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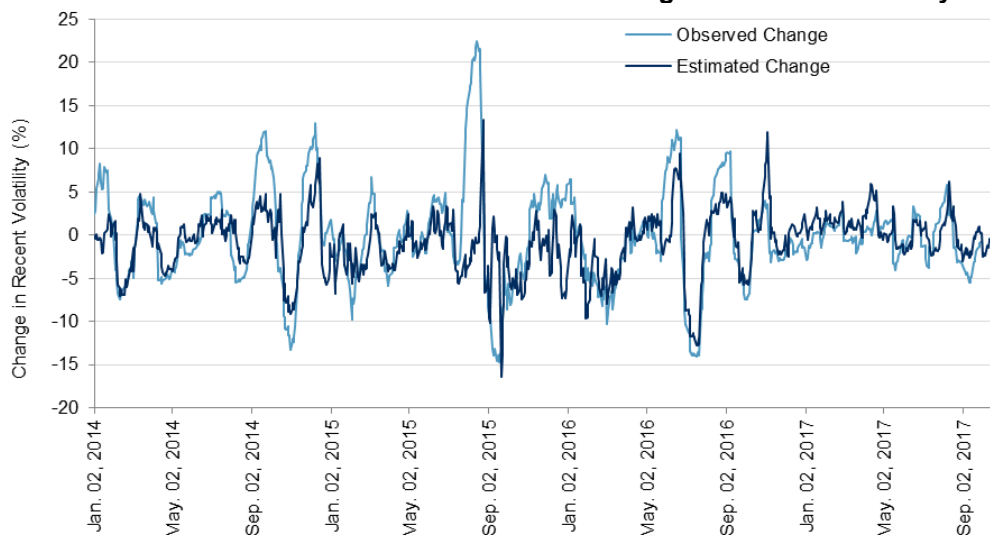
# A Practitioner's Guide to Reading VIX<sup>®</sup>

## EXECUTIVE SUMMARY

Known as Wall Street's "fear gauge," VIX<sup>1</sup> is followed by a multitude of market participants; its levels and trends have become part of the common language of market commentary. Unfortunately, the meaning of a given VIX level is frequently misunderstood. Our recent paper,<sup>2</sup> "[Reading VIX: Does VIX Predict Future Volatility?](#)" provides market participants with simple rules that translate VIX levels into potentially more meaningful predictions or measures of market sentiment.

This document serves as an introduction to, and summary of, "Reading VIX: Does VIX Predict Future Volatility?" bypassing some of the academic rigor of the original in order to be more accessible to the practitioner. Exhibit 1 provides a key highlight: the extent to which our analysis could have provided market participants with a useful estimation of future changes in [S&P 500<sup>®</sup>](#) realized volatility, one month in advance.

### Exhibit 1: VIX-Based Prediction Versus Actual Change in S&P 500 Volatility



Source: S&P Dow Jones Indices LLC and CBOE. Data from Jan. 2, 2014, to Oct. 30, 2017. See "[Reading VIX: Does VIX Predict Future Volatility?](#)" for details. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

<sup>1</sup> For details on how VIX is calculated, please see <https://www.cboe.com/micro/vix/vixwhite.pdf>.

<sup>2</sup> Edwards and Preston, "[Reading VIX: Does VIX Predict Future Volatility?](#)" (November 2017).

## PREDICTIVE ASPECTS OF VIX

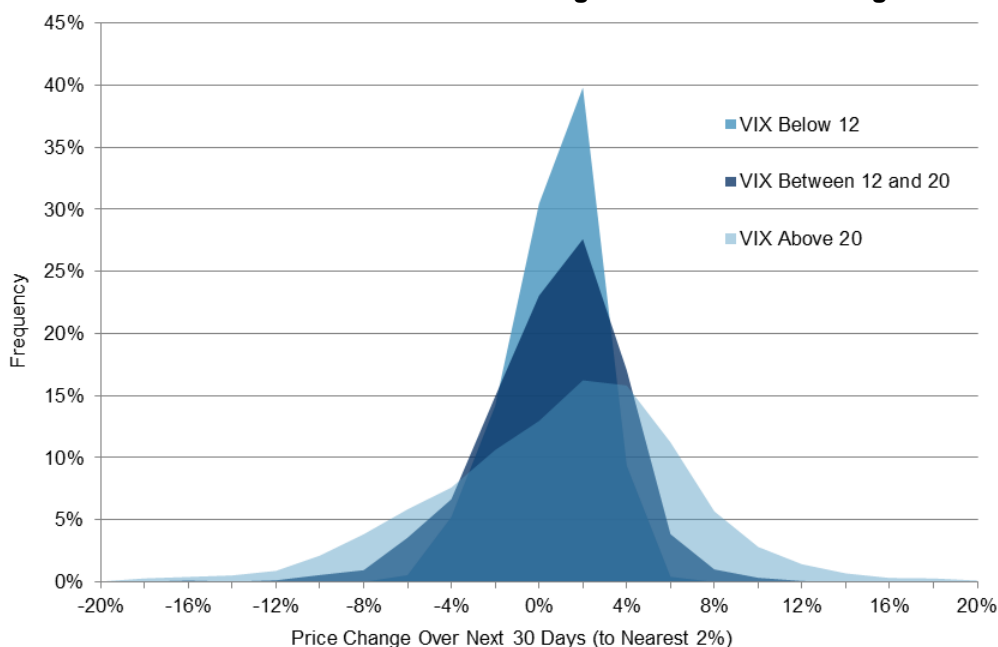
“My interest is in the future...I am going to spend the rest of my life there”

– C.F. Kettering.

That VIX should contain some predictive content is to be expected. It is calculated from the prices of a particular basket of S&P 500 options, whose value to their holders depends primarily on the future level of S&P 500 volatility.

**Even simple interpretations of VIX can offer predictive informational content regarding future volatility.** One such example takes a VIX level below 12 to be “low,” a level above 20 to be “high,” and a level in between to be “normal.” Exhibit 2 illustrates the historical distribution of S&P 500 price changes over 30-day periods after a low VIX, after a high VIX, and after a normal VIX. Based on Exhibit 2, we might suppose that VIX has been somewhat predictive of the subsequent magnitude (if not direction) of changes in the S&P 500.

**Exhibit 2: Distribution of S&P 500 Price Changes for Different VIX Regimes**



Source: S&P Dow Jones Indices LLC and CBOE. Data from Dec. 31, 1990, to Oct. 23, 2017. Chart is based on VIX levels on each date and the distribution of subsequent 30-day price changes in the S&P 500, using closing price levels. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

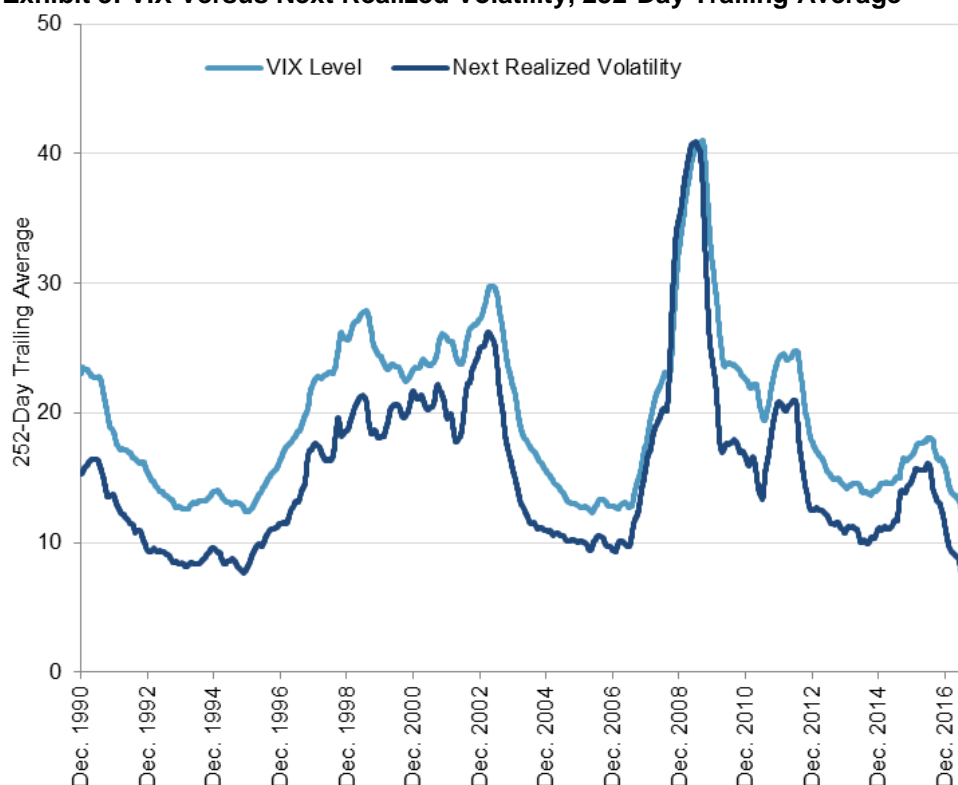
That VIX should contain *some* predictive content is to be expected. VIX is calculated from the prices of a particular basket of S&P 500 options, whose value to their holders depends importantly on the future level of S&P 500 volatility. If market participants are rationally processing what might already be deduced about future volatility—from upcoming earnings, central bank announcements, political events, and so on, as well as from the expected *frequency* of unanticipated market moving events—then **VIX might be said to provide a crowd-sourced estimate for the degree to which the market is uncertain about the future.**

However, pinpointing exactly *what* VIX is indicating about future volatility is slightly trickier. **One common misconception is that VIX levels correspond directly to the volatility observed 30 days later**—assuming that a VIX level of 25 means an anticipated volatility of 25%, for instance. Instead, because there has typically been an excess of demand from market participants seeking the insurance-like characteristics that options can provide, **there has been a discernable “premium” in VIX**—otherwise said, VIX today more often than not **overstates** the level of actual volatility experienced in the next 30 days.

To illustrate the historical extent to which VIX has overestimated subsequent volatility, Exhibit 3 compares a 252-trading-day trailing average of VIX with the corresponding trailing average of S&P 500 volatility that was observed over the next 30 days (“next realized volatility”).<sup>3</sup> An overestimate, or premium—averaging around 4 to 5 percentage points—appears typical.

The imposition of a one-year trailing average helps to illustrate the broader trend when comparing VIX with the 30-day S&P 500 volatility that was subsequently observed.

**Exhibit 3: VIX Versus Next Realized Volatility, 252-Day Trailing Average**



Source: S&P Dow Jones Indices LLC and CBOE. Data from Jan. 2, 1990, to Oct. 31 2017. Chart is based on VIX levels and their corresponding S&P 500 recent volatility levels on each trading day. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

In fact, this degree of overestimation—or premium—appears to vary in a fairly predictable manner. Understanding this relationship requires two

<sup>3</sup> For purposes of brevity, the reader is directed to [“Reading VIX: Does VIX Predict Future Volatility?”](#) for full details of the various terms used in Exhibit 3 and those that follow.

Examining the historical mean reversion in S&P 500 volatility and premium in VIX provides the basis for calculating an “Expected VIX”, based on recent volatility, that then be can be compared to the current VIX.

conceptual steps, the justification and calibration of which comprise a significant proportion of our original paper.

The first step is to incorporate the well-known observation that **realized volatility is mean reverting**. Examining historical S&P 500 volatility lets us estimate a “speed” and “destination” that may be used to calculate a so-called mean reversion volatility (MR volatility)—effectively the level of volatility that would be expected 30 days hence under mean reversion *alone*.

The second step is to **calculate the expected level of the volatility premium**. This is done by comparing VIX levels to the then-current MR volatility, which reveals a nearly linear (or straight line) relationship. Specifically, we find that a linear approximation provides a good estimation for the relationship between the historical levels of MR volatility *squared* and VIX *squared*.

The completion of these two steps leads us to an estimate for what VIX *ought to be*. We call this the “expected VIX” and it is calculated as:

$$\text{Expected VIX} = \text{Recent Volatility} + \text{MR Adjustment} + \text{Volatility Premium}$$

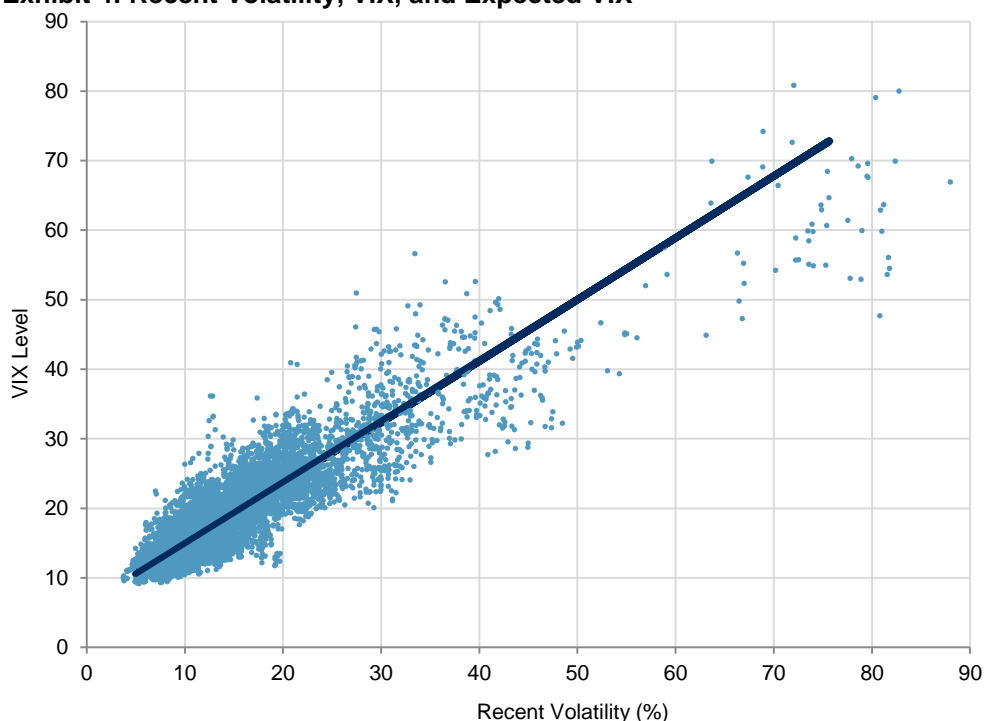
Note that this calculation is based entirely on the currently observable levels of—and historical relationships between—VIX and S&P 500 realized volatility.

## THE EXPECTED VIX EXAMINED

“It is said that the present is pregnant with the future”

– Voltaire.

Exhibit 4 shows the daily levels of recent volatility in the S&P 500, and the concurrent levels of VIX (the light blue dots), as well as the concurrent levels of the “expected VIX” (the navy line), for trading days between Jan. 2, 1990, and Oct. 31, 2017.

**Exhibit 4: Recent Volatility, VIX, and Expected VIX**

Source: S&P Dow Jones Indices LLC and CBOE. Data from Jan. 2, 1990, to Oct. 31 2017. Chart is based on VIX levels and corresponding S&P 500 recent volatility levels on each trading day. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

The particular usefulness of expected VIX is that it provides us at any point in time with a better-calibrated measure of whether VIX is high, low, or normal. For example, recent volatility and VIX have maintained unusually low levels so far in 2017. Our construction of expected VIX allows us to assess where VIX stood, *relative to where we might have otherwise expected it to be*. Our analysis shows that indeed VIX **was lower than we would have expected during the first ten months of 2017**, an observation that improves upon—and has more meaning than—the factually correct statement that VIX was unusually low.

Our construction of expected VIX allows us to assess where VIX stood, relative to where we might have otherwise expected it to be.

But what are we to make of the *differences* between a VIX level and its expected value? Naturally, a large difference would suggest a market that is unusually calm (or concerned) about the future. Also, we might hope to incorporate such differences into predictions; a VIX two percentage points higher than expected VIX might be implying two percentage points more volatility. In practice, a minor additional subtlety is required.

## PREDICTING VOLATILITY USING VIX

“To expect the unexpected shows a thoroughly modern intellect”

– Oscar Wilde.

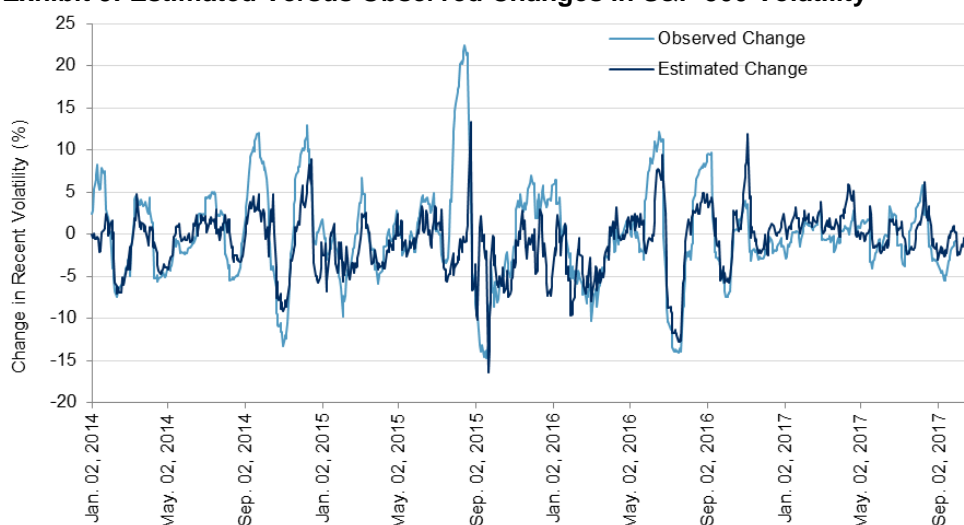
If the level of VIX, when viewed in light of recent volatility, is equal to the expected VIX, this might be taken to imply that we only expect the “usual” to occur. As indicated earlier, mean reversion in volatility is “usual.” In contrast, **the difference between VIX and expected VIX relates to the “unusual.”**

Thus, we arrive at a potential prediction for future changes in volatility, based on recent volatility and VIX, which comprises first, a mean reversion adjustment and second, the difference between VIX and expected VIX.

If the level of VIX, when viewed in light of recent volatility, is equal to the expected VIX, this might be taken to imply that we only expect the “usual” to occur.

Exhibit 5 (as already encountered in the introduction) illustrates how useful such predictions might have been historically. In more detail, the first series of Exhibit 5—labelled “Observed Change”—reflects changes in the level of one-month S&P 500 realized volatility that occurred between trading days 30 calendar days apart. The second series of Exhibit 5—labelled “Estimated Change”—reflects the changes that would have been anticipated by a market participant following the simple rules outlined above. These estimated changes can be calculated 30 days ahead of the corresponding observed changes in volatility; the second series is available for the one-month period after our last reported observed change in volatility (indicated by the orange line).

**Exhibit 5: Estimated Versus Observed Changes in S&P 500 Volatility**



Source: S&P Dow Jones Indices LLC and CBOE. Data from Jan. 2, 2014, to Oct. 30, 2017. Chart is based on the predicted change in volatility and the differences between recent volatility and next realized volatility in the S&P 500, as calculated on each trading day when possible. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 5 shows an **encouraging similarity** between the two series—suggesting that market participants might have been well served by using

our simple approach to interpreting VIX. However, **it does not offer a crystal ball.**

Although the VCR is by no means perfect, it appears to have merit in comparison with some common alternatives.

Exhibit 6 shows the potential relative benefit of this approach (called VIX-implied change in realized volatility or VCR in our paper) by comparing it to other simple alternatives. The first alternative takes VIX as an outright prediction of future volatility (raw VIX). The second alternative assumes future volatility will remain equal to its current level (recent volatility), and the third and final alternative adjusts for mean reversion alone (MR adjustment). Exhibit 6 shows the median and the average, along with the 25<sup>th</sup> and 75<sup>th</sup> percentiles, of the “errors” in each case. These errors are calculated by taking the absolute difference between the *actual* changes in realized volatility and those *predicted*.

**Exhibit 6: Comparing Our Prediction to Some Alternatives**

ABSOLUTE DIFFERENCE	VCR	RAW VIX	RECENT VOLATILITY	MR ADJUSTMENT
Median	2.31	4.62	3.06	3.02
Average	3.58	5.27	4.25	4.08
25 <sup>th</sup> Percentile	1.09	2.65	1.37	1.47
75 <sup>th</sup> Percentile	4.45	7.01	5.66	5.20

Source: S&P Dow Jones Indices LLC and CBOE. Data from Dec. 21, 1990, to Sep. 30, 2017. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

Exhibit 6 shows that, although the VCR is by no means perfect, it appears to have merit in comparison with some common alternatives.

## GLOBAL APPLICATIONS TO VIX INDICES

Since the Chicago Board Options Exchange (CBOE) first created and began publishing VIX levels in January 1990, CBOE, S&P Dow Jones Indices, and others have applied the same VIX methodology to a wide range of equity, fixed income, and currency markets.

From an analytical perspective, these indices provide out-of-sample tests for our approach. A total of 10 other indices—listed in Exhibit 7—are examined in the paper. The resulting tests of predictions based on our approach delivered similarly encouraging results in many markets.

From a practical perspective, the availability of a global range of VIX indices—and the applicability of our approach to their interpretation—provides market participants with a broad toolkit to assess what, if anything, is currently implied by implied volatility.

Comparing the actual VIX levels to those that might be expected is helpful in identifying whether VIX is “high” or “low” and can provide clearer indications of what the market is predicting about volatility.

**Exhibit 7: Selected Global VIX Indices**

INDEX	UNDERLYING INDEX USED IN ANALYSIS
VIX	S&P 500
S&P/ASX 200 VIX	S&P/ASX 200
VSTOXX®	Euro STOXX 50
S&P/TSX 60 VIX	S&P/TSX 60
HSI Volatility Index	Hang Seng Index
S&P/JPX JGB VIX	S&P 10-Year JGB Futures Index (TR)
CBOE/CME FX Euro Volatility	EUR/USD Spot Rate
CBOE/CME FX GBP Volatility	GBP/USD Spot Rate
CBOE/CME FX Yen Volatility	JPY/USD Spot Rate
CBOE Gold ETF Volatility	LBMA Gold Price PM
CBOE VIX of VIX	VIX

Source: S&P Dow Jones Indices LLC, “[Reading VIX: Does VIX Predict Future Volatility?](#)” Table is provided for illustrative purposes.

## CONCLUSION

VIX can be put in a specific context that teases out predictive information. In particular, using recent market volatility, typical premiums, and an expectation for mean reversion in volatility can provide a measure of where VIX *ought to be*. Comparing the actual VIX levels to those that might be expected is helpful in identifying whether VIX is “high” or “low” and can provide clearer indications of what the market is predicting about future realized volatility. The fact that similar results can be observed in various VIX indices for different equity, currency, and fixed income markets globally offers further practical applications for our approach.



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