Forecasting a Volatility Tsunami

Andrew Thrasher
Financial Enhancement Group

Introduction

According to the United Kingdom's National Oceanography Centre, tsunami waves can be as much as 125 miles in length and have resulted in some of the deadliest natural disasters in history. Fortunately, scientists have discovered warning signs of these massive waves, which are believed to be caused by shifts in the earth's tectonic plates. One of the visible signs of a forthcoming tsunami is the receding of water from a coast line, exposing the ocean floor. This is often referred to as "the calm before the storm." The same type of activity can also be found in financial markets, specifically when analyzing the CBOE Volatility Index (VIX). It is often believed that when volatility gets to a "low" level the likelihood of a spike increases. However, as this paper will show, there is a more optimal tsunami-like condition that takes place within the markets, providing a better indication of potential future equity market loss and Volatility Index increase.

Great importance is found in the study of market volatility due to the historically negative correlation the Volatility Index has had to U.S. equities. By knowing the warning signs of a tsunami wave of volatility, professional and non-professional traders can better prepare their portfolios for potential downside risks as well as have the opportunity to profit from advances in volatility and/or declines in equities.

The popularity of volatility trading has seen steady growth to over $4 billion with more than 30 index-listed Exchange Traded Products. Drimus and Farkas (2012) note that "the average daily volume for VIX options in 2011 has almost doubled compared to 2010 and is nearly 20 times larger than in the year of their launch, 2006." We can also see the increase in interest surrounding the Volatility Index by looking at trends in online searches with regards to low levels within the VIX. As of September 20th, 2016 there were 423,000 Google search results for "low VIX" and 4,610 results for "historic low volatility." Few investors would deny the importance of volatility when it comes to the evaluation of financial markets.

In this paper the author will provide a brief literature review concerning the history of the Volatility Index, important prior studies surrounding the topic of volatility followed by a discussion of alterative, yet ultimately suboptimal, methods of predicting large swings in the VIX. The paper will conclude with the description, analysis, and results based on the author's proposed methodology for forecasting outsized spikes within the VIX Index and how this approach may be used from a portfolio management standpoint to help investors better prepare based on the "calm before the storm."

Those that believe in the adage of buy-and-hold investing often mention that missing the ten or twenty best trading days has a substantially negative impact on a portfolio's overall return. They then in turn reject the idea of attempting to avoid the worst days in the market and active management as a whole. However, as Gire (2005) wrote in an article for the Journal of Financial Planning, the best and the worst days are often very close in time to one another. Specifically, 50% of the worst and best days were no more than 12 days apart. Looking at the bull market in the S&P 500 between 1984 and 1998, the Index rose an annualized 17.89%. Gire found that by missing the ten best days the annualized return fell to 14.24%, the statistic often cited by the passive investing advocates. Missing the ten worst days increased the return to 24.17% and missing both best and worst days produced an annualized return of 20.31%, with lower overall portfolio gyration. With the negative correlation between the Volatility Index and the S&P 500, by having an ability to forecast large spikes in the VIX the author proposes the ability to potentially curtail an investor's exposure to some of the worst performing days within the equity market.

History of the Volatility Index

To better research, test, and analyze a financial instrument, it's important to understand its history and purpose. The CBOE Volatility Index was originally created by Robert E. Whaley, Professor of Finance at The Owen Graduate School of Management at Vanderbilt University. The Index was first written about by Whaley in his paper, "Derivatives on Market Volatility: Hedging Tools Long Overdue" in 1993 in The Journal of Derivatives. Whaley (1993) wrote, "The Chicago Board of Options Exchange Market Volatility Index (ticker symbol VIX), which is based on the implied volatilities of eight different OEX option series, represents a markets consensus forecast for stock market volatility over the next thirty calendar days."

Whaley believed the Volatility Index served two functions; first, to provide a tool to analyze "market anxiety" and second, to be used as an index that could be used to price futures and options contracts. The initial function helped give the VIX its nickname of being the "fear gauge" which aids to provide a narrative explanation for why the Index can have such large and quick spikes as investor emotions flow through their trading terminals.

The Chicago Board of Options Exchange (CBOE) eventually launched Volatility Index (VIX) futures and options in 2004 and 2006, respectively. The VIX in its current form, according to the CBOE, "measures the level of expected volatility of the S&P 500 Index over the next 30 days that is implied in the bid/ask quotations of SPX options."

Literature Review

Comparing Rising & Falling Volatility Environments

It is often stated in the financial markets community that volatility is mean-reverting, meaning that like objects affected by gravity – what goes up must come down. Many market professionals attempt to take advantage of the rising and falling trends within the volatility market by echoing Warren Buffett's famous quote, "Buy when there's blood in the streets," using an elevated reading in the Volatility Index as their measuring stick for the level of figurative blood flowing down Wall Street. However, as Zakamunlin (2006) states, the median and average duration for rising and falling Volatility are not equal. In fact, Zakamunlin found that the timespan for declines in volatility surpass the length of rising volatility by a factor of 1.4 and the resulting impact on equity markets is asymmetric, with a perceived over-reaction to rising volatility compared to declining volatility. This is important, as it tells us that there is less time for an investor to react to rising volatility than there is to react after volatility has already spiked. Thus, the resulting impact on stock prices is disproportionately biased with stocks declining in value more than they rise in value during environments of increasing and decreasing volatility, respectively.

Using Volatility to Predict Equity Returns

Much attention has been paid to the creation of investment strategies based on capturing the perceived favorable risk situation of elevated readings from the Volatility Index. Cipollini and Manzini (2007) concluded that when implied volatility is elevated, a clear signal can be discerned for forecasting future three-month S&P 500 returns contrasted to when volatility is low. When evaluating the Volatility Index's forecasting ability when at low levels, their research notes that, "On the contrary, at low levels of implied volatility the model is less effective." Cipollini and Manzini's work shows that there may be a degree of predictability when the VIX is elevated but that the same level of forecasting power diminishes when analyzing low readings in the Volatility Index. In a study conducted by Giot (2002), the Volatility Index is categorized into percentiles based on its value and modeled against the forward-looking returns for the S&P 100 Index for 1-, 5-, 20-, and 60-day periods. When looking at the tenth percentile (equal to 12.76 on the Volatility Index), which includes a sample size of 414 observations, the 20-day mean return was found to be 1.06%, however Giot observed the standard deviation of 2.18, and the minimum and maximum returns ranged from -6.83% to 5.3%. While Giot demonstrates a relationship between volatility and forward equity returns, the research also diminishes the confidence that can be had in the directional forecasting power of returns within intermediate time periods for the underlying equity index. We can take from this that while a low reading within the VIX has shown some value in predicting future volatility, the forecasting of the degree and severity of the predicted move is less reliable, as it has a suboptimal degree of variance.

Data Used

For purposes of crafting the methodology and charts used within this paper, data was obtained from several credible sources. CBOE Volatility Index data has been acquired from StockCharts.com, which curates its data from the NYSE, NASDAQ, and TSX exchanges. Data for the CBOE VIX of the VIX was obtained through a data request submitted directly to the Chicago Board Options Exchange.

Volatility Spikes

While some degree of gyration in stock prices is considered normal and acceptable by most of the investment management community, large swings in price are what catch many investors off guard. It's these "fat tail" events that keep investors up at night, which are often accompanied by sudden spikes found in the Volatility Index. Fortunately, many of these spikes can be forecasted; however, first we must address what a "spike" is. While the parameters of defining a "spike" can vary, this author will use a 30% advance in closing price to a high achieved within a five-trading day period. Chart 1 shows the Volatility Index between May 22, 2006 and June 29, 2016. Marked on the chart are instances where the VIX has risen by at least 30% (from close to the highest high) in a five-day period when a previous 30+% advance had not occurred in the prior ten trading days. There have been 70 such occurrences of these spikes in the above-mentioned time period.

While previous studies have been conducted on forecasting future volatility, through a search on the SSRN it does not appear published analysis has been conducted specifically on forecasting spikes in volatility. From an asset management perspective, whether the reader is a professional or non-professional, a volatility spike, and with it a decline in stocks, impact on an equity portfolio is a more frequent risk than that of a bear market. Historically, the S&P 500 averages four 5% declines every year but we've only had 28 bear markets (20% or more decline from peak to trough) since the 1920s.

Methods of Volatility Forecasting

The traditional thought process that low volatility precedes higher volatility, a topic Whaley addresses in his 2008 paper, stating that, "Volatility tends to follow a mean-reverting process: when VIX is high, it tends to be pulled back down to its long-run mean, and, when VIX is too low, it tends to be pulled back up" is true, in a general sense, although this concept does not act as the best predictor of quick spikes in the VIX. Chart 2 (next page) provides an example of this, as it shows the occurrences where the daily close of the Volatility Index is at a four-week low. The four-week period is not based on optimization but was chosen as an example time period of roughly one month. What can also be observed is the large sample size that is produced, with 100 signals in the roughly ten-year period. The author realizes that by expanding the four-week time window, the sample size would lessen but the same basic result would still be reached – a greater sample size of occurrences than of previously-defined spikes in the VIX. The trouble this causes for the investor is an over-reaction each time volatility reaches a new four week low, as the VIX many times continues its trend lower, not resulting in a spike higher. This shows that simply because the VIX has fallen to a multi-week low, it does not necessitate a forthcoming spike within the underlying Index.

Chart 1: Spikes of 30+% in the Volatility Index, daily data

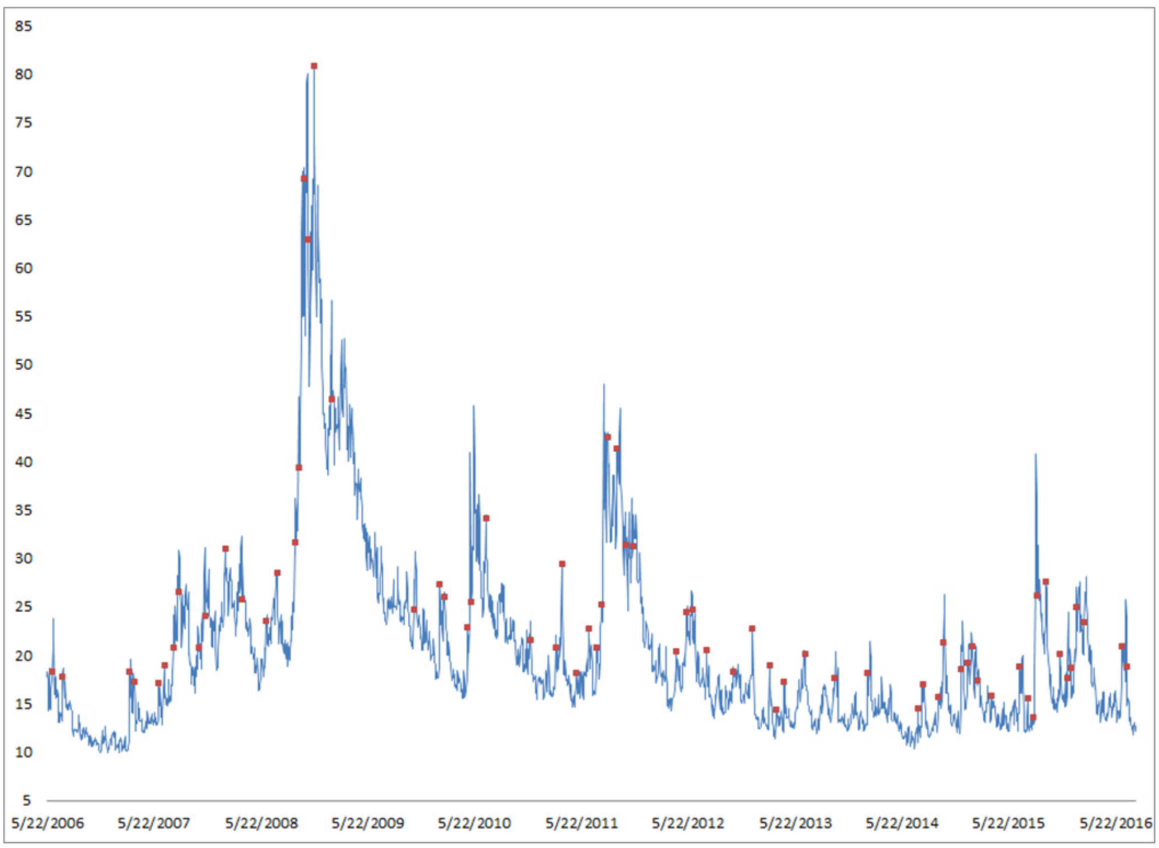


Chart 2: Lowest Volatility Index close in four weeks, daily data

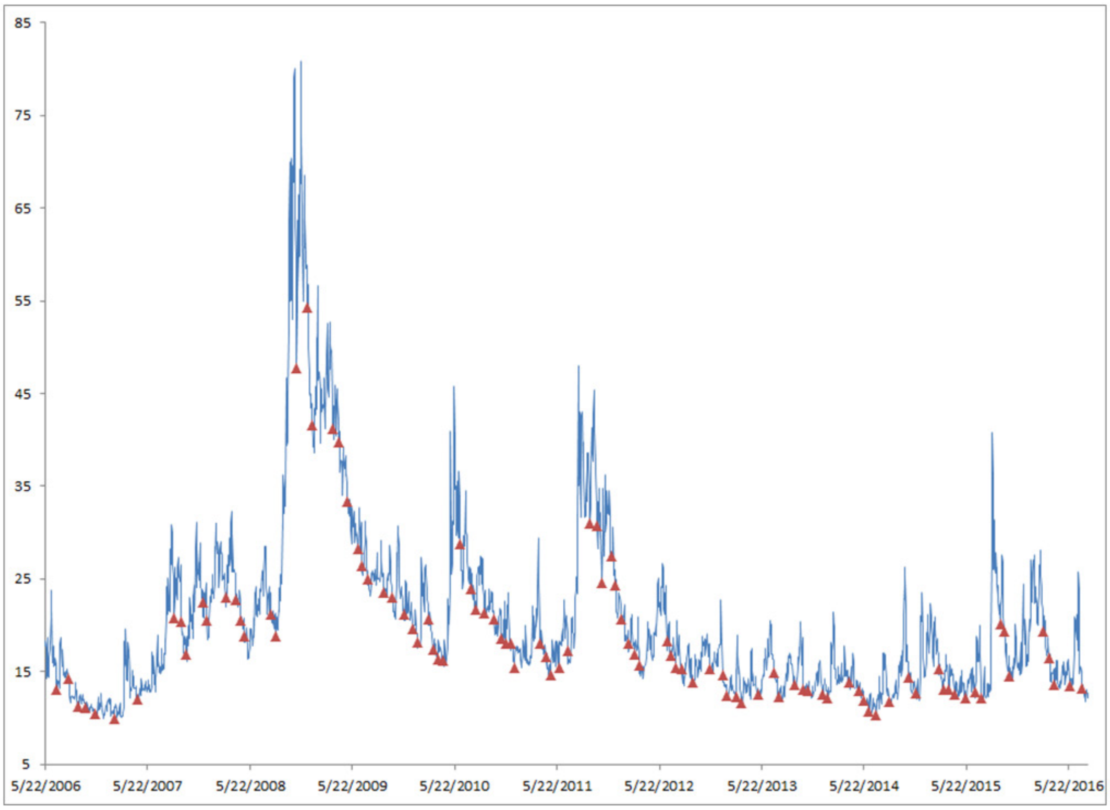
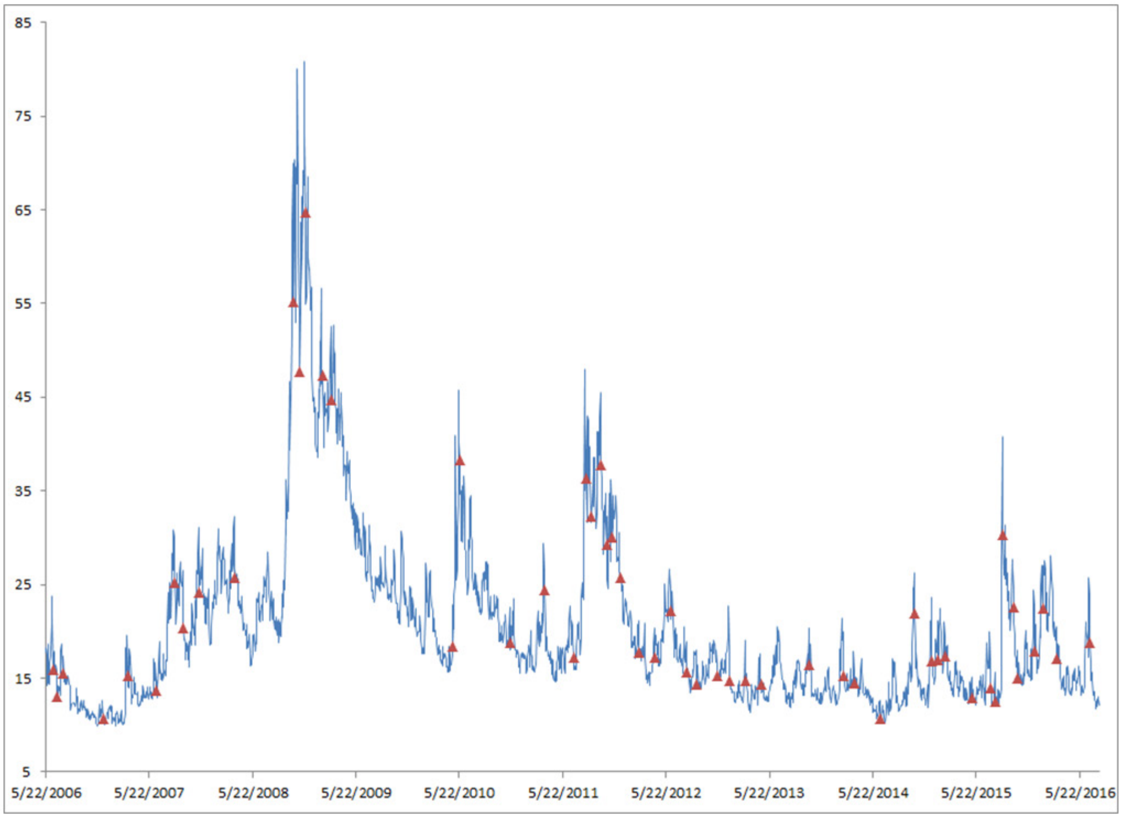


Chart 3: 15+% decline in three days in the Volatility Index, daily data



One could also argue that because of the nature for the Volatility Index to mean-revert, that volatility becomes overly-discounted after a large decline, which is reason enough that it should then spike higher. This can be measured by looking for instances where the VIX has fallen by at least 15% in a three-day period, as shown by markers in Chart 3 (previous page). While forgiving the occurrences that take place immediately after a spike within the VIX, looking at periods where volatility has fallen by a large amount in a short period of time increases the predictability of future large increases in the Volatility Index. However, while the sample size decreases to 53, there are still quite a few occurrences that produce false-signals in preceding VIX spikes. It is of this author's opinion that neither of these methods (a four-week low or 15+% decline), provide an optimal warning to an investor of a heighted risk of forthcoming elevated volatility.

Volatility Dispersion Methodology

J.M. Hurst was one of the early adopters of trading bands according to his book The Profit Magic of Stock Transaction Timing, drawing envelopes around price and a specified Moving Average. According to John Bollinger, CFA, CMT, Marc Chaikin was next to improve upon the practice of using bands within trading, using a fixed percentage around the 21-day moving average. Ultimately, in the 1980s, Bollinger built upon the work of Hurst and Chaikin by shifting the outer bands to incorporate volatility of the underlying market or security through the use of standard deviation above and below the 20-period moving average. Bollinger chose to use a 20-period moving average as "it is descriptive of the intermediate-term trend."12 Bollinger notes that by applying analysis to the width of the bands, "a sharp expansion in volatility usually occurs in the very near future." This idea of narrowing bands as a measure of contraction in the dispersion of a security is the topic this paper will focus on going forward.

While financial markets are never at complete rest per se, the closest they come is by trading in a very narrow range. This range can be observed in several ways, whether using Bollinger Bands®, an average true range indicator, or by simply calculating the standard deviation of price. Just as the seas become calm and the tide pulls back from the shore before the striking of a violent tsunami, the movement of the VIX often declines, sending the index's dispersion to extremely low levels prior to the Index spiking higher. Chart 4 shows the CBOE Volatility Index and its 20-day standard deviation. While it is outside the scope of this paper, the lookback period used for the standard deviation could be optimized to better suit the timeframe and risk appetite of the investor; however, this author has chosen a period of 20 days in accordance with the timeframe used by Bollinger for his Bollinger Bands. While the VIX and its 20-day standard deviation move in lock-step with one another, additional forecasting ability can be achieved by applying further analysis to the dispersion measurement.

Chart 4: The Volatility Index and 20-day standard deviation, daily data

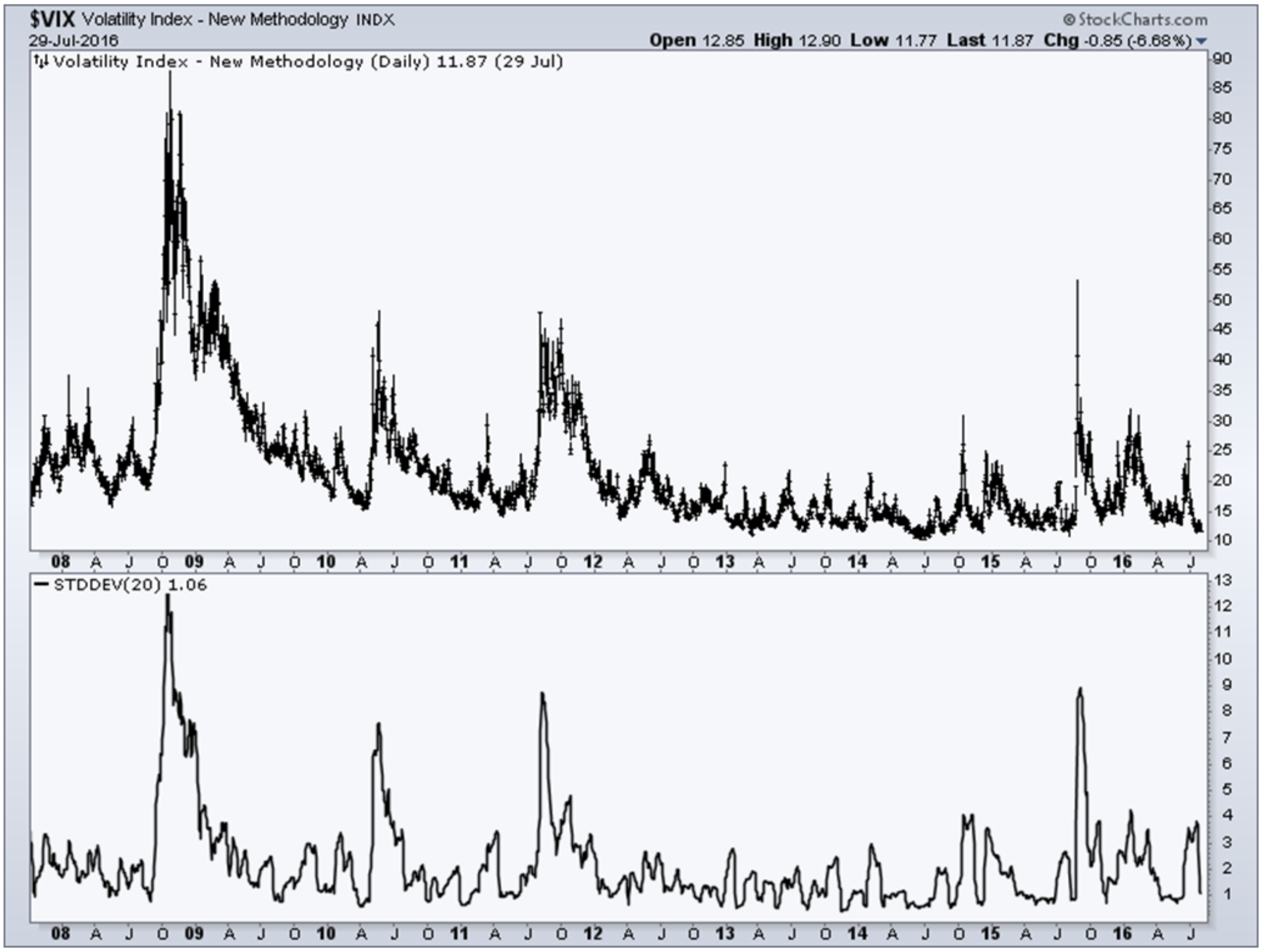
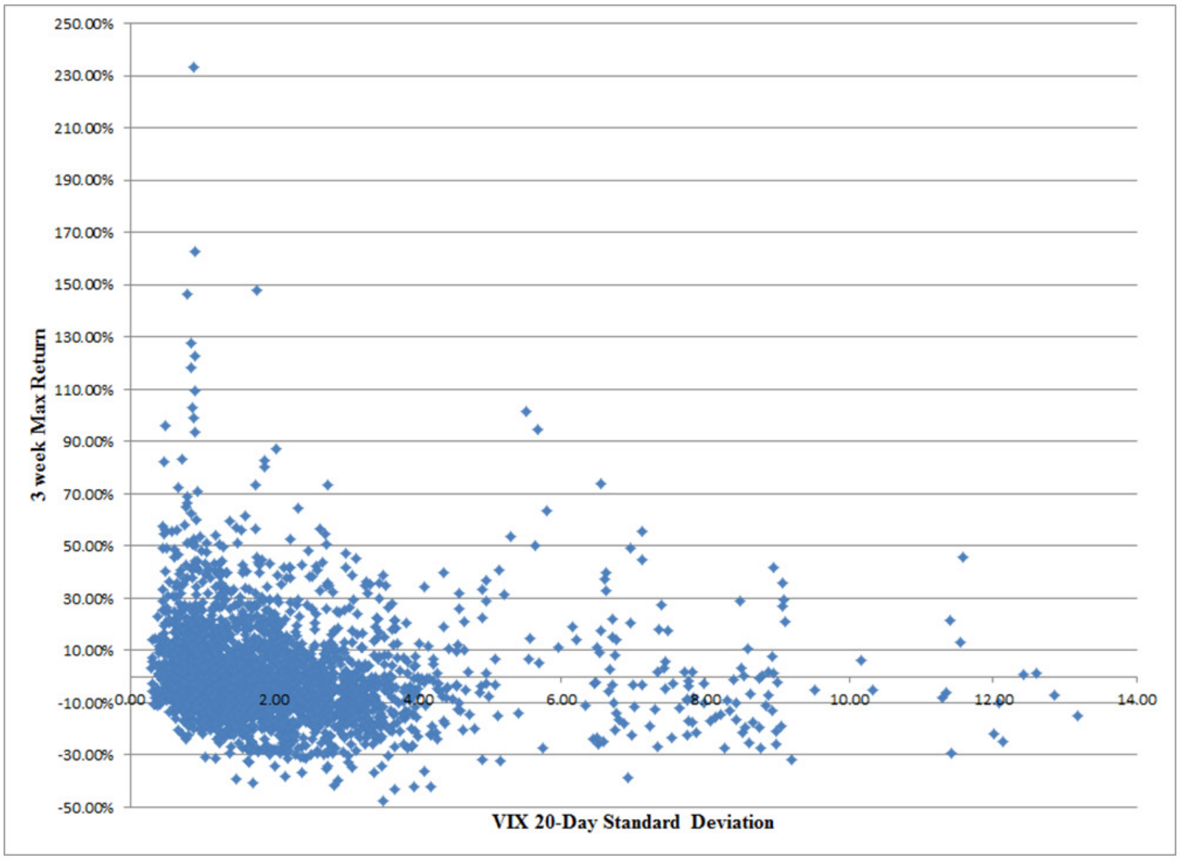


Chart 5: Scatter plot of the 20-day standard deviation and 3-week maximum change, daily data



In order to find an appropriate threshold with forecasting spikes in the Volatility Index, the daily standard deviation readings were ranked by percentile for the time period of May 2006 through June 2016. As a result, the fifteenth percentile allowed a sizable sample size of 373 to be obtained. The fifteenth percentile standard deviation during the above-mentioned timeframe for the Volatility Index is 0.86. Chart 5 shows the scatter plot of the data observed for the 20-day standard deviation for the VIX and the resulting three-week maximum change in the Index, which was calculated by using the highest high in the subsequent fifteen trading days for each data point. By looking at the maximum change in the VIX we can begin to see that the largest spikes within a three-week period occur when price dispersion is extremely low; while the three-week maximum change in the VIX diminishes the larger the dispersion becomes.

To provide a graphical representation of the threshold being met, Chart 6 on the following page shows the daily Volatility Index marked with occurrences of standard deviation being at or below 0.86 when a prior reading of at or below 0.86 has not occurred during the prior ten trading days. The ten-day lookback is used to avoid clusters of occurrences and to better show the initial signal of the threshold being met, which leaves 52 signals in the sample. The sample size with the standard deviation threshold diminishes significantly compared to the previously mentioned prediction method of the VIX being at a four-week low as well as improved foreshadowing of eventual spikes in volatility compared to 15+% declines in the VIX.

A spike was defined previously as a rise of 30+% in a five-day period. Chart 7 on the following page displays volatility spikes but also includes the standard deviation signal markers to show that the majority of spikes that have taken place in the Index occur after the dispersion of the VIX has fallen below the specified threshold. In fact, based on this ten-year data period, very few instances of the threshold being met were not followed by a 30+% spike in volatility. As the seas become calm and the tide pulls back in the ocean before a massive wave, so too does volatility's dispersion narrow before an eventual spike higher. While not every defined spike is preceded with volatility's standard deviation declining to a low level, only a handful of signals are not followed by large increases in VIX readings. In other words, not every spike follows a signal but nearly every signal is followed by a spike.

Because standard deviation is essentially a measure of volatility in-and-of-itself, by using it to analyze the VIX we are in essence evaluating the volatility of the Volatility Index. Fortunately, the CBOE also has created a tool for measuring the volatility of the Volatility Index, called the VIX of the VIX (VVIX). This type of tool can be useful as the scope of this paper is focused on not just forecasting future volatility but specifically spikes in volatility, which can be improved by the incorporation of VVIX.

The CBOE summarizes VVIX as "an indicator of the expected volatility of the 30-day forward price of the VIX. This volatility drives nearby VIX option prices." Park (2015) notes that the VVIX acts as a better measurement of tail risk due to the VIX options market having larger trading volume, a lower bid-ask

Chart 6: Volatility Index with standard deviation signal markers, daily data

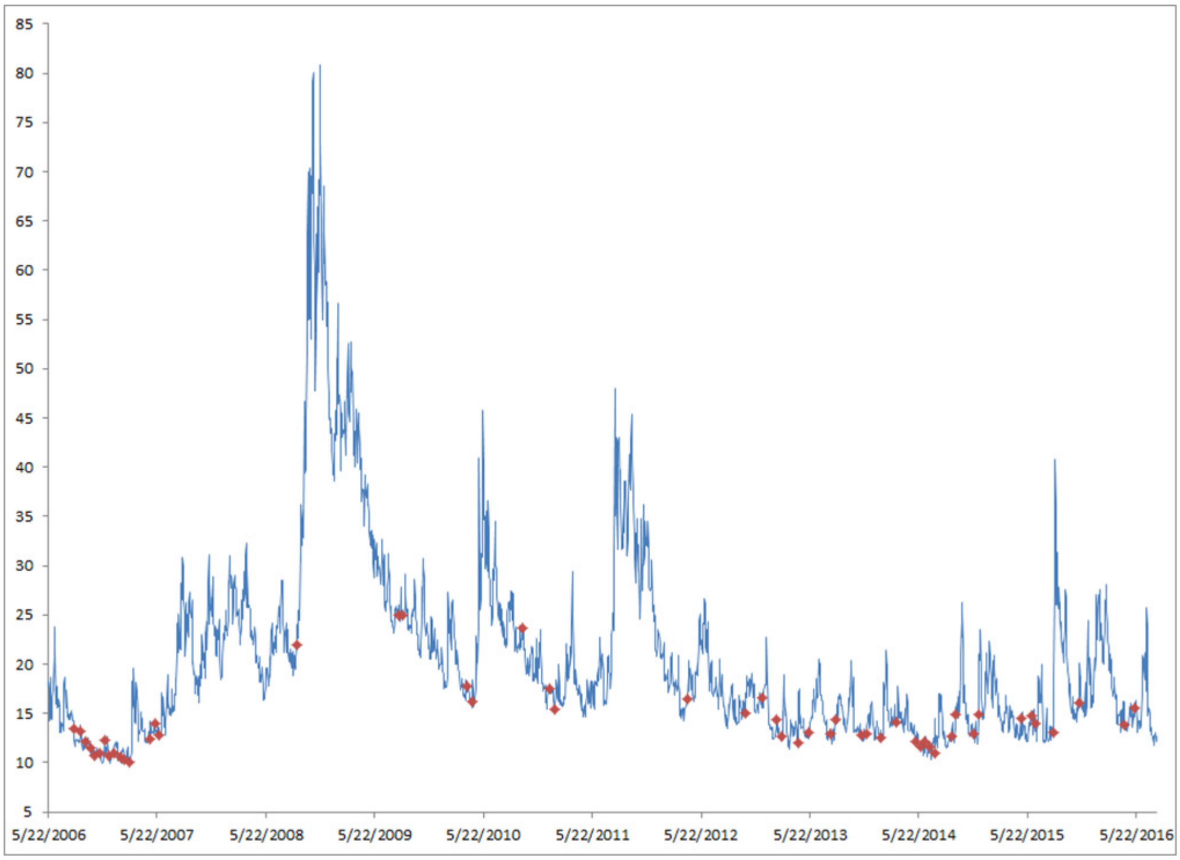


Chart 7: Volatility Index with standard deviation and spike signal markers, daily data

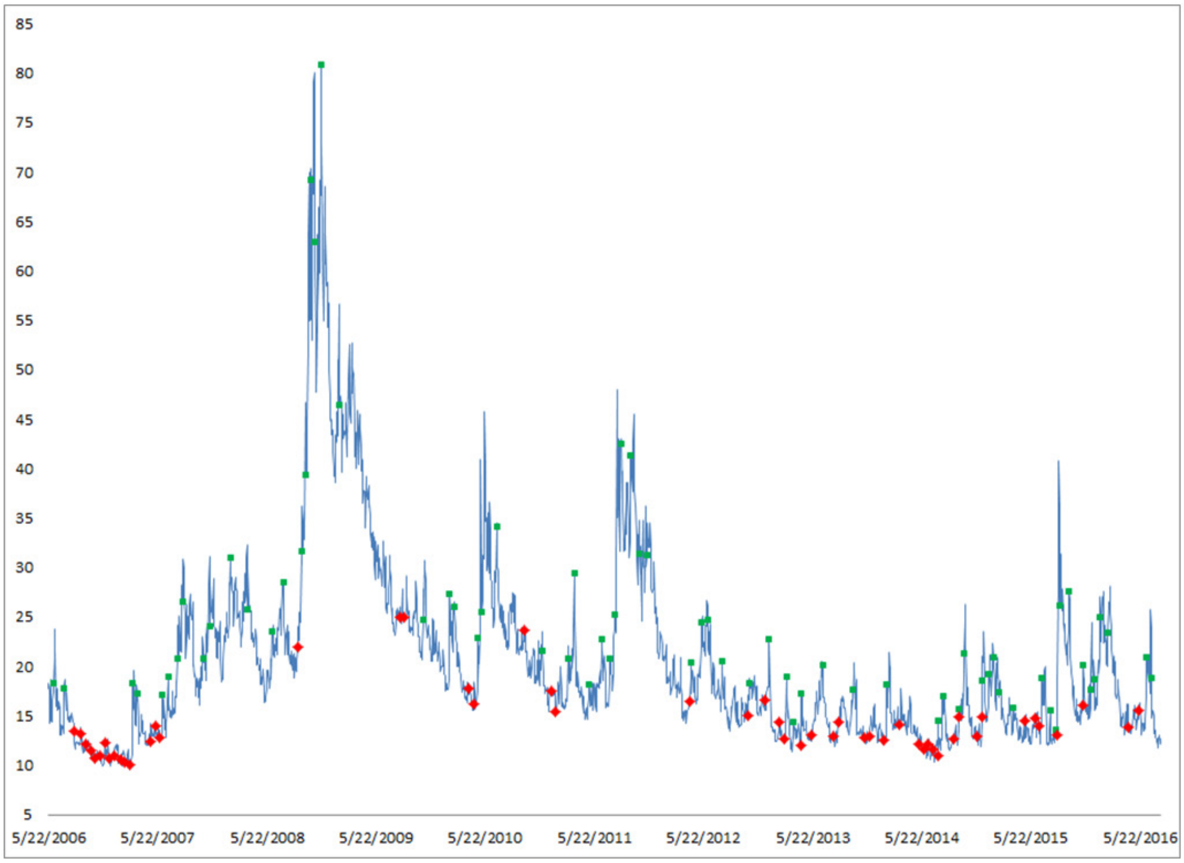
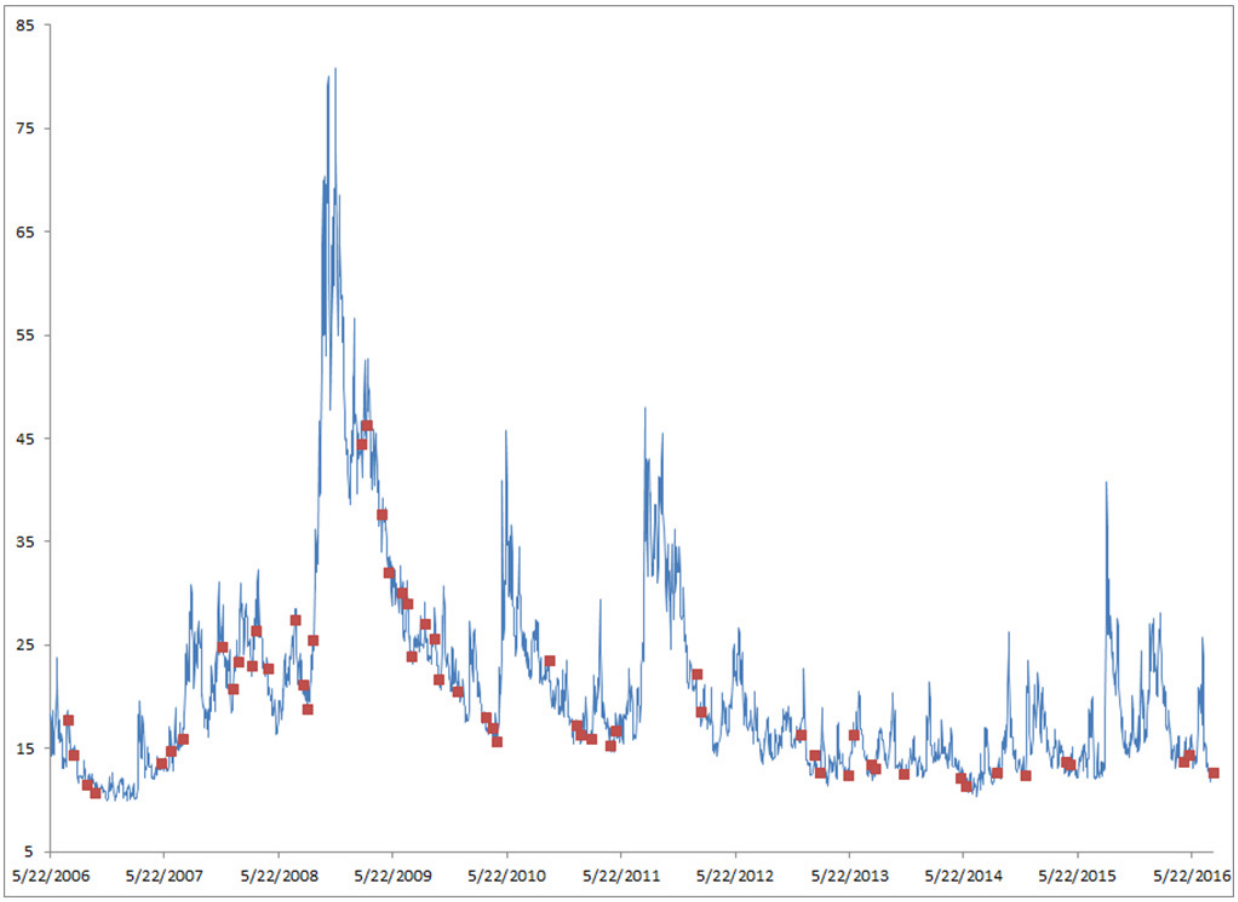


Chart 8: Volatility Index with VVIX standard deviation signal markers, daily data



spread, and more liquidity compared to the S&P 500 options market. This allows for the capability to be potentially more accurate with the forecasting ability of volatility's dispersion.

By applying the same level of analysis to the VVIX as we did with the VIX we can find the fifteenth percentile 20-day standard deviation for the VIX of the VIX is 3.16. Chart 8 plots the Volatility Index with markers notating the instances when VVIX standard deviation is at or below 3.16. Similar to the previously discussed dispersion of the VIX, the dispersion for the VVIX has a small sample size of 54 over the studied time period. However, similar to the suboptimal method of using large declines in the VIX as a predictor of future spikes, the VVIX dispersion threshold has many false-signals that are now followed by volatility spikes.

In order to continue to improve upon the idea that volatility dispersion is an optimal predictor of future VIX spikes, a simple system can be created using both the VIX and VVIX. This is accomplished by testing when both the VIX and the VVIX have readings of their respective 20-day standard deviation at or below their defined thresholds. Chart 9 on the following page shows where the combination of the two signals (red square markers) is met as well as just the VIX signal (green triangle markers) in order to show the differences and overlap of the two methods. As to be expected, the sample size decreases when the two volatility measurements thresholds are combined into a single signal. While the VIX alone produces more triggers of low dispersion, it appears the combination of the VIX and VVIX are timelier in their production of a signal before spikes within the Volatility Index.

Up to this point only a visual representation of the signals has been shown, but next we shall look at the numerical changes that occur in the VIX following the methods previously discussed in this paper along with the superior method outlined in the section above.

Table 1 on the next page shows the three week change in the VIX, utilizing the maximum and minimum average and median. We can see that the previously discussed methods of using a low in the VIX (lowest close in four weeks) and large declines (15+% decline in three days) do not produce an 'edge' over the average three week change in all VIX readings. However, we do see a much larger maximum and smaller minimum when using the VIX, VVIX, and combined signal.

In fact, the VIX signal has an average three-week maximum that is 54% greater than that of the large VIX drop with the minimum change being smaller by 49%. Not only does the VIX rise on average by a greater degree for the VIX, VVIX, and combined signal, the VIX declines less after a signal has been produced as well. This increase in 'edge', with the previously discussed decrease in sample sizes produces a more manageable signal generation with more accurate forecasting ability than the discussed alternative methods of VIX spike forecasting.

Chart 9: Volatility Index with VIX and combined signal markers, daily data

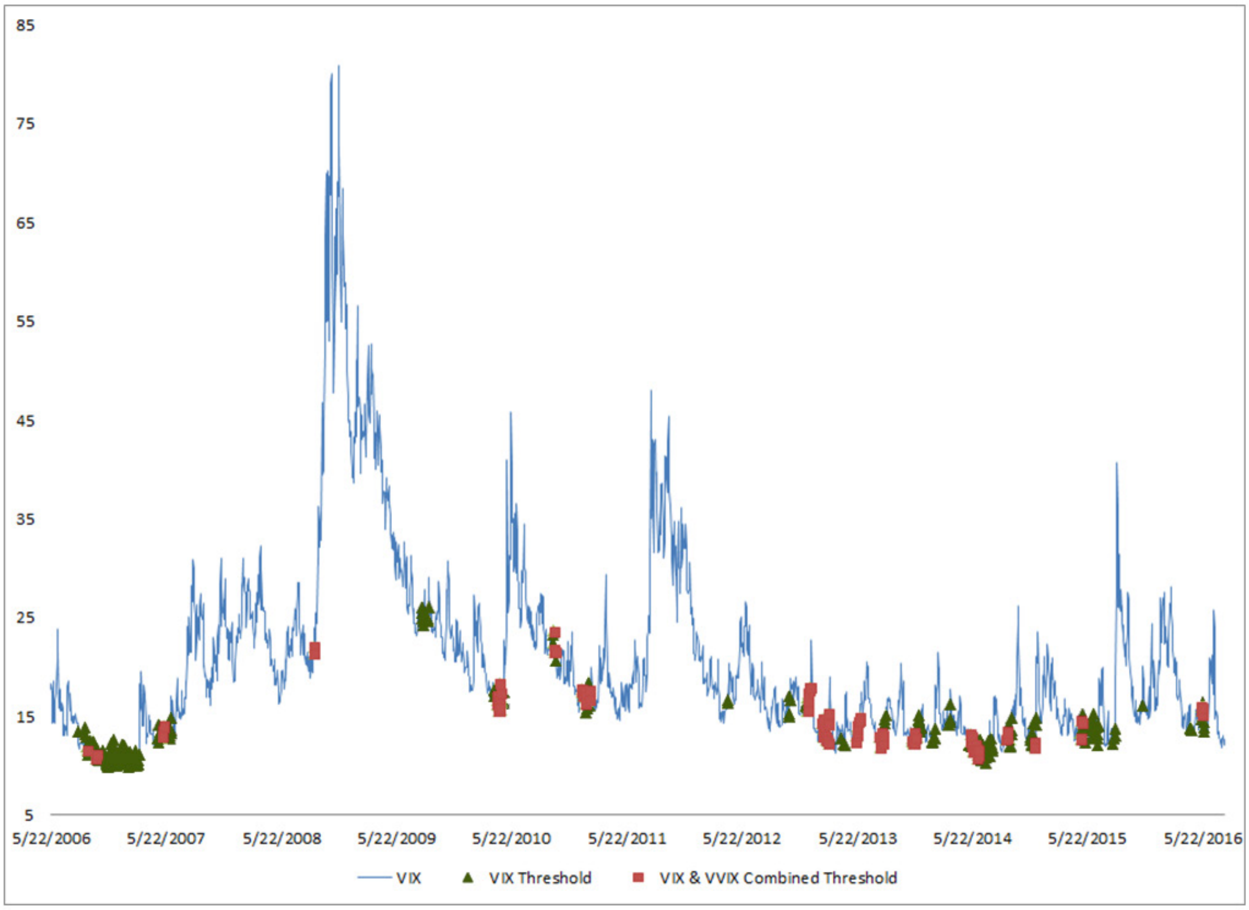


Table 1: Maximum and minimum change is calculated using the highest high and lowest low relative to the close VIX reading on the day of signal over the subsequent fifteen trading days, daily data

Method	Average Maximum Three Week Change	Median Maximum Three Week Change	Average Minimum Three Week Change	Median Minimum Three Week Change
VIX Signal	34.30%	23.01%	-8.67%	-8.74%
VVIX Signal	27.21%	15.93%	-10.71%	-10.06%
Combined Signal	27.53%	14.95%	-10.45%	-9.76%
4 Week Low VIX	24.94%	20.13%	-9.26%	-7.85%
Large VIX Drop	22.27%	16.13%	-17.07%	-15.81%
All VIX	25.76%	17.71%	-14.07%	-12.87%

Conclusion

This paper provides an argument for using the dispersion of the VIX, through the use of a 20-day standard deviation as a superior tool in forecasting spikes within the Volatility Index. While not every trader has a specific focus on the Volatility Index within their own respective trading styles or strategies, Munenzon (2010) shows that the VIX has important implications for return expectations for many different asset classes such has bonds, commodities, and real estate. Although the Volatility Index itself cannot be bought or sold directly, by knowing how to properly evaluate volatility, an investor can better prepare his or her portfolio, whether from a standpoint of defense (raising cash, decreasing beta, etc.) or offense (initiating a trading position to capitalize on the expected rise in volatility through the use of ETNs, futures and/or options). With Charts 6 through 9, it has been shown that the evaluation of the dispersion within the VIX and VVIX act as accurate barometers for future large advances in the Index. Table 1 provides evidence that the VIX rises more and declines less after a signal has be established through dispersion analysis over more commonly used methods applied to volatility. While the scope of this paper is not to create a standalone investment strategy, the concept discussed within can be taken and utilized in a broad scope of investment paradigms and timeframes.

It is believed by the investment community that by having the VIX at relatively low levels or following large declines, its nature to mean-revert would carry the Index immediately higher, snapping like a rubber band to elevated levels. This line of thinking produces signals with sample sizes much greater than most traders would likely be able to act upon or monitor, and as Table 1 shows, forecasts on average, sub-par future changes within the VIX. While the parameters used within this paper to analyze the dispersion of the Volatility Index were not optimized, the author believes further research can be done to better hone the forecasting ability of analysis when the VIX and VVIX trade in narrow ranges prior to spikes in the underlying Index.

With relative confidence, the author believes dispersion of price, as measured by the daily standard deviation of the VIX and VVIX acts as a more accurate and timely method of forecasting spikes, as defined in this paper, in the Volatility Index. This method provides an early warning signal of a potential oncoming “volatility tsunami” that can have large negative implications for an investment portfolio and allows for the potential to profit from the rising tide of the VIX.

Endnotes

1. See National Oceanography Centre 2011
2. See Whaley 2013
3. See Gire 2005
4. See Whaley 2008
5. See CBOE 2016
6. See Zakamunlin 2006
7. See Cipollini & Manzini 2007
8. See Giot 2002
9. Stockcharts.com
10. See Hulbert 2016
11. See Whaley 2008
12. See Bollinger
13. See CBOE
14. See Park 2015

References

1. Bollinger, John. "Bollinger’s Brainstorm." Bollinger Bands. Bollinger Capital Management, Inc., n.d. Web. 12 Oct. 2016. <http://www.bollingerbands.com/services/bb/>.

2. CBOE Volatility Index FAQs, Chicago Board of Options Exchange, n.d. Web. 4 Nov. 2016. <http://www.cboe.com/micro/vix/faq.aspx#1>.

3. CBOE VVIXSM Index, Chicago Board of Options Exchange, n.d. Web. 4 Nov. 2016. <http://www.cboe.com/micro/vvix/>.

4. Cipollini, Alessandro Paolo Luigi and Manzini, Antonio, "Can the VIX Signal Market's Direction? An Asymmetric Dynamic Strategy" (April 2007). Available at SSRN: https://ssrn.com/abstract=996384 or http://dx.doi.org/10.2139/ssrn.996384

5. Data and Ticker Symbols, StockCharts.com, Web. 4 Nov. 2016. <http://stockcharts.com/docs/doku.php?id=data>.

6. Drimus, Gabriel G. and Farkas, Walter, "Local Volatility of Volatility for the VIX Market" (December 10, 2011). Review of Derivatives Research, 16(3), 267-293, (2013). Available at SSRN: https://ssrn.com/abstract=1970547 or http://dx.doi.org/10.2139/ssrn.1970547

7. Giot, Pierre, "Implied Volatility Indices as Leading Indicators of Stock Index Returns?" (September 2002). CORE Discussion Paper No. 2002/50. Available at SSRN: https://ssrn.com/abstract=371461 or http://dx.doi.org/10.2139/ssrn.371461

8. Gire, Paul J. (2005) "Missing the Ten Best," *Journal of Financial Planning.*

9. "How a Tsunami Wave Works," National Oceanography Centre, 11 Mar. 2011. Web. 27 Oct. 2016. <http://noc.ac.uk/news/how-tsunami-wave-works>.

10. Hulbert, Mark. "Bear Markets Can Be Shorter Than You Think." *The Wall Street Journal*, 06 Mar. 2016. Web. 08 Oct. 2016. <http://www.wsj.com/articles/bear-markets-can-be-shorter-than-you-think-1457321010>.

11. Munenzon, Mikhail, "20 Years of VIX: Fear, Greed and Implications for Alternative Investment Strategies" (April 29, 2010). Available at SSRN: https://ssrn.com/abstract=1597904 or http://dx.doi.org/10.2139/ssrn.1597904

12. Park, Yang-Ho, "Volatility-of-Volatility and Tail Risk Hedging Returns" (May 18, 2015). *Journal of Financial Markets, Forthcoming.* Available at SSRN: https://ssrn.com/abstract=2236158 or http://dx.doi.org/10.2139/ssrn.2236158

13. Whaley, R. E., "Derivatives on market volatility: Hedging tools long overdue," *Journal of Derivatives* 1 (Fall 1993), 71-84.

14. Whaley, R. E. (2009). "Understanding the VIX." *The Journal of Portfolio Management*, 35(3), 98-105. doi:10.3905/jpm.2009.35.3.098

15. Whaley, Robert E., "Trading Volatility: At What Cost?" (May 6, 2013). Available at SSRN: https://ssrn.com/abstract=2261387 or http://dx.doi.org/10.2139/ssrn.2261387

16. Zakamulin, Valeriy, "Abnormal Stock Market Returns Around Peaks in VIX: The Evidence of Investor Overreaction?" (May 1, 2016). Available at SSRN: https://ssrn.com/abstract=2773134 or http://dx.doi.org/10.2139/ssrn.2773134

Author Bio

Andrew Thrasher, *CMT*
Financial Enhancement Group, LLC

Andrew Thrasher, CMT holds a bachelor's degree from Purdue University as well as the Chartered Market Technician (CMT) designation from the Market Technicians Association. Mr. Thrasher serves as the Portfolio Manager for the Financial Enhancement Group, LLC, a wealth management firm in Indianapolis, Indiana which works with high net-worth families and several corporate pension plans. Mr. Thrasher manages one tactical strategy, co-manages five asset allocations strategies, and one alternative strategy. Through the use of individual stocks and Exchange Traded Funds (ETFs) Mr. Thrasher builds and manages portfolios while managing risk through the use of several proprietary investment models.