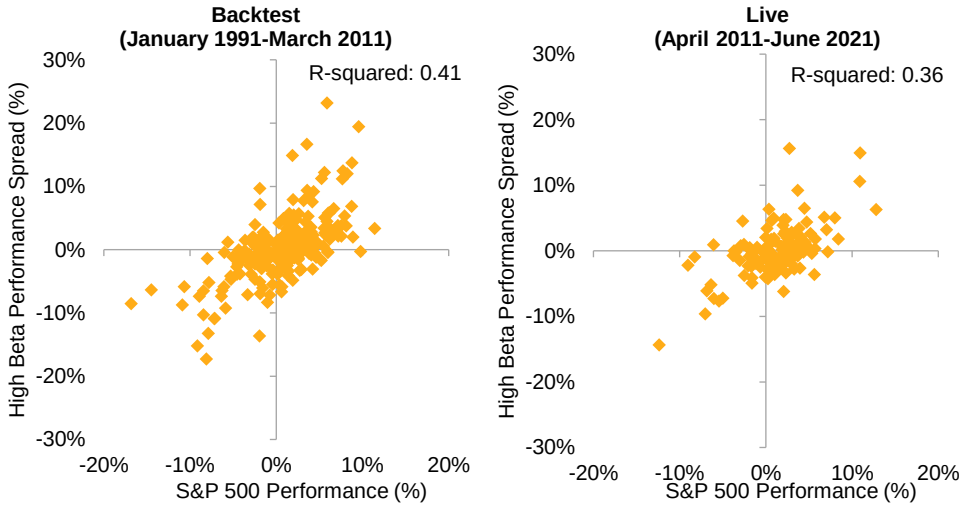
The relationships for low volatility and high beta exhibited the same patterns in the live and backtest periods.

Exhibit 5b: The Opposite Was True of the Relative Performance of High Beta



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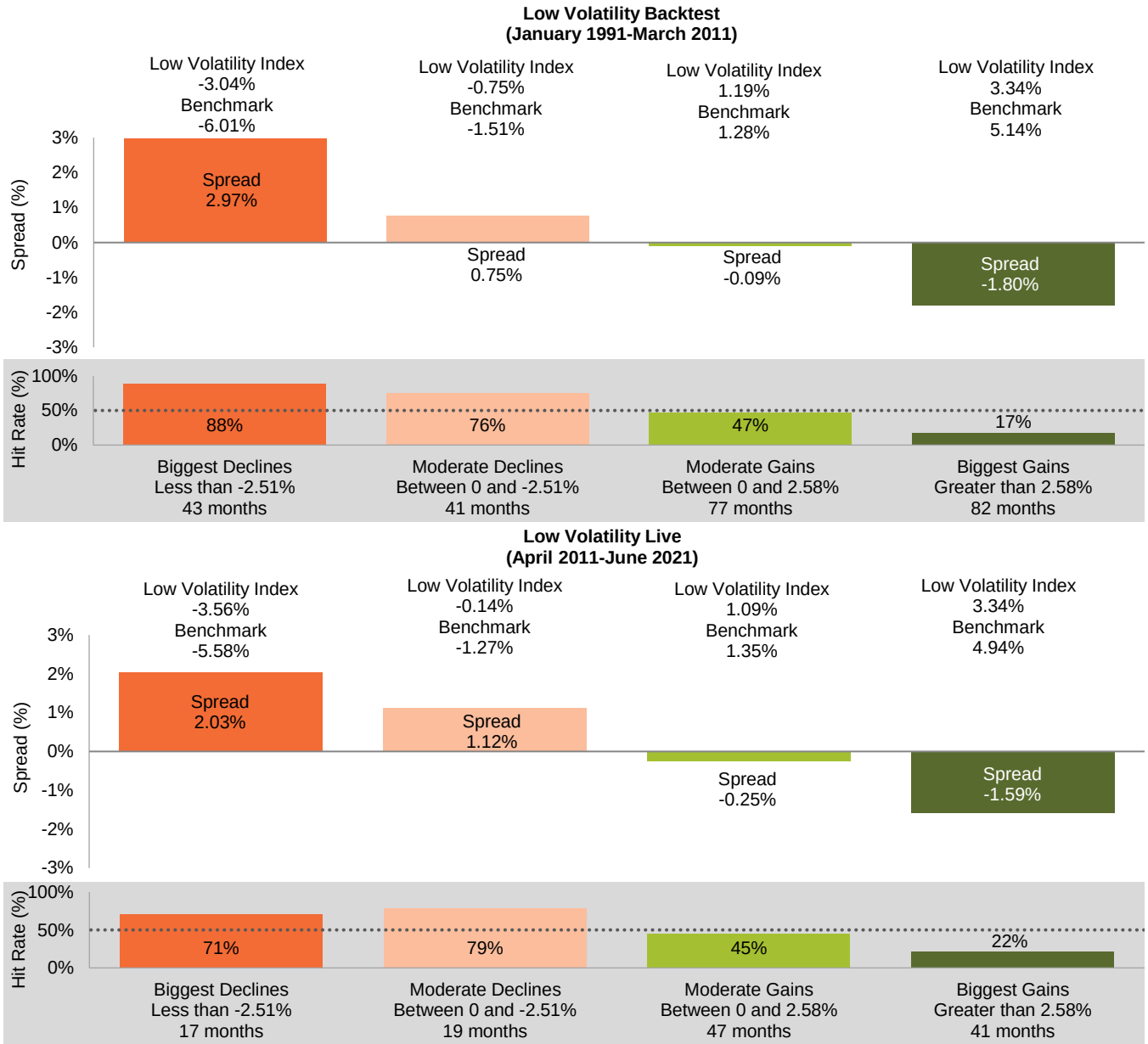
Sorting the months in Exhibit 5 into different market environments offers more insight into the *magnitude* of Low Volatility and High Beta's relative performance. We first separate the months in our data into positive or negative categories, depending on the performance of the S&P 500. We then divide each category in half, producing four distinct market environments: large declines, moderate declines, moderate gains, and large gains. Separating backtest and live periods lets us see if their behavior patterns were consistent.

Exhibit 6a: Relative Performance for Low Volatility Was Consistent in Backtest and Live Periods

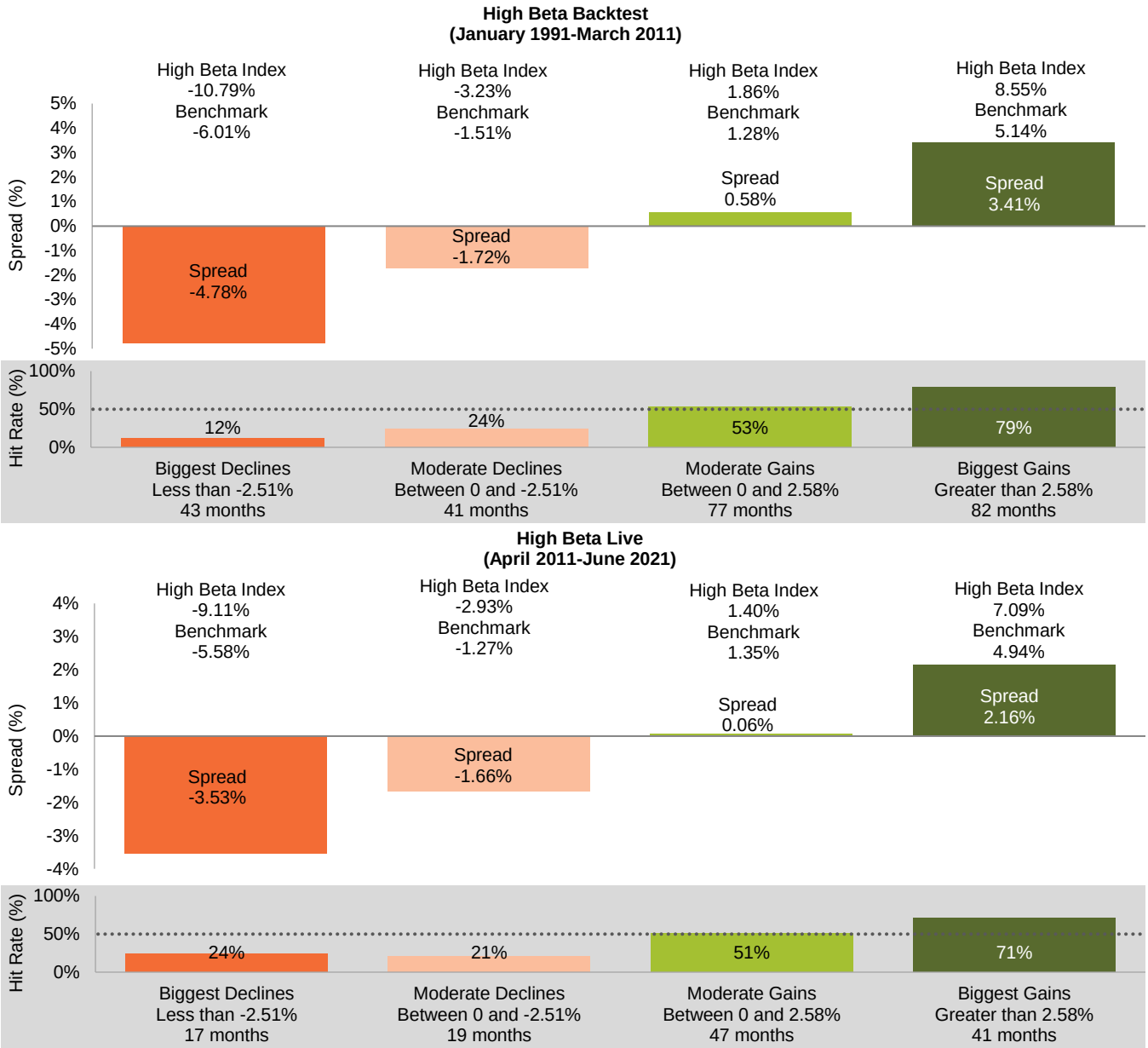


Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to June 30, 2021. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with backtested performance.

The spreads in the top half of each time period in the chart represent the *magnitude* by which Low Volatility out- or underperformed. The hit rate in the bottom half of the chart shows the *frequency* with which Low Volatility out- or underperformed. In both periods, Low Volatility's behavior was the same. It

outperformed by the most in the worst market environments and, monotonically, its performance differentials declined as the market environments improved. Hit rates followed a similar pattern. Low Volatility outperformed most often in the worst market environments and the frequency of outperformance declined monotonically as market environments improved.

Exhibit 6b: Relative Performances for High Beta Were Also Consistent in Backtest and Live Periods



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High Beta's performance differentials were almost the mirror image of Low Volatility's and, again, consistent in backtest and live periods. The index underperformed by the most in the worst months and improved monotonically as the market environment improved, with its best relative performance concentrated in the months with the biggest gains.

DISPARITIES IN MARKET DYNAMICS

For both low volatility and high beta, performance spreads were smaller in the live period versus the backtest period.

Another observation we can make from Exhibits 6a and 6b is that for both Low Volatility and High Beta, performance spreads were smaller in the live period than in the backtest period. That is because *dispersion* was lower in the backtest period compared to the live period.

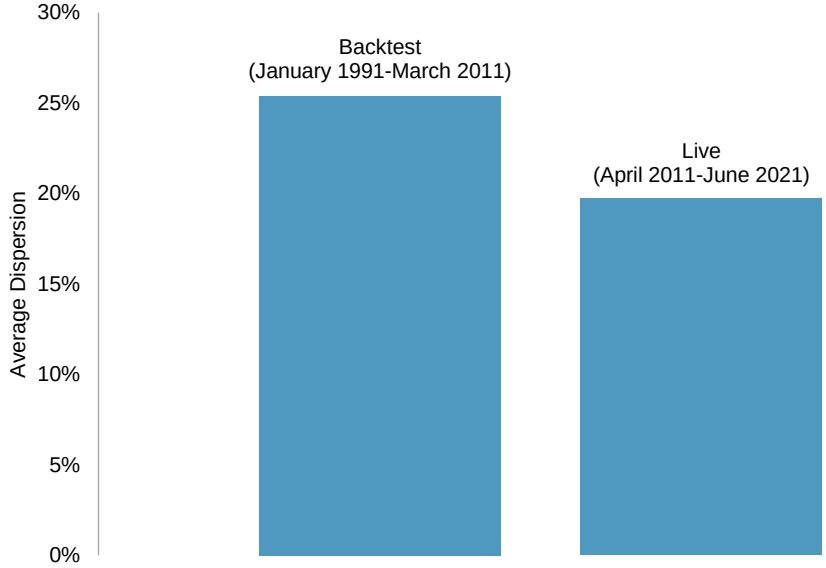
Dispersion measures the degree of stock returns' variability in a given market.[5] The higher dispersion is, the greater the opportunity for difference between the returns of a capitalization-weighted index and the returns of factor indices such as Low Volatility and High Beta.[6]

Weak markets tend to occur in times of relatively high volatility, and high volatility is typically associated with high dispersion.[7] One notable difference between the backtest period and the live period is that dispersion was significantly lower in the latter.

Average monthly dispersion in the S&P 500 in the backtest period was much higher than the live period.

The average monthly dispersion in the S&P 500 from January 1991 through March 2011 was 25.4%, much higher than the 19.8% in the period from April 2011 through June 2021 (see Exhibit 7). This means that the magnitude of performance spreads was more constrained in the live period than the backtest period.

Exhibit 7: Average Dispersion Level for the S&P 500 Was Higher in the Backtest Period than the Live History Performance



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Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1990, to June 30, 2021. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

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

[6] 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.

[7] Chan, Fei Mei and Craig J. Lazzara, "The Best Offense: When Defensive Strategies Win," S&P Dow Jones Indices, March 2015. See also Edwards, Tim and Craig J. Lazzara, "The Landscape of Risk," S&P Dow Jones Indices, December 2014.

CONCLUSION

Subject to market constraints, Low Volatility and High Beta behaved exactly as they were designed to behave.

Subject to market constraints, Low Volatility and High Beta **behaved exactly as they were designed to behave**. While both indices outperformed in the backtest period and underperformed in the live period, the two periods were significantly different market environments. The backtest period between January 1991 and March 2011 contained two major market crises—the rupture of the technology bubble and the global financial crisis of 2008—complete with aftermaths that took years for the market to digest. Since then, the U.S. equity market, aside from the short-lived COVID-19 ripple, has not experienced a sustained trauma. In the proper context, the performances of Low Volatility and High Beta were in line with defined goals.

PERFORMANCE DISCLOSURE/BACKTESTED DATA

The S&P 500 Low Volatility Index and S&P 500 High Beta Index were launched April 4, 2011. All information presented prior to an index's Launch Date is hypothetical (backtested), 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 backtested 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.spglobal.com/spdji. Past performance of the Index is not an indication of future results. Backtested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, backtested returns. Past performance is not an indication or guarantee of future results. Please refer to the methodology for the Index 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. Backtested performance is for use with institutions only; not for use with retail investors.

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 backtested) for a given index. The Base Date is the date at which the index is set to a fixed value for calculation purposes. The Launch Date designates the date when 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 backtested. 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 data feed 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.

Typically, when S&P DJI creates backtested index data, S&P DJI uses actual historical constituent-level data (e.g., historical price, market capitalization, and corporate action data) in its calculations. As ESG investing is still in early stages of development, certain datapoints used to calculate S&P DJI's ESG indices may not be available for the entire desired period of backtested history. The same data availability issue could be true for other indices as well. In cases when actual data is not available for all relevant historical periods, S&P DJI may employ a process of using "Backward Data Assumption" (or pulling back) of ESG data for the calculation of backtested historical performance. "Backward Data Assumption" is a process that applies the earliest actual live data point available for an index constituent company to all prior historical instances in the index performance. For example, Backward Data Assumption inherently assumes that companies currently not involved in a specific business activity (also known as "product involvement") were never involved historically and similarly also assumes that companies currently involved in a specific business activity were involved historically too. The Backward Data Assumption allows the hypothetical back-test to be extended over more historical years than would be feasible using only actual data. For more information on "Backward Data Assumption" please refer to the FAQ. The methodology and factsheets of any index that employs backward assumption in the backtested history will explicitly state so. The methodology will include an Appendix with a table setting forth the specific data points and relevant time period for which backward projected data was used.

Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices 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 backtested 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).

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