CFA INSTITUTE RESEARCH FOUNDATION / **BRIEF**

THE VIX INDEX AND VOLATILITY-BASED GLOBAL INDEXES AND TRADING INSTRUMENTS

A GUIDE TO INVESTMENT AND TRADING FEATURES

MATTHEW T. MORAN
BERLINDA LIU

CFA Institute Research Foundation

THE VIX INDEX AND VOLATILITY-BASED GLOBAL INDEXES AND TRADING INSTRUMENTS

A Guide to Investment and Trading Features

Matthew T. Moran
and Berlinda Liu

CFA Institute
Research
Foundation

Statement of Purpose

CFA Institute Research Foundation is a not-for-profit organization established to promote the development and dissemination of relevant research for investment practitioners worldwide.

Cover photo credit: Roland Shainidze Photography / Moment / Getty Images

ISBN 978-1-944960-95-7

CONTENTS

CE Qualified Activity CFA Institute

This publication qualifies for 2 CE credits under the guidelines of the CFA Institute Continuing Education Program.

FOREWORD

My tenure on Wall Street began at the bottom of the bull market in August 1982, just before the 1983 launch of options on the S&P 100 and S&P 500 indexes. As a research analyst covering index and stock options, I did my best to extract implied volatility metrics from their prices. At that time this meant using spreadsheet tools (VisiCalc and Lotus 1-2-3) and computer programming languages such as Fortran and Pascal. Forecasts of volatility for equities were highly valued by investors as a measure of traders' uncertainty about a stock or index price for a specific time frame.

As it turned out, S&P 100 implied volatility was one of the few indicators suggesting heightened investor risk expectations just prior to the now infamous October 1987 crash. In the days just before the crash, it moved up to a record 30% level. On 19 October the S&P 500 fell an unheard of 20.5% and shaken investors sent implied volatility that day and week for both the S&P 100 and S&P 500 soaring to levels well in excess of 100%. For the rest of my long career as a derivatives strategist, I was always grateful for the lessons learned by studying implied volatility in those early years. It taught me about how "storms" can develop rapidly in quiet equity markets and how investor psychology and liquidity pressures can be major factors driving equity prices.

The VIX Index, together with its derivative trading products and indexes, was an outgrowth of the attention focused on market barometers of uncertainty during and after the market turbulence in 1987. As the world's most widely followed measure of investor sentiment and expected equity market risk, the VIX is monitored by a wide range of investors—even those who never use futures and options. The original VIX Index, launched in 1993, was based on S&P 100 options, but it has developed its methodology to become the VIX we know today. It measures implied or expected volatility of the S&P 500 over the next 30 days, as calculated from near-term S&P 500 option prices for a range of stock prices. The VIX calculation methodology is used for VIX-type indexes in equity benchmarks around the world that have active options trading.

As vice chair and head of the Research Committee for the CFA Institute Research Foundation, I am excited to share with you the publication of this primer—"The VIX Index and Volatility-Based Global Indexes and Trading Instruments." Futures on the VIX began trading in 2004 on the Cboe Options Exchange and options in 2006. Indexes constructed from these futures prices serve as benchmarks for exchange-traded funds, exchange-traded notes, and other fund products that investors turn to for risk management and for taking views on changes in the volatility expectations of broad equity indexes. The co-authors, Matthew Moran of Cboe and Berlinda Liu of S&P Dow Jones Indices, have been educating investors about the VIX and VIX futures and indexes almost since the inception of these products. We are fortunate to have them write this Brief to help broaden and deepen the knowledge of investors in this complex and critical area of the financial marketplace.

The many investors that regularly follow the VIX and volatility-trading products are interested in obtaining a deeper understanding of how the products behave in various market conditions. This publication covers all of these

topics. The distribution of the VIX is positively skewed: It may stay below average for long periods but will rise to multiples of average and median levels. VIX index levels exhibit mean reversion over time and reflect volatility expectations that are, on average, higher than realized S&P 500 volatility. (This difference is called the "volatility risk premium.")

VIX futures and associated indexes reflect expectations for 30-day index volatility out in time. Their returns are correlated with the VIX but can be significantly above (in contango) or below (in backwardation) spot VIX levels. VIX futures indexes have unique return drivers, including the cost of rolling VIX futures positions, which can be a significant component of returns over time. Investors appreciate that VIX futures and futures indexes have returns that are negatively correlated with equities and realize that how the futures products perform in a portfolio context is key to using them effectively.

Few of us expected to see anything like the extreme levels of October 1987 equity volatility again in our lifetimes, but in early 2020, a global pandemic and its economic fallout descended upon us—just the type of event that can instill sufficient uncertainty in investors to set new records for indexes like the VIX. As this publication was going to press (with data ending in December 2019), financial markets were reacting to the developing news of the spread of the global COVID-19 pandemic. Between the S&P 500's high on 19 February 2020 and its low on 23 March 2020, the S&P 500 fell almost 34%. The VIX moved from 14% to 62%, and the S&P 500 VIX Short-Term Futures Index moved up more than 300%. During this period, the VIX reached its highest closing level ever (83%) on 16 March, a day when the S&P 500 fell some 12%. Over the full turbulent 26 trading days between 20 February and 26 March, the VIX averaged 50%, compared with its average of 15% in 2019 and 14% in 2020 through February 19.

Similar equity market declines and VIX-like surges were occurring globally. In Europe, the VSTOXX, which measures implied volatility of EURO STOXX 50 Index options, closed at 86% on 16 March 2020, its second highest daily close ever.

As is typical in highly uncertain market conditions, investors from 20 February to 26 March 2020 turned to volatility-trading products. VIX futures volume over the that period was 77% higher than the 2019 level, and options activity was up as much as 161%. By the end of the week beginning 27 March 2020, central bankers and governments around the globe had responded with policy initiatives, and equity markets had rebounded somewhat. But the VIX was still high—66%.

The public health, economic, and financial market picture is still evolving as I write this foreword. We have seen such extremes in investor uncertainty infrequently, thank goodness. For decades, investors have understood that financial markets reward risk taking but that risk can change dramatically from one economic cycle to another and as new information emerges unexpectedly. Index option prices are set in competitive and open markets and will continue to serve as valuable measures of the changing perceptions of risk to broad market indexes. Understanding the VIX Index and the trading and investment products based on it is highly valuable for anyone who wishes to assess or manage equity risk.

Joanne M. Hill
Vice Chair, CFA Institute Research Foundation
30 March 2020

THE VIX INDEX AND VOLATILITY-BASED GLOBAL INDEXES AND TRADING INSTRUMENTS: A GUIDE TO INVESTMENT AND TRADING FEATURES

Matthew T. Moran and Berlinda Liu
Matthew T. Moran is head of Global Benchmark Indexes Advancement at Cboe Global Markets, Chicago.

Berlinda Liu is director of Global Research & Design at S&P Dow Jones Indices, New York City.

The Cboe Volatility Index® (VIX® Index) measures the market's expectation of future volatility conveyed by S&P 500 Index option prices. The VIX is recognized as a premier gauge of expected US equity market volatility. The 2000–09 decade experienced two deep bear markets for equities that saw numerous short-term periods of high levels of investor uncertainty. Most investors recall how during the financial crisis of 2008–2009, the correlations between equities rose globally and traditional diversification goals became difficult to achieve. Exchange-listed VIX futures were launched in 2004, and VIX options were launched in 2006. During the 2008–09 financial crisis, VIX futures and VIX options experienced tremendous growth, as interest in and use of such index-based products as exchange-traded notes and exchange-traded funds grew. These products have become widely used in investors' strategies ranging from trading tactical views on volatility to incorporating volatility trades and hedges in risk management and multiasset strategies.

This study addresses several questions investors have asked related to the VIX Index, volatility-based trading products, and the use of VIX futures in portfolio construction. These questions include the following:

1. What does the VIX Index measure, and what does a VIX level signify?
2. What are some indexes that measure expected volatility of European or Asian stock indexes?
3. How do features such as convexity and negative correlation make the VIX an intriguing investment gauge?
4. Is the VIX Index tradable, and if not, why?
5. What tradable volatility-based futures and options products are available?
6. How do contango and backwardation affect the returns of VIX futures-based strategies?
7. What volatility benchmark indexes are available, and what is their impact when added to S&P 500 portfolios?

THE VIX INDEX: A GAUGE OF EXPECTED FUTURE VOLATILITY

Volatility is a key consideration for many traders and investors. *Historical volatility* measures the extent of return fluctuations over a historical period—for example, the annualized standard deviation of the day-to-day (closing price) returns on a set number of past trading days, expressed as an annualized percentage. *Implied volatility* is derived from a market's current price of an options contract and reflects expectations of *future* volatility. Investors look at historical volatility to gain insights into past market movements, but investors also analyze volatility indexes, such as the VIX, to gain real-time updates on market sentiment and expectations of future volatility. The VIX, introduced in 1993, measures the market's expectation of future 30-day volatility. Like conventional indexes, the VIX uses rules for selecting the component options and a formula for calculating index values.

In 1993, the Chicago Board Options Exchange® (now known as Cboe®) introduced the original version of the VIX Index to measure the market's expectation of 30-day volatility of the S&P 100 Index as implied by the prices of at-the-money options (see Whaley 1993). The VIX soon became a leading gauge for US stock market volatility. In 2003, the VIX methodology was revised to reflect a new way of measuring expected volatility. The changes to its methodology were intended to make it more robust and relevant to volatility traders and hedgers. Specifically, since 2003, the VIX has been based on options on the S&P 500 Index (SPX), the core index for US equities. The VIX estimates expected volatility by aggregating the weighted prices of SPX puts and calls over a wide range of strike prices. By supplying a means of replicating volatility exposure with a portfolio of SPX options, this methodology transformed the VIX from an abstract concept into a practical standard for trading and hedging volatility.[1]

The VIX Index (often referred to as the "spot VIX") is not itself investable. Rather, it is designed to reflect volatility expectations at a future time based on SPX options. Because the VIX is always measuring expected volatility 30 days ahead, directly from option prices, the composition of the strip of SPX options used to calculate the VIX level often changes throughout the trading day. This ever-changing basket of SPX options used to calculate the VIX makes it impractical and expensive to hold on an ongoing basis.

In 2014, Cboe enhanced the VIX to include SPX weekly options expirations in its calculation. Only SPX options with Friday expirations (standard and weekly expirations) are used to calculate the VIX. (Cboe lists SPX options that expire on days other than Friday, but non-Friday SPX expirations are not used to calculate the VIX.) The inclusion of SPX weekly options allows the VIX to be calculated with SPX option series that more precisely match the 30-day target time frame for expected volatility that the VIX is intended to represent. Using SPX options with more than 23 days and fewer than 37 days to expiration ensures that the VIX always reflects an interpolation of two points along the S&P 500 volatility term structure.[2]

[1]The price history for the Cboe S&P 100 Volatility Index (ticker VXO), using the original 1993 methodology based on S&P 100 options, is available from 1986 to the present, and the price history for the current version of the VIX (based on SPX options since 2003) is available from 1990 to the present.

[2]Detailed information regarding the VIX methodology is available on the Cboe website: www.cboe.com/vix.

How VIX Levels Translate into Expected Risk

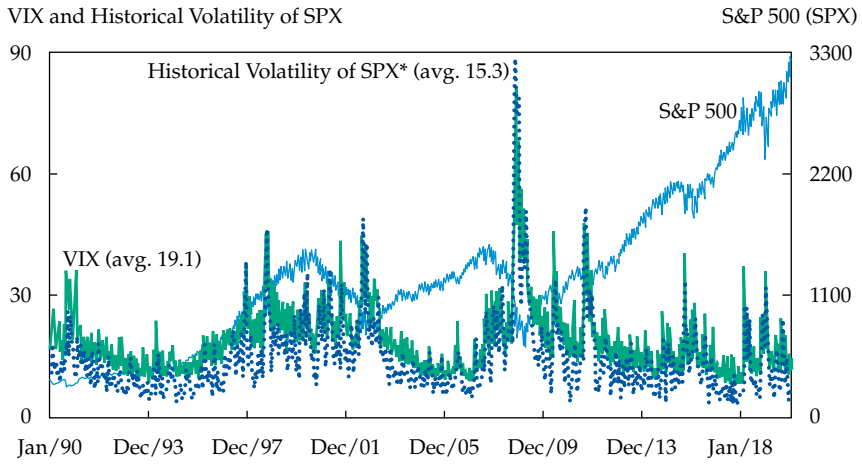
In the 30-year period from 1990 through 2019, the daily closing values of the VIX have fluctuated in a wide range, as shown in **Figure 1**, with short-term surges to levels well above the mean and median values.

Over this period, the daily closing levels of the VIX had a median value of 17.2 and an average value of 19.1, with daily closing levels ranging from a low of 9.14 on 3 November 2017 to a high of 80.86 on 20 November 2008. The VIX also tended to be higher than realized volatility (measured over 20 subsequent trading days) except when historical volatility was very high. In addition, almost all spikes in the VIX occurred during periods of steep declines in the S&P 500. The only exception was during 1998–1999, when the S&P 500 was in an uptrend related to strong returns from the technology sector but the expected volatility of the S&P 500 (as measured by the VIX) indicated that investors perceived rising uncertainty about sustaining the gains from this sector.

Correlations and Worldwide Volatility

A key feature of the VIX that often attracts attention is that its movements have usually had a negative correlation with price movements of the key global stock indexes. Moreover, these correlations have generally become even more negative in times of market turbulence, such as during the year 2008. When stock market indexes suffer sharp declines, expected volatility tends to rise, reflecting an increase in demand for protecting a stock portfolio with SPX put options and the associated increase in option prices as a result of heightened risk aversion.

FIGURE 1. VIX INDEX, HISTORICAL VOLATILITY, AND STOCK INDEX PRICES, 1990–2019



*20-trading-day historical volatility.

Notes: Daily closing values. The VIX Index and historical volatility are measured on the left axis; the S&P 500 is measured on the right axis.

Sources: Bloomberg and Cboe.

A challenge for investors who try to diversify across global equity markets is that the correlations of the global stock indexes have generally risen over the past three decades. During the 2007–09 crisis, a number of indexes—including the S&P 500, EURO STOXX 50 Index, Hang Seng Index for Hong Kong stocks, and the S&P GSCI (Goldman Sachs Commodity Index)—all experienced drawdowns of worse than 50%. As a result, the desired diversification benefit of owning global equities and commodities failed to materialize.

Conversely, as shown in **Table 1**, in 2008, five of the world's leading volatility indexes all rose by at least 50%, and the correlations of the weekly returns of the volatility indexes versus the local stock indexes were negative. For four of the five volatility indexes, the correlations in 2008 were even more negative than they were during the 12-year period. All five volatility indexes have somewhat similar methodologies but are based on stock index options traded in various world markets. The S&P/ASX 200 VIX reflects expected volatility of the S&P/ASX 200 Index in Australia, the HSI Volatility Index (VHSI) is based on the Hang Seng in Hong Kong, the India VIX reflects expected volatility of India's NIFTY 50 Index, and the EURO STOXX 50 Volatility Index (VSTOXX) is based on the EURO STOXX 50. The negative correlations of many volatility indexes have helped stimulate interest in exploring the possibility of using volatility-related products for portfolio diversification. For an overview of 30 volatility indexes and worldwide volatility, please see Moran (2014).

The Volatility Risk Premium: Implied minus Historical Volatility

A number of studies have noted that key index options markets have supplied a volatility risk premium since the 1990s. Specifically, for SPX options, implied volatilities usually have been higher than historical (or realized) volatilities for the S&P 500 (Feldman and Roy 2005; Hill, Balasubramanian, Gregory, and Tierens 2006; He, Hsu, and Rue 2015; Black and Szado 2016; Wilshire Analytics Applied Research Group 2019). In 29 of the 30 years from 1990 through

TABLE 1. FIVE GLOBAL VOLATILITY INDEXES OVER 12 YEARS, 2008–2019

				Correlations of Weekly Returns		
Index	Maximum Daily Close	Minimum Daily Close	% Change in 2008	With Local Stock Index in 2008	With Local Stock Index over 12 Years	With VIX over 12 Years
VIX Index	80.86	9.14	77.8%	−0.82	−0.71	1.00
AXVI [S&P/ASX 200 VIX]	66.72	7.39	81.6%	−0.75	−0.65	0.58
VHSI [HSI Volatility Index]	104.29	11.36	51.6%	−0.66	−0.51	0.51
NVIX [India VIX]	85.13	10.45	69.8%	−0.20	−0.37	0.32
VSTOXX [EURO STOXX 50 Volatility]	87.51	10.68	142.9%	−0.83	−0.73	0.78

Note: The five local stock indexes are the S&P 500, S&P/ASX 200, Hang Seng, NIFTY 50, and EURO STOXX 50.

Sources: Bloomberg and Cboe.

2019, the average daily closing level for the VIX was higher than the subsequent 30-day realized volatility of the S&P 500.

The existence of a volatility risk premium can also be seen in the legend in Figure 1, which shows that the average daily VIX closing values were 19.1 (compared with an average of 15.3 for the historical volatility of the S&P 500) over the 1990–2019 period. This premium can be attributed to several factors, including (1) an imbalance in the number of investors who want to buy protection and those who want to sell protection and (2) the tendency for index levels to move quickly and sharply in response to significant new information, which accounts for short-horizon traders' tendency to use options to capitalize on these moves.

The persistence of a volatility risk premium priced into SPX options can facilitate higher returns for option-selling strategies over option-buying strategies with similar market exposure. An index that sells index options—the Cboe S&P 500 30-Delta BuyWrite Index (BXMD^{SM})—generated higher returns and higher risk-adjusted returns than both the S&P 500 and the Cboe S&P 500 5% Put Protection Index (PPUT^{SM}) over a period of more than 32 years (Wilshire Analytics Applied Research Group 2019), but none of these indexes are guaranteed such outperformance in the future. Also, the returns of volatility-selling strategies tend to be negatively skewed; performance during periods of sharp volatility increases can be negative, so investors must be aware of the potential for losses in these periods when deciding whether such strategies are consistent with their risk preferences.

FUTURES AND OPTIONS ON THE VIX

As noted, the VIX Index is not itself investable. Exchange-listed futures and options on the VIX provide market participants with a vehicle to trade expected volatility. VIX futures were launched in March 2004 for trading on the Cboe Futures Exchange, are traded electronically with a $1,000 multiplier, and are regulated by the US Commodity Futures Trading Commission. VIX options were launched in February 2006 with a $100 multiplier, are regulated by the US SEC, and are traded both electronically and on an open-outcry trading floor at Cboe. Expiration and cash settlement for VIX futures and options usually occur on Wednesday mornings in the United States. In 2019, the total annual volume was 127 million contracts for VIX options, 62 million for VIX futures, 16 million for VSTOXX mini-futures, and 7 million for VSTOXX options.

VIX futures and VIX options reflect the market's estimate of the value of the VIX on various expiration dates in the future, and the contracts provide market participants with a variety of opportunities to implement their views by using volatility-trading strategies, including risk management, alpha generation, and portfolio diversification.

VIX Futures: Pricing, Term Structure, Contango, and Backwardation

VIX futures are contracts on future, 30-day, SPX option-implied volatilities that are expected on the future expiration date. For example, in March, a June VIX futures contract is a contract on what 30-day implied SPX option volatility will be on the June expiration date, and a July VIX futures contract reflects the expectation of what the 30-day implied volatility will be on the July expiration date.

The rapid growth in the volume of VIX options and futures has been driven by these products' use not only as short-term tactical tools for seeking profit from short-term moves in expected

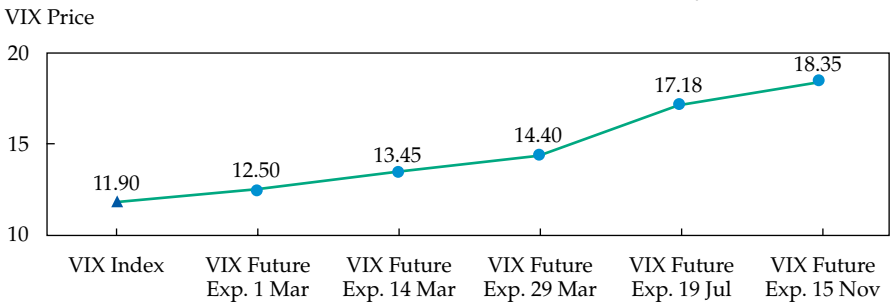
volatility, but also as a means for investors to incorporate more enduring long- or short-term volatility exposures into their hedge fund and multiasset strategies. VIX futures and options strategies include (1) the buying of VIX futures or VIX call options by investors who are concerned about stock market tail risk and believe that near-term volatility could skyrocket and (2) the selling of VIX futures if the futures are "in contango," as explained in the following paragraphs.

For investors who wish to invest in futures contracts related to commodities, interest rates, or volatility, key concepts to understand are *contango* and *backwardation*. Futures are said to be *in contango* when futures with more time to expiration have higher prices than those with a shorter time to expiration; futures are *in backwardation* when longer-term futures have lower prices than short-term futures. A comparison of the prices of front-month VIX futures with second-month VIX futures from 2007 through 2019 indicates that (1) the daily closing prices for VIX futures were in contango on approximately 80% of the days during the 13-year period, but (2) the daily closing prices for VIX futures were in backwardation on most days in the months of October 2008 and August 2011, when the level of the VIX generally was higher than its long-term average.

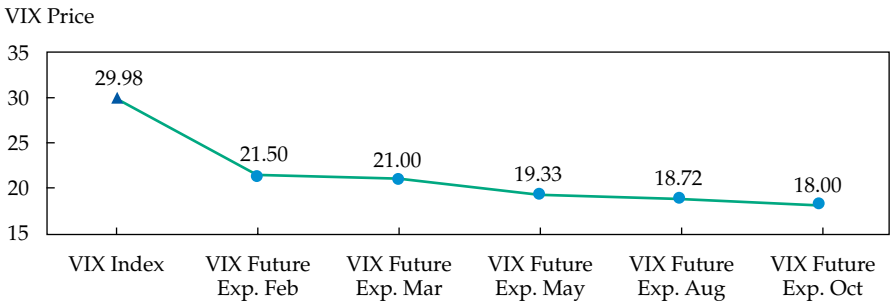
Figure 2 presents examples of contango and backwardation. As Panel A shows, on the afternoon of 23 February 2017, the VIX futures were in contango: The VIX futures term structure was

FIGURE 2. PRICING, TERM STRUCTURE, CONTANGO, AND BACKWARDATION: EXAMPLES

A. VIX and Select VIX Futures on 23 February 2017



B. VIX and Select VIX Futures on 6 February 2018



Note: In Panel A, the last reported prices were at approximately 2:40 PM US Central Time.

Source: Cboe Futures Exchange.

upward sloping, with VIX longer-dated futures priced higher than the near-term VIX futures prices and the value of the VIX. In contrast, Panel B shows an example of backwardation that occurred on 6 February 2018: That day, the VIX closed at 29.98 while all listed VIX futures closed more than 8 points lower than the closing VIX value; the resulting VIX term structure was generally downward sloping.

To expand understanding of volatility instruments, we now show how the VIX Index moves compared with VIX futures in response to a major event that is a shock to the financial markets. Events with negative implications for future equity earnings or risk can have a big impact on the next month's expected volatility; the event's impact on 30-day expected volatility several months into the future, however, tends to be more muted. Panel A of **Figure 3** shows the price movements for the VIX and select VIX futures in August 2011. On 5 August, Standard & Poor's downgraded US Treasury debt to AA+, and as the graph shows, on 8 August, the VIX rose 50% to close at 48. Panel B depicts price movements for the VIX and VIX futures in August 2015, when many financial market participants were concerned about a possible cooling of the Chinese stock market. In three trading days ending 24 August, the SPX Index fell 9%; the VIX Index rose 167%, VIX Week 35 futures rose 147%, and VIX September futures rose 60%.

During the big VIX upward moves shown in Figure 3, near-term VIX futures saw upward moves that were not quite as large as those of the VIX Index, and the longer-dated VIX futures had smaller upward moves. This is because the futures were pricing volatility expectations for the 30 days subsequent to their expiration date rather than volatility over the next 30 days. Studies with more information on the use of VIX futures and options include Moran and Dash (2007), Szado (2009), and Hill (2013).

BENCHMARK INDEXES FOR FUTURES AND OPTIONS ON THE VIX

On 22 January 2009, S&P Dow Jones Indices launched the first index based on rolled positions in VIX futures, the S&P 500 VIX Short-Term Futures Index. The investment community quickly adopted this index as a benchmark of hypothetical short-term VIX futures performance.

The concept behind VIX futures indexes is similar to that used in commodity futures indexes, with the rolling of positions incorporated into the index. Although commodity futures indexes have rules-based strategies for rolling futures close to expiration, the VIX futures indexes rolled an equivalent portion each trading day to smooth out the rolling process over a calendar month. A suite of benchmark indexes based on VIX futures and options was subsequently created to address various investment demands.

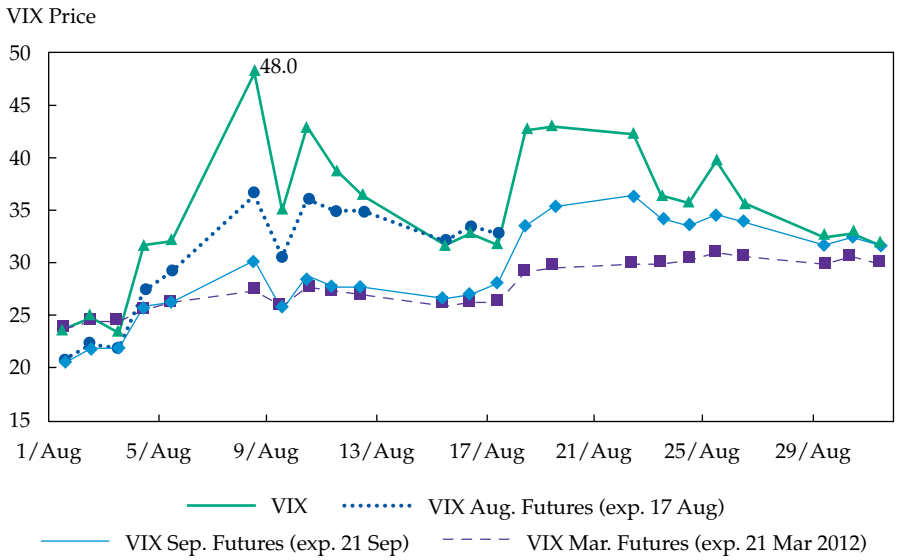
Methodology

The widely followed S&P 500 VIX Short-Term Futures Index replicates a hypothetical VIX futures portfolio that continuously reflects VIX expectations one month out by rolling approximately 5% of its positions daily from the first-month futures contract to the second-month contract. This index is used by investment products that seek to provide long exposure and leveraged long exposure to the index as well as inverse index exposure.

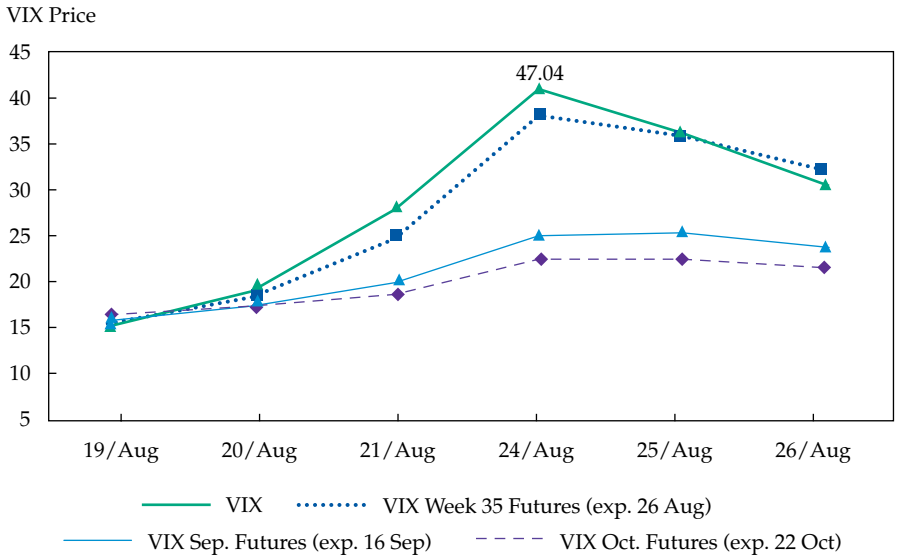
The S&P 500 VIX Mid-Term Futures Index was launched at the same time as the S&P 500 VIX Short-Term Futures Index and aims to capture VIX expectations continuously five months out. It replicates a hypothetical VIX futures portfolio that holds the fourth-, fifth-, sixth-, and

FIGURE 3. PRICE MOVEMENTS OF VIX FUTURES IN VOLATILE MONTHS

A. VIX and Select Futures in August 2011



B. VIX and Select Futures in August 2015



Notes: Shown in each panel are daily closing values for VIX and daily settlement values for select VIX futures. Past performance is not predictive of future returns.

Source: Cboe Futures Exchange.

seventh-month VIX futures. It maintains a constant five-month maturity by rolling a portion of positions continuously from the fourth month to the seventh month.

As mentioned, the VIX futures curve is usually in contango, meaning the short-term futures contracts are typically less expensive than the long-term ones. As a result, both the S&P 500 VIX Short-Term Futures Index and the S&P 500 VIX Mid-Term Futures Index have tended to decline over the long term because of roll costs (that is, to borrow a term from commodity trading, "negative roll yield"). The S&P 500 Dynamic VIX Futures Index was created to offer long VIX exposure at a reduced hedging cost.

The S&P 500 Dynamic VIX Futures Index monitors the steepness of the implied volatility curve, measured as the ratio between the VIX and the Cboe 3-Month Volatility Index (VIX3M), and allocates between the S&P 500 VIX Short-Term Futures Index and the S&P 500 VIX Mid-Term Futures Index accordingly. When the curve steepens, implying a relatively high probability of market downturn, the VIX3M increases its exposure to the two underlying VIX futures indexes to implement the hedge. When the curve flattens, implying a relatively stable market environment, the VIX3M holds a long position in the S&P 500 VIX Mid-Term Futures Index and finances this long exposure by shorting the S&P 500 VIX Short-Term Futures Index. Generally, the VIX3M holds a neutral or long exposure to volatility.

Exhibit 1 provides a summary of benchmark indexes that incorporate VIX futures or VIX

EXHIBIT 1. METHODOLOGIES FOR SELECT VIX-RELATED PERFORMANCE BENCHMARK INDEXES

Ticker	Description	Web Page
VIX Futures Indexes		
SPVIXSTR	The S&P 500 VIX Short-Term Futures Index replicates a position that rolls the nearest month VIX futures to the next month on a daily basis in equal fractional amounts. The result is a constant one-month rolling long position in first- and second-month VIX futures contracts.	http://us.spindices.com/indices/strategy/sp-500-vix-short-term-index-mcap
SPVIXMTR	The S&P 500 VIX Mid-Term Futures Index replicates a hypothetical portfolio that takes long positions in the fourth-, fifth-, sixth-, and seventh-month VIX futures contracts. It rolls the fourth-month VIX futures to the seventh-month figures on a daily basis in equal fractional amounts. The result is a constant five-month rolling long position.	http://us.spindices.com/indices/strategy/sp-500-vix-mid-term-futures-index
SPVXSPIT	The S&P 500 VIX® Short-Term Futures Inverse Daily Index is designed to measure the performance of the inverse of the S&P 500 VIX Short-Term Futures Index.	http://us.spindices.com/indices/strategy/sp-500-vix-short-term-futures-inverse-daily-index-tr

(continued)

EXHIBIT 1. METHODOLOGIES FOR SELECT VIX-RELATED PERFORMANCE BENCHMARK INDEXES *(CONTINUED)*

Ticker	Description	Web Page
SPVXMPIT	The S&P 500 VIX Mid-Term Futures Inverse Daily Index is designed to measure the performance of the inverse of the S&P 500 VIX Mid-Term Futures Index.	http://us.spindices.com/indices/strategy/sp-500-vix-mid-term-futures-inverse-daily-index-tr
SPDVIXT	The S&P 500 Dynamic VIX Futures Index dynamically allocates between the S&P 500 VIX Short-Term Futures Index and S&P 500 Mid-Term Futures Index by monitoring the steepness of the implied volatility curve and provides a cost-efficient exposure to forward implied volatility.	http://us.spindices.com/indices/strategy/sp-500-dynamic-vix-futures-tr
VIX Allocation Strategy Indexes		
SPVQDTID	The S&P 500 Dynamic VEQTOR Index tracks a strategy that dynamically allocates long-only exposure between the S&P 500, the S&P VIX Short-Term Futures Index, and cash to measure broad equity market exposure with an implied volatility hedge. The strategy is designed with the potential to help mitigate downside risk in volatile markets.	http://us.spindices.com/indices/multi-asset/sp-500-dynamic-veqtor-index-total-return
VPD	The Cboe VIX Premium Strategy Index tracks a strategy that overlays a sequence of short, one-month VIX futures on a money market account; the short VIX futures positions are held until expiration, and new VIX futures are then sold.	www.cboe.com/VPD
VPN	The Cboe Capped VIX Premium Strategy Index tracks the performance of a strategy that systematically sells one-month VIX futures, capped by the purchase of a VIX call option; the short VIX futures position is capped with long VIX calls struck approximately 25 points higher than the VIX futures price.	www.cboe.com/VPN
VSTG	The Cboe VIX Strangle Index is a premium capture index that tracks a strategy that overlays short VIX call and put options with a capped long VIX call option position. The position is collateralized by fixing the number of strangles such that 80% of capital is reserved.	www.cboe.com/VSTG
VXTH	The Cboe VIX Tail Hedge Index tracks a strategy that buys and holds S&P 500 stocks and also often buys 30-delta VIX call options.	www.cboe.com/VXTH

Sources: S&P Global and Cboe.

options exposure, including descriptions and website references. In addition to the rolled VIX futures indexes just described, several strategy indexes allocate between VIX futures and VIX options and other asset classes. The purpose of these indexes is to provide a packaged investment solution that meets specific investment goals and addresses issues in volatility investment such as hedge ratio and roll cost.

Two indexes for risk reduction are of particular interest. The first is the S&P 500 Dynamic VEQTOR, which allocates among VIX futures, equity, and cash to provide a hedged equity market exposure at reduced cost. It monitors the implied-volatility trend as well as the realized volatility of the S&P 500. The long-only exposure to the S&P 500 VIX Short-Term Futures Index is adjusted accordingly. A goal of the index is to hedge tail risk while reducing roll costs.

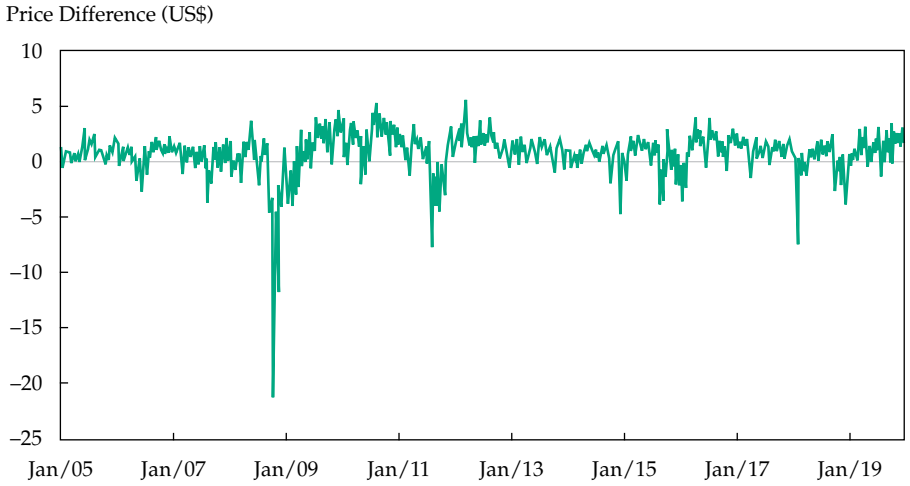
The second is the Cboe VIX Tail Hedge Index, also designed to provide a tail-risk hedge with VIX-related products. It buys and holds S&P 500 stocks and also often buys call options on the VIX.

Performance Impact of Rolling Costs/Benefits in VIX

Before we investigate the performance of VIX-related benchmark indexes, we will look at the cost of rolling long VIX futures exposure because this cost has a significant impact on index performance, especially over long holding periods.

Consider the widely followed S&P 500 VIX Short-Term Futures Index as an example. It rolls continuously from the first-month futures to the second-month futures. **Figure 4** shows the price difference between these two contracts since 3 January 2005, calculated as the second-month VIX futures price minus the first-month VIX futures price. Thus, a positive number means contango, and a negative number means backwardation.

FIGURE 4. PRICE DIFFERENCE BETWEEN FIRST- AND SECOND-MONTH VIX FUTURES, 3 JANUARY 2005–31 DECEMBER 2019



Source: Bloomberg.

We can quantify the VIX futures curve on any given day, t, as its slope, S_t, between the first- and second-month contracts:

$$S_t = \frac{UX2_t - UX1_t}{UX1_t},$$

where $UX1$ and $UX2$ refer, respectively, to the first- and second-month VIX futures closing price on day t.

Of the 3,776 trading days in the period shown in Figure 4, contango between the first- and second-month VIX futures contracts occurred on 3,102 days (82.15% of the time). Given that approximately 5% of the portfolio of the S&P 500 VIX Short-Term Futures Index is rolled on a daily basis, the median daily roll cost on a percentage basis, calculated as 5% of the position times slope S_t, was 28 bps. This amount may seem tiny, but it represents a median *monthly* (not annual) rolling cost of 5.66%, so the cumulative performance impact may be sizable over a long period. If the VIX were to remain unchanged for a year, the benchmark index could lose approximately half of its value from the continuous daily roll.

Although some analysts interpret this rolling cost as a "drag" on performance, it is, in fact, similar to the cost of rolling put options, another type of risk management tool. The cost of an ongoing risk control strategy such as using long VIX futures or SPX protective put options can be high if the S&P 500 does not have significant downside moves. As Figure 4 shows, the very negative levels of the rolling cost (that is, the large gain from backwardation) in high-volatility periods in 2008 and 2011 provided protection against the stock market declines. The payoff of long exposure to VIX futures as a risk reduction strategy, then, can be high in turbulent market periods. Many investors with long positions in VIX futures may be hoping that a future payoff when the equity index declines—which often is associated with upward VIX moves and rolling costs of less than zero—will be high enough to offset the more frequent but lower rolling costs of carrying a long VIX futures position.

Variation in Annualized Volatilities of VIX Spot and Futures

Market participants should also be aware of variations in annualized volatility levels of the VIX futures short-term and mid-term indexes and of the strategy indexes. The VIX at 83% volatility was almost six times as volatile as the S&P 500 over the 2005–19 period. The S&P 500 VIX Short-Term Futures Index and Mid-Term Futures Index had lower volatility than the VIX because the futures market tends to be less sensitive to market movements than is the spot price.

ADDING VIX FUTURES INDEXES TO PORTFOLIOS

The VIX is not directly tradable, but an investor can use VIX futures and options to gain exposure to expected volatility. In the following discussion, we examine the portfolio impact of using the S&P 500 VIX Short-Term Futures Index as a benchmark index for the buying of VIX futures exposure and the S&P 500 VIX Short-Term Futures Inverse Daily Index (hereafter, Inverse Daily) as a benchmark index for the selling of VIX futures exposure. To understand their applications to portfolios, an investor needs to consider both the negative correlation of the VIX with the equity market and the VIX futures term structure.

Table 2, using monthly returns between March 2006 and December 2019, shows the

TABLE 2. CORRELATION OF MONTHLY RETURNS OF SELECTED INDEXES, 31 MARCH 2006–31 DECEMBER 2019

Index	VIX	S&P 500 VIX Short-Term Futures	Inverse Daily
S&P 500	−0.69	−0.79	0.75
VIX	1.00	0.81	−0.78
S&P 500 VIX Short-Term Futures		1.00	−0.93
Inverse Daily			1.00

Notes: All indexes except the VIX are total-return indexes. Past performance is not predictive of future returns.
Sources: Bloomberg and S&P Global.

correlations between the broad equity market, VIX values, and two VIX futures indexes.

The correlation analysis shows the following:

- a strong negative correlation between the S&P 500 and the VIX,
- a strong positive correlation between the VIX and the S&P 500 VIX Short-Term Futures Index, and
- a strong positive correlation between the S&P 500 and the Inverse Daily.

Although the correlation analysis confirms that VIX futures often move in the same direction as the VIX, the magnitude of their moves in response to a percentage change in the S&P 500 is lower, and the shape of the VIX futures curve dictates whether rolling futures over time incurs a cost or a benefit for an investor. For example, assume a market participant holds a long VIX futures position when the VIX futures curve is in contango. Upon the expiration of the current VIX futures contract, the market participant may choose to either let the contract expire or roll to the next contract. In the case of expiration, the futures price is likely to drop because it is expected to converge to the value of the VIX; in the case of rolling, the investor has to pay the price difference to roll to the next futures contract. Either way, the investor incurs a loss as a result of contango. Similarly, when the VIX futures market is in backwardation, a market participant with a long VIX futures position benefits from the VIX futures term structure upon expiration of the futures contract, whether the market participant chooses to let the contract expire or to roll to the next one. This benefit is called "roll yield." Neither roll cost nor roll yield is unique to VIX futures; commodity futures investors also confront the roll costs and roll yields.

The VIX futures term structure (Figure 4) is the primary reason that holding and rolling a long position in VIX futures over the long term has tended to produce losses.

Long VIX Futures and Options Exposure for Risk Management

Tail risk can cause portfolios to suffer large losses in steep equity market declines and is thus of special interest to portfolio managers. Given the strong negative correlation between the S&P 500 VIX Short-Term Futures Index and the S&P

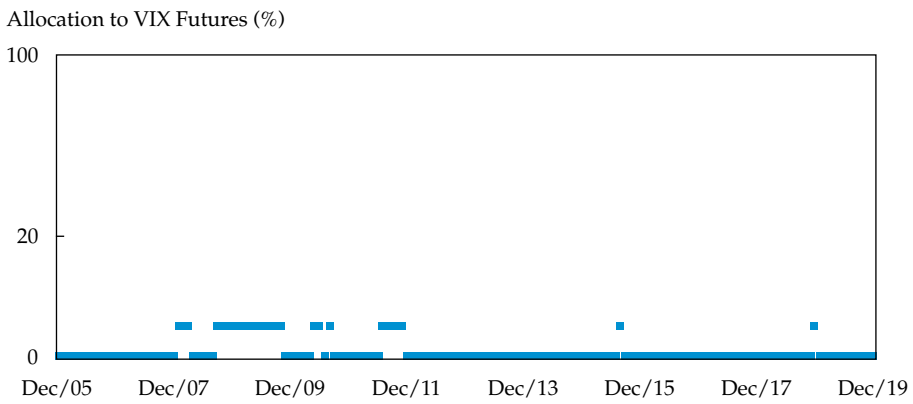
500, VIX futures may hold tail risk–hedging opportunities for portfolios. Given the typically high volatility of long VIX futures and their tendency to go into backwardation in volatile periods, even a small position in these futures can help manage risk during periods of steep S&P 500 declines. As mentioned, the rolling cost, however, for the majority of time periods when contango is in place may create a sizable performance drag, which a market participant who wishes to institute a cost-efficient tail-risk hedge via VIX futures should take into consideration. The dynamic allocation strategies implemented by the S&P 500 Dynamic VEQTOR Index and the Cboe VIX Tail Hedge Index both attempt to capture market signals and adjust the allocation of the long VIX futures or options positions. Both indexes had higher returns than the S&P 500 in 2008 and 2011.

To evaluate the effectiveness and cost of applying a long VIX futures strategy for risk reduction, we considered both a *static* strategy with the VIX futures index at a small weight and a *tactical* or *dynamic* strategy that used the index at a higher weight but only when expected volatility was at high levels (i.e., the spot VIX at 25% or higher). For this comparison, we ran two simple backtests:

- Static allocation: Allocating a small static weight of 5% to VIX futures in an equity portfolio and rebalancing monthly.
- Dynamic allocation: Dynamically allocating 5% of the portfolio to VIX futures in periods when the VIX reached a high level, which often coincided with volatile and declining S&P 500 periods. At each month's end, if the VIX spot was ≥25, 5% of the portfolio was allocated to VIX futures in the next month. If the VIX spot at month's end was <25, the allocation to VIX futures was zero.

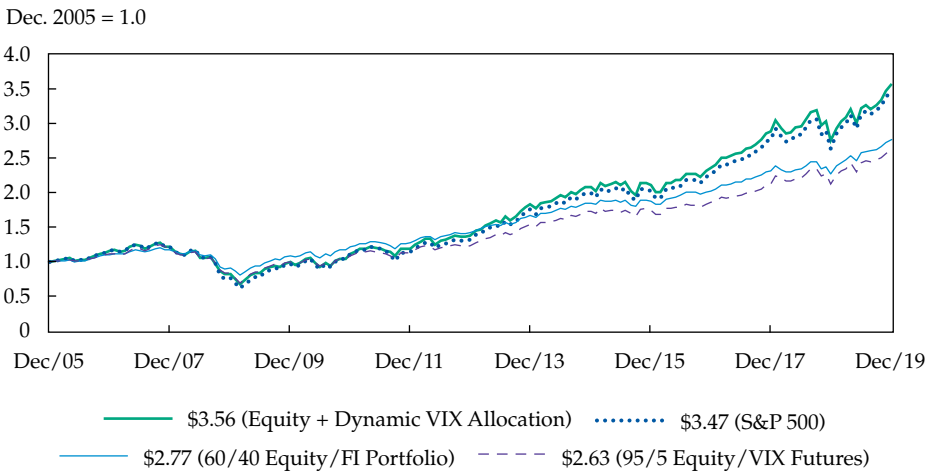
For the dynamic allocation, the trigger level of 25 was selected on the basis of historical long-term statistics for the VIX spot index. Between 2 January 1990 and 31 March 2018, the VIX daily closing levels ranged from 9.14 to 80.86. Because we were interested in the hedging property of VIX futures for tail risk, we set the trigger close to the 80th percentile of the distribution of historical VIX values (24.25). The actual allocation to VIX futures in the testing period is shown in **Figure 5**. Note that the

FIGURE 5. DYNAMIC ALLOCATION TO VIX SHORT-TERM FUTURES INDEX, 2005–2019



Source: S&P Global.

FIGURE 6. PERFORMANCE OF VIX FUTURES INDEX RISK MANAGEMENT STRATEGIES, 30 DECEMBER 2005–31 DECEMBER 2019



Note: Past performance is not predictive of future returns.

Sources: Bloomberg and S&P Global.

strategy allocated to the VIX futures index on a regular basis over the 2007–11 period but showed almost no investment in VIX futures in the 2012–19 period. This pattern is consistent with volatility shifting between high and low "regimes" that last for several years.

We then compared these two strategies with a pure equity portfolio as well as a typical 60/40 equity/fixed-income (FI) portfolio. We used the S&P 500 as the proxy for the broad equity market and the Bloomberg Barclays US Aggregate Total Return Index as the proxy for the FI market. The results, showing backtested, hypothetical performance, are in **Figure 6** and **Table 3**.

From the perspective of volatility reduction, Table 3 shows that even a small, static

TABLE 3. PERFORMANCE DATA FOR VIX FUTURES INDEX RISK MANAGEMENT STRATEGIES, 30 DECEMBER 2005–31 DECEMBER 2019

Strategy	Annualized Return	Annualized Volatility	Return/ Volatility	Correlation with S&P 500	Maximum Drawdown
Equity + dynamic VIX allocation	9.50%	12.88%	0.74	0.99	–46.32%
S&P 500	9.30%	14.14%	0.66	1.00	–50.96%
60/40 Equity/FI	7.54%	8.57%	0.88	0.99	–32.54%
95/5 Equity/VIX futures	7.15%	10.99%	0.65	0.98	–43.97%

Note: Past performance is not predictive of future returns.

Sources: Bloomberg and S&P Global.

hypothetical allocation that included a long position in VIX futures reduced annualized volatility and lessened the severity of the maximum drawdown when compared with an equity portfolio. Performance drag was significant in a bull market with low volatility, however, because of the roll cost of even a small VIX futures position.

Also, over this period, the overall diversification benefit of allocating just 5% of an S&P 500 equity portfolio to VIX futures would have underperformed the traditional 60%/40% equity/FI portfolio and had higher volatility. That said, we also note that the static VIX futures strategy still would have outperformed the 60/40 equity/FI portfolio by more than 1 percentage point in years when the equity market had strong performance—2009 (19.65% vs. 18.40%), 2013 (24.89% vs. 17.56%), 2014 (11.95% vs. 10.62%), and 2017 (16.69% vs. 13.11%)—because equity was the dominant source of return in the portfolio.

The data in Table 3 show that a dynamic allocation with the same size VIX futures position during high-volatility regimes, rebalanced at month end, would have provided downside protection and lessened portfolio drawdown. Compared with a pure equity portfolio, return per unit of risk (the Sharpe ratio) would have improved from 0.66 to 0.74, and maximum drawdown would have been reduced from –50.95% to –46.32%. These results suggest that dynamic exposure to long positions in short-term VIX futures based on a regime-dependent approach can be a valuable risk reduction strategy. Triggers identifying high-volatility regimes and using monthly or weekly rebalancing may be considered for investors concerned about mitigating tail risk in their portfolios without a large sacrifice in returns.

The key to incorporating a long position in VIX futures in an equity portfolio is to be aware of the potential performance drag attributable to the roll cost of the futures position in low- and normal-volatility market conditions. Even a small allocation to VIX futures may produce a sizable performance drag over a long horizon.

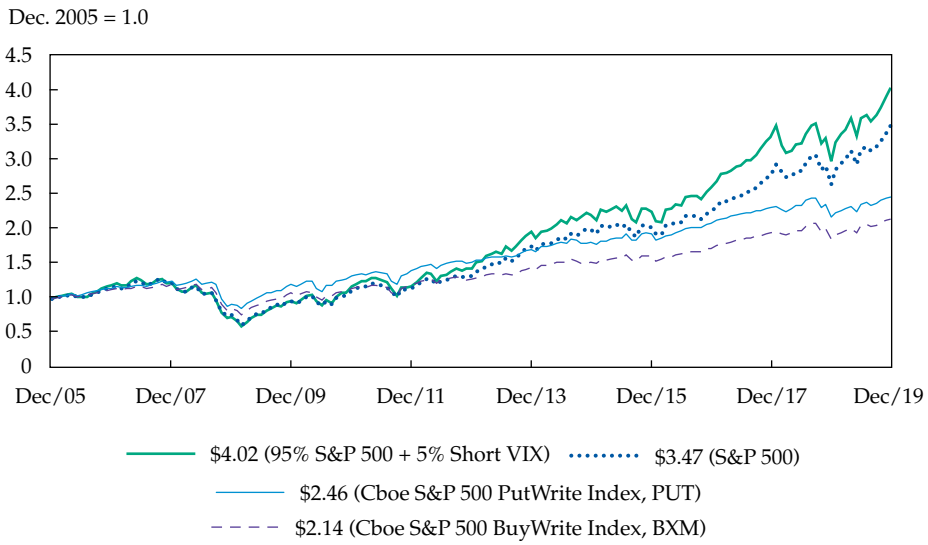
Short-Term Volatility Exposure for Income and as an Equity Alternative

Selling volatility can be a source of portfolio income that does not rely on interest rates or dividends. Historically, investors have used covered option selling strategies to generate income. Selling VIX futures may be an operationally simple strategy that provides short-term volatility exposure through exchange-traded liquid instruments. Because VIX futures indexes are generally negatively correlated with the S&P 500, inverse exposure also brings in a position that benefits from higher S&P 500 returns and that can, in effect, be considered a form of long-term equity market exposure.

As shown in Figure 5, the VIX futures curve has been in contango approximately 80% of the time, which creates the insurance-like premium that is paid by a long position and received by a short position. In a stressed market, the term structure can invert and create a negative roll return for the short position. This characteristic delivers the potential to capture significant returns over long horizons, with infrequent sharp losses, through a small allocation to a short VIX futures position. When using short-term VIX futures, a critical step is to size the position appropriately because short positions in volatility are susceptible to large and sudden losses in the event of volatility spikes when negative news appears for equities.

To illustrate the pros and cons of short-term VIX positions, we backtested a hypothetical (monthly rebalanced) portfolio that allocated

FIGURE 7. PERFORMANCE OF SHORT VOLATILITY STRATEGIES, 30 DECEMBER 2005–31 DECEMBER 2019



Sources: Bloomberg and S&P Global.

95% to the S&P 500 and 5% to the Inverse Daily. We then compared the hypothetical portfolio's performance with that of a pure equity portfolio and two popular option-writing strategies, represented by the Cboe S&P 500 BuyWrite Index (BXM^{SM}) and the Cboe S&P 500 PutWrite Index (PUT^{SM}). The BXM represents a strategy that holds a stock position and sells SPX call options every month; the PUT represents a strategy that holds US T-bills and sells SPX put options every month. The results are shown in **Figure 7** and **Table 4**.

Figure 7 shows that selling VIX futures could have a financial impact completely different

TABLE 4. PERFORMANCE DATA FOR SHORT VOLATILITY STRATEGIES, 30 DECEMBER 2005–31 DECEMBER 2019

Strategy	Annualized Return	Annualized Volatility	Return/ Volatility	Correlation with S&P 500	Maximum Drawdown
95% S&P 500 + 5% Short VIX	10.45%	16.07%	0.65	0.99	–52.68%
S&P 500	9.30%	14.14%	0.66	1.00	–50.95%
PUT	6.65%	10.47%	0.64	0.86	–32.66%
BXM	5.60%	10.36%	0.54	0.89	–35.81%

Note: Past performance is not predictive of future returns.

Sources: Bloomberg and S&P Global.

from that of selling index options on an equity portfolio:

- Selling VIX futures at a 5% weight with a 95% exposure to the S&P 500 would have increased both annualized return and volatility. Writing put or call options would tend to reduce portfolio volatility by forgoing part of the returns.
- Despite the increased drawdown caused by the strategy, shorting VIX futures would have increased the long-term annualized return of the equity portfolio by more than 1 percentage point. The trade-off is that it also would have elevated the portfolio's annualized volatility from 14.14% to 16.07%.
- Risk-adjusted returns, measured by return per unit of volatility, would have been comparable in all four portfolios.
- Investors looking to have risk and drawdown at or below levels of the S&P 500 while selling VIX futures might consider combining the position with a shift of some S&P 500 exposure into cash equivalents to reduce the equity risk.

Unlike a buy–write strategy that sells a covered call, shorting VIX futures performs best in a bull market and suffers the most in a turbulent bear market. The reason is that shorting VIX futures involves selling volatility across all strike prices and essentially adds long exposure to the equity market as a result of the negative correlation between the VIX and equities and between VIX futures and equities. In contrast, a buy–write strategy limits the upside potential of the equity market and incurs a performance drag in a strong bull market. The option premium received, however, mitigates the loss, and the buy–write index generally outperforms when the market goes down. Over the period depicted in Figure 7, when market volatility spiked, even a 5% allocation to the Inverse Daily VIX futures position would have caused a sharp loss in the portfolio. For example, in February 2018, the equity market lost 3.69%. Option premiums collected from the option-writing strategies would have moderately reduced the loss (the BXM return was down 1.42%, and the PUT return was down 2.16%), whereas the portfolio with a 5% allocation to the inverse VIX futures strategy would have more than doubled the loss (down 8.27%).

The key to incorporating a short-term VIX futures strategy into a portfolio is to remember that sharp negative returns may occur. This strategy is not suitable for large portfolio allocations. Investors must be aware that the futures curve may flip from contango to backwardation when a volatility event hits the market, which will further increase the loss from a short VIX futures position.

CONCLUSION

During the past two decades, the Cboe Volatility Index, a key measure of investor sentiment and near-term volatility expectations known as the VIX Index, has generated much investor attention because of its unique and powerful features. The introduction of VIX futures in 2004, VIX options in 2006, and other volatility-related trading instruments provided traders and investors access to exchange-traded vehicles for taking long and short exposures to expected S&P 500 volatility for a particular time frame. Certain VIX-related tradable products have the potential to provide benefits when used as tools for tail-risk hedging, diversification, risk management, or alpha generation, but before investing, investors should closely study the pricing, roll cost, and volatility features of VIX-related tradable products and read the applicable prospectus and risk disclosure statements.

The authors thank Joanne Hill for her valuable suggestions for this Brief.

Disclosures

Past performance is not predictive of future returns. S&P Dow Jones Indices and Cboe Exchange, Inc., do not sponsor, endorse, sell, promote, or manage any investment fund or other investment vehicle that is offered by third parties and that seeks to provide an investment return based on the performance of any index. S&P Dow Jones Indices and Cboe Exchange, Inc., make no assurance that investment products based on an index will accurately track index performance or provide positive investment returns. Options involve risk and are not suitable for all investors. Prior to buying or selling an option, a person must receive a copy of Characteristics and Risks of Standardized Options (the "ODD"). The ODD and supporting documentation for any claims, comparisons, recommendations, statistics, or other technical data in these materials are available by calling 1-888-OPTIONS or contacting Cboe at www.Cboe.com/Contact. Futures trading is not suitable for all investors and involves the risk of loss. The risk of loss in futures can be substantial. You should, therefore, carefully consider whether such trading is suitable for you in light of your circumstances and financial resources. For additional information regarding futures trading risks, see the Risk Disclosure Statement set forth in US Commodity Futures Trading Commission Regulation §1.55(b). The information in this article is provided solely for general education and information purposes and, therefore, should not be considered complete, precise, or current. The methodologies of many of the indexes in this article are owned by Cboe Exchange, Inc. or S&P Dow Jones Indices, and the indexes may be covered by one or more patents or pending patent applications. S&P® and S&P 500® are registered trademarks of Standard & Poor's Financial Services, LLC, and are licensed for use by Cboe Exchange, Inc., and Cboe Futures Exchange, LLC. Cboe Volatility Index®, VIX®, Cboe®, and Chicago Board Options Exchange® are registered trademarks, and BXM and PUT are service marks of Cboe Exchange, Inc. All other trademarks and service marks are the property of their respective owners.

REFERENCES

Black, Keith, and Edward Szado. 2016. "Performance Analysis of Options-Based Equity Mutual Funds, Closed-End Funds, and Exchange-Traded Funds." *Journal of Wealth Management* 19 (1): 51–69.

Feldman, Barry, and Dhruv Roy. 2005. "Passive Options-Based Investment Strategies: The Case of the CBOE S&P 500 BuyWrite Index." *Journal of Investing* 14 (2): 66–83.

He, Donald X., Jason C. Hsu, and Neil Rue. 2015. "Option-Writing Strategies in a Low-Volatility Framework." *Journal of Investing* 24 (3): 116–28.

Hill, Joanne. 2013. "The Different Faces of Volatility Exposure in Portfolio Management." *Journal of Alternative Investments* l5 (3): 9–31.

Hill, Joanne, Venkatesh Balasubramanian, Krag (Buzz) Gregory, and Ingrid Tierens. 2006. "Finding Alpha via Covered Index Writing." *Financial Analysts Journal* 62 (5): 29–46.

Moran, Matthew T. 2014. "Thirty Volatility Indexes: Worldwide Tools to Gauge Sentiment and Diversify Portfolios." *Journal of Index Investing* 4 (4): 69–87.

Moran, Matthew T., and Srikant Dash. 2007. "VIX Futures and Options: Pricing and Using Volatility Products to Manage Downside Risk and Improve Efficiency in Equity Portfolios." *Journal of Trading* 2 (3): 96–105.

Szado, Edward. 2009. "VIX Futures and Options: A Case Study of Portfolio Diversification during the 2008 Financial Crisis." *Journal of Alternative Investments* 12 (2): 68–85.

Whaley, Robert E. 1993. "Derivatives on Market Volatility: Hedging Tools Long Overdue." *Journal of Derivatives* 1 (1): 71–84.

Wilshire Analytics Applied Research Group. 2019. "Options-Based Benchmark Indexes: Performance, Risk and Premium Capture (June 1986–December 2018): An Update." Wilshire Associates Incorporated.

Named Endowments

CFA Institute Research Foundation acknowledges with sincere gratitude the generous contributions of the Named Endowment participants listed below.

Gifts of at least US$100,000 qualify donors for membership in the Named Endowment category, which recognizes in perpetuity the commitment toward unbiased, practitioner-oriented, relevant research that these firms and individuals have expressed through their generous support of the CFA Institute Research Foundation.

Ameritech
Anonymous
Robert D. Arnott
Theodore R. Aronson, CFA
Asahi Mutual Life Insurance Company
Batterymarch Financial Management
Boston Company
Boston Partners Asset Management, L.P.
Gary P. Brinson, CFA
Brinson Partners, Inc.
Capital Group International, Inc.
Concord Capital Management
Dai-Ichi Life Insurance Company
Daiwa Securities
Mr. and Mrs. Jeffrey Diermeier
Gifford Fong Associates
John A. Gunn, CFA
Investment Counsel Association of America, Inc.
Jacobs Levy Equity Management
Jon L. Hagler Foundation
Long-Term Credit Bank of Japan, Ltd.
Lynch, Jones & Ryan, LLC
Meiji Mutual Life Insurance Company
Miller Anderson & Sherrerd, LLP
John B. Neff, CFA
Nikko Securities Co., Ltd.
Nippon Life Insurance Company of Japan
Nomura Securities Co., Ltd.
Payden & Rygel
Provident National Bank
Frank K. Reilly, CFA
Salomon Brothers
Sassoon Holdings Pte. Ltd.
Scudder Stevens & Clark
Security Analysts Association of Japan
Shaw Data Securities, Inc.
Sit Investment Associates, Inc.
Standish, Ayer & Wood, Inc.
State Farm Insurance Company
Sumitomo Life America, Inc.
T. Rowe Price Associates, Inc.
Templeton Investment Counsel Inc.
Frank Trainer, CFA
Travelers Insurance Co.
USF&G Companies
Yamaichi Securities Co., Ltd.

Senior Research Fellows

Financial Services Analyst Association

CFA Institute
Research
Foundation

Available online at www.cfainstitute.org

ISBN 978-1-944960-95-7