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THE CBOE VOLATILITY INDEX (VIX) AS A PREDICTOR OF S&P 500 VOLATILITY AND RETURNS

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ABSTRACT

In this thesis, the relationship between the CBOE Volatility Index (VIX) and the S&P 500, the barometer for the stock market, from which the VIX is derived, is explored. As periods of stock market crashes such as the .com bubble or Financial Crisis have shown, rising volatility and falling stock prices are the norm. With this basic relationship in mind, this thesis looks to analyze how effective the VIX is in forecasting expected volatility of the S&P 500 in addition to assessing the relationship between the VIX and returns on the S&P 500.

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Chapter 1

Introduction

The recent Financial Crisis in 2008 brought massive volatility to the markets as seen through wild swings in equity markets and its indexes. One of these indexes, the S&P 500, is an equity index comprised of the 500 largest domestic stocks weighted by market capitalization. The S&P 500 is largely considered a benchmark for institutional and retail investors in evaluating investment performance. As the S&P 500 fell drastically during 2008, expectations for future, or implied, volatility began to rise. This expectation was embedded in S&P 500 index options, which became pricier the more expectations for volatility increased. While one can determine the implied volatility based on option prices, it is easier to examine the CBOE Volatility Index (VIX) which tracks the expected volatility of the S&P 500 over the next 30 calendar days. During the Financial Crisis, the VIX spiked as the S&P 500 tumbled leading many news outlets to dub it the "fear gauge." This was in large part due to the assumption that the VIX would increase as investors grew more fearful and domestic equity markets tumbled lower.

In this thesis, I wish to analyze the VIX and its forecasting abilities related to volatility and market returns. First, the VIX and its embedded implied volatility of the S&P 500 will be assessed versus the true realized volatility of the S&P 500 over those same 30 calendar days, or 22 trading days, on which it implies volatility. This analysis will be done on a wholesome and level by level basis. Finally, this analysis will examine the relationship between VIX level changes and returns on the S&P 500 index through linear regression and other statistical analyses. These analyses will be done on a daily and monthly basis in an attempt to assert the notion that the VIX is the investor fear gauge.

Chapter 2

Literature Review

Upon its creation in 1993, the VIX was to serve two purposes. First and foremost, the VIX was intended to provide an index to track expected short-term market volatility, specifically over the next 30 days. Moreover, the VIX was supposed to provide an index upon which futures and options contracts concerning volatility could be written. The financial and social benefits of trading volatility have been evident over the years. As a result of this push, the Chicago Board Options Exchange (CBOE) began trading VIX futures contracts in May 2004 and VIX option contracts in February 2006 (Whaley).

The VIX was created by Robert E. Whaley in 1993. The index is quoted much like the Dow Jones Industrial Average or S&P 500 in which it is calculated on a real-time basis every trading day. The index itself measures volatility, and in order to provide a historical comparison minute by minute levels were computed using option prices dating back to the start of the calendar year in 1986. This was important to Whaley because it documented the highest ever reading of the VIX, the October 1987 crash which was the worst level of market anxiety since the Great Depression (Whaley).

The original calculation of the VIX centered around the prices of S&P 100 index option prices known as OEX instead of the current calculation of S&P 500 index option prices known as SPX. In 1992, OEX options were the most-active traded and accounted for 75% of the total index option volume. On the other hand, SPX options only accounted for 16.1% of the index option market. However, the usefulness of any implied volatility index relies on an active index option market that has considerable depth. After the inception of the VIX, the index option market changed considerably with the SPX option market becoming the most active index option market in the United States. Although the shift from OEX to SPX options is still uncertain as to why, SPX options traded 12.7 times more frequently than OEX options by 2008 (Whaley).

In addition to the shift in the index option market, market participants showed a shift in trading index options from the time the VIX was incepted. In 1992, trading volumes were balanced for both index calls and puts with OEX calls having an average daily volume of 120,475 and OEX puts having an average daily trading volume of 125,302. At this time, both calls and puts had equally significant parts in trading strategies. As time went on the index option market became dominated by portfolio insurers who buy out-of-the-money and at-the-money index puts for insurance purposes. With this shift taking place, the first ten months of 2008 saw the average daily volume of SPX puts be 72% more than that of SPX calls. As Whaley and Bollen detailed in an earlier paper (2004), the need for implied volatility indexes is a result of this movement toward demand for out-of-the-money and at-the-money SPX puts (Whaley).

While the VIX methodology was changed in September 2003 to reflect SPX options and the growing use of the S&P 500 as a benchmark, the original methodology still held a lot of the fundamental assumptions of Robert E. Whaley that would remain after the switch to SPX options. Another important change in the calculation of the VIX was in regards to it being based off of prices of eight at-the-money index calls and puts. These nearby and second-nearby calls and puts were used because at the time the at-the-money options were the most actively traded index options. Index options with exercise prices far away from the current index level lacked depth and this stale trading yielded stale price quotes and wide bid/ask spreads. While Whaley asserted on using midpoints in bid-ask spreads as a point of true market pricing, using such out-of-the-money options made little sense and were discarded from the calculation in order to best represent an accurate and timely VIX. When the switch to SPX options was made on September 22, 2003, the VIX calculation started to include the out-of-the-money options in computation in order to account for demand for portfolio insurance as a result of market volatility. It is also important to note that including additional options in the calculation allows for the sensitivity of the VIX to prices of single options to go down and also makes it less likely to be manipulated (Whaley).

With the rise in demand for out-of-the-money and at-the-money index puts, the VIX has been called the "investor fear gauge." Although volatility can mean unexpected moves in an upward or downward direction, it is important to understand the domination of the S&P 500 index option market by hedgers buying index puts when they are concerned about a potential drop in the stock market. Hedgers use this as portfolio insurance, thus the higher demand for portfolio insurance, the higher the price of the option, which is ultimately reflected in the level of the VIX (Whaley).

In a paper written by Robert E. Whaley, the creator of the VIX and professor at Vanderbilt University, Whaley attempts to refute misconceptions about the VIX during the Financial crisis when it received a multitude of media attention. In this paper, Whaley asserts that the VIX is an index computed on a real-time basis throughout each trading day although it continually computes volatility and not price (Whaley).

According to Whaley, the first key to understanding the VIX is the emphasis that it is a forward-looking measure of volatility and not at all backward-looking or measuring already realized volatility. For comparison purposes, the VIX is essentially a bond's yield to maturity. Much like yield to maturity is the discount rate that equates a bond's price to the present value of its promised payments, the bond's yield is implied by current price and represents the expected future return of the bond over its given life. On the same note, the VIX is implied by current prices of S&P500 index options and represents expected future market volatility over the next 30 days (Whaley).

Examining historic VIX levels, characterizations of normal and abnormal behavior may be given although imperfect. Over its history through 2008, the median daily closing level of the VIX is 18.88. Furthermore, fifty percent of the time the VIX closed between 14.50 and 23.66. When examining a seventy-five percent range, the VIX closed between 12.04 and 29.14. Finally, when examining a ninety-five percent range, the VIX closed between 11.30 and 37.22. Looking back from 2008, the two widest historical ranges were in 2008 during the Financial Crisis in addition to 1987 in which the stock market crashed (Whaley).

Most importantly, Whaley finds a probable VIX prediction about future volatility and the expected range of the rate of return of the S&P 500 index level over the next 30 days. In addition, Whaley examined VIX performance as a predictor utilizing simple statistical experiments. In the same way Whaley found the expected range of the rate of return of the S&P 500 index, Whaley examined 274 months of data and saw whether or not the predicted ranges based upon 50%, 75%, and 95% fit the resulting data. During the 274 trials, 34.7% fell outside the 50% range, 7.3% fell outside the 75% range, and 3 or 1.1% fell outside the 95% range. With this data considered, the VIX works considerably well as a predictor of expected stock index movements (Whaley).

When examining VIX futures on the CBOE website, contract specifications and relationships are detailed. VIX futures represent standard futures contracts that cash settle to a Special Opening Quotation on the VIX. Thus, VIX futures are contracts on forward 30-day implied volatility. For example, if a May futures contract is bought in March, then it represents a forward contract on what 30-day implied volatility will be on the May expiration date. As such, a June futures is a forward contract on 30-day implied volatility on the June expiration date ("VIX Futures: The Basics").

Two noteworthy consequences are noted by the spot/forward relationship between the VIX and VIX futures. First, the price of VIX futures can be lower, equal, or higher than the VIX with the sole dependent of the market assumption of volatility in the 30-day forward period covered by VIX futures contract than in the 30-day spot period covered by the VIX. Secondly, although not necessarily important to this thesis, there is no cost-of-carry relationship between the price of VIX futures and the VIX, and, as such, it is not possible to replicate a position equivalent to taking one in VIX futures ("VIX Futures: The Basics").

In a March 2004 article in Barron's, Kopin Tan details the basics of the VIX and "how to use the new fear gauge futures" (Tan). At the time of the publication, the introduction of VIX futures was highly anticipated and offered further opportunities for portfolio managers to diversify their portfolios and hedge stock portfolios. Tan furthers this use of the VIX but also adds that the volatility component found in the call options in convertible bonds represents another use of the VIX. In the case of a fixed-income investor with a sizeable position in convertible bonds, they may be over-exposed to volatility, and thus buying or selling volatility via VIX futures may provide investors with another tool to manage this risk. In addition, VIX futures could be used to hedge credit risks which show a strong correlation between credit spreads and volatility, said Barry Colvin in the article. Credit spreads, the difference between the yield on a corporate bond and a U.S. treasury, represent the added yield necessary required by investors to take on the risk associated with a corporate bond. Since credit spreads increase when risk rises, they work similarly to volatility levels and thus VIX futures could be put to work by asset managers in need of a credit hedge (Tan).

The forecasting efficiency of implied volatility is often compared against historical volatility and has been the subject of numerous studies outside of VIX-specific implied volatility and its relationship to realized volatility of the S&P 500. Generally, implied volatility is considered to be a better indicator of future volatility as it is based off of option markets and options traders have more information at their hands than just historical volatility (Shu and Zhang). Thus, while historical volatility may serve as a foundation for future volatility, the other information at their disposal allows for the correct option pricing and thus better estimate of future volatility given the implied volatility embedded in the option. While implied volatility is considered a better indicator of future realized volatility, one study showed that the implied volatility of S&P 100 index options (OEX) contained no information about future volatility (Canina and Figlewski).

If this were true, then the foundation of option pricing would be questionable as the option price is based upon the underlying asset price. With that considered, it is hard to conclude that implied volatility has no relationship with the volatility of the underlying asset unless there are factors that could distort this (Shu and Zhang). One study found that using daily overlapping data would diminish the forecast ability of implied volatility and overestimate the ability of historical volatility. Only by using data at a monthly level would correctly show the forecast ability of implied volatility in order to account for the daily overlapping problems (Christensen and Prabhala). Another study found again that the implied volatility from S&P 100 index options better predicts realized volatility than historical volatility, but, most importantly, it found that that implied volatility remains an upward biased forecast of realized volatility (Fleming).

In order to examine the relationship between implied and realized volatility, Shu and Zhang examined the calculation of realized volatility as an error source in four different ways including classical which is used in this thesis. All the while, they examined measuring implied volatility as the second source of error (Shu and Zhang). In previous research, the poor forecast ability of implied volatility was considered to be a result of poor assumptions regarding the Black-Scholes option pricing model. As the Black-Scholes model assumes constant volatility, previous research found that this wasn't the true volatility perceived by the market, and thus explaining why implied volatility had no relationship with future realized volatility (Canina and Figlewski). Despite this research, Shu and Zhang found that the implied volatility from the Black-Scholes model, and thus option pricing, has the highest explanatory power in forecast ability. In order to best show the relation between implied volatility and realized volatility, Shu and Zhang concluded that one must first improved their measurement of realized volatility such as constructing it from intraday returns in low minute intervals.

Furthermore, this study found that not only does the relationship between implied and realized volatility exist, but implied volatility remains a better forecasting method than historical volatility as implied volatility already contains all information reflected by historical volatility. As such, implied volatility remains the best forecasting method and confirms that the option market prices information such as expected future volatility correctly (Shu and Zhang).

Giot wanted to study whether or not implied volatility readings contain relevant information regarding whether or not stock prices will move up or down. As he noted, not many studies existed on the topic at the time, largely due to the belief that markets were efficient so that such a relationship shouldn't exist (Giot).

Giot tested whether or not high levels of the VIX indicate bottoming stock markets by dividing VIX price history into 21 equally spaced rolling percentiles and examining the returns on the S&P 100 for various future holdings periods up to 60 days for each of the 21 percentiles (revise this). Giot found that high levels of the VIX predict future positive returns, and low levels of the VIX predict future negative returns. With this considered, his findings point to irregularly high levels of the VIX presenting potential buying opportunities. Since VIX readings are readily available, this is puzzling, as this shouldn't allow for timing profits if markets are efficient. One possible explanation, would be that the volatility of the market is a systematic risk factor and the returns would not be abnormal after adjusting for this systematic factor. Giot noted that other studies have found there is a negative market price of volatility risk and thus, if investors are volatility averse, there will be high price risk premiums since prices and volatility are negatively correlated. In addition, Giot found an important distinction in the relationship between changes in the VIX and changes in market returns. Giot found this relationship to be asymmetric in that negative returns for the stock index saw greater relative changes than positive returns in the implied volatility index (VIX). As noted earlier, this was also confirmed by Whaley in 2008. Moreover, this asymmetry effect differed as it was more prevalent in low-volatility periods that saw an increase in implied volatility than it was in high-volatility periods (Giot).

Copeland and Copeland (1999) focused on the characteristics of stocks rather than plain equity indices. They found that high levels of the VIX represent a style shift in investors portfolios, as they look to add safety. As such, investors will rotate into larger and value stocks, thus earnings higher returns after implied volatility increases as seen in VIX readings (Copeland and Copeland).

Banerjee, Doran, and Peterson conducted a similar study in examining the relationship between VIX levels and future market returns. They extended previous work by examining future returns and current implied volatility levels in addition to examining portfolios based upon book-to-market equity, size, and beta, and finally controlled for risk factors. This study too found that the VIX-related implied volatility readings have strong predictive ability for future returns. These findings included a tendency towards a strong relationship in high beta portfolios, but, most importantly, found that VIX levels are positively related to future returns in a 30-day period and even strong in a 60-day period. Banerjee, Doran, and Peterson found that the strength in the relationship came from the apparent quickness in how the VIX mean-reverts, meaning that it retreats lower to its average or historical levels, which is usually 60 calendar days (Banerjee, Doran, and Peterson).

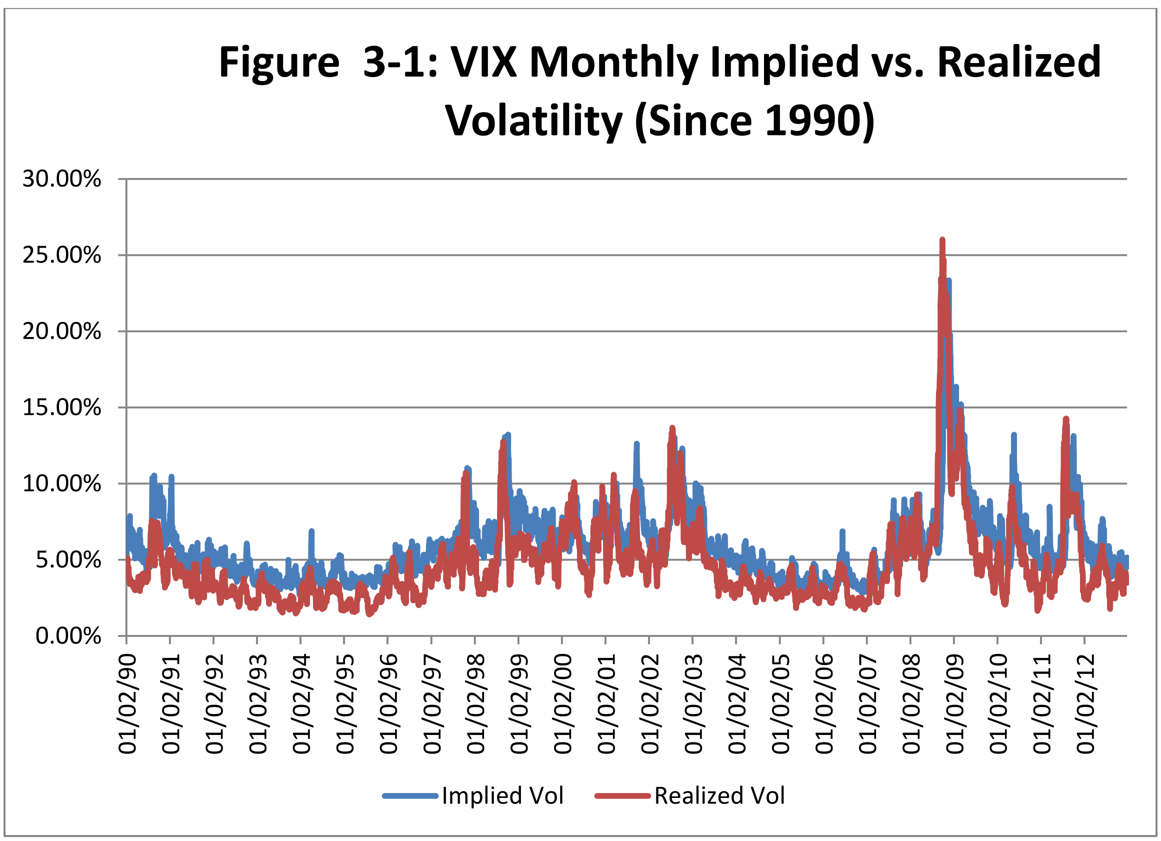
Moreover, this study examined whether or not the condition of the market has any effect on the relationship between implied volatility and future market returns. The results showed that “bull” and “bear” markets had no effect on this relationship, and that a negative volatility price premium still existed that showed a positive relation between VIX readings and future prices. In addition, this study was able to quantity the annual contribution of a value one standard deviation above the mean across 12 portfolios and found it varied from close to zero to 4.44%. In 10 of 12 portfolios, these returns were more than two standard errors above zero while also confirming the directional forecasting ability of the VIX to be high. In conclusion, this study also found that VIX information makes significant contribution to returns (Banerjee, Doran, and Peterson).

Chapter 3

Analysis and Findings

In this analysis of the VIX, both the relationship between the implied volatility of the VIX and realized volatility of the S&P 500 was examined in addition to the relationship between VIX readings and S&P 500 index returns. In the first analysis, the volatility forecasting ability of the VIX was tested by examining the implied volatility of the S&P 500 over the next 30 calendar days (22 trading days) based upon the VIX reading and then comparing it to the calculated realized volatility of the S&P 500 index over those same 30 calendar days. Both studies examined data from January 1990 until December 24th 2012.

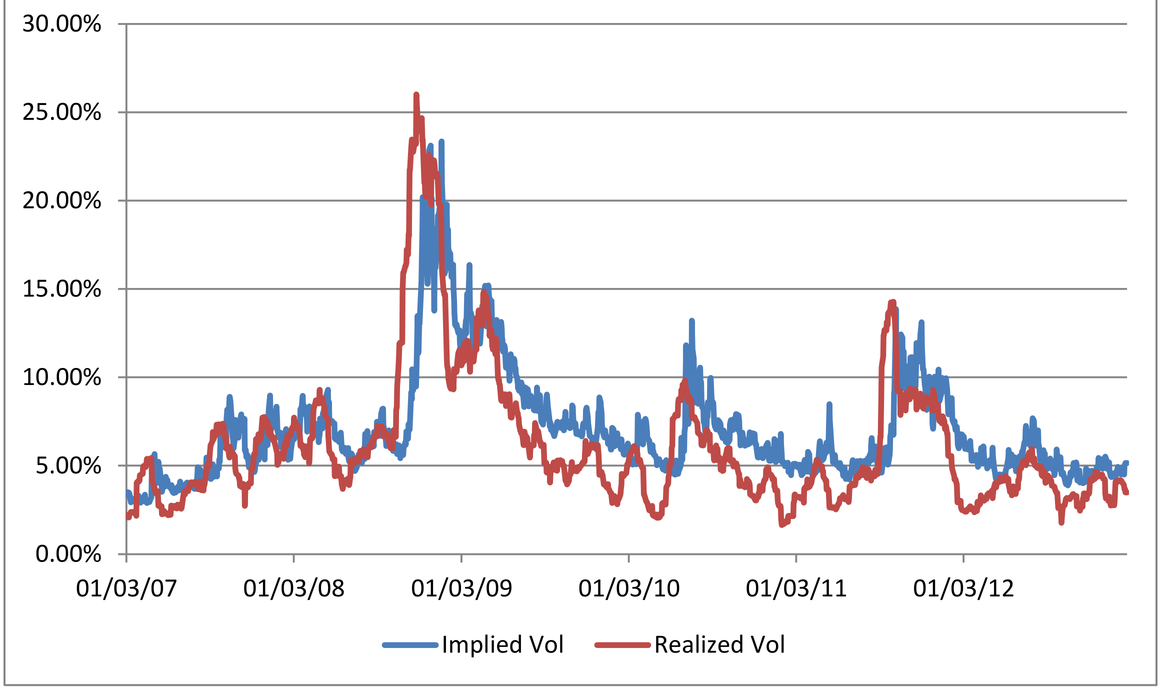
For the first study, it was important to understand that a VIX reading was an annualized implied volatility, and, thus, a level of 20 represented a 20% volatility expectation for the next year. The monthly expectation, or implied volatility of the S&P 500, was calculated by taking the closing VIX level and dividing it by the square root of 12. For example, in the case of a reading of 20, the implied volatility for the next 30 calendar days would be approximately 5.77%. On the other hand, in order to calculate realized volatility by classical methods as the standard deviation of an asset, this required examining the returns of the S&P 500 over the same 30 calendar days over which the implied volatility was calculated based on the VIX level. It is important to note that closing levels of the S&P 500 adjusted for dividends were used in order to account for dividends being also accounted for in S&P 500 options for which the VIX readings are calculated from. The realized volatility was calculated by taking these closing levels and finding daily returns for the 22 trading days examined and then finding a mean of those returns for which deviations could be calculated from, squared, and summed. With these deviations squared at hand for the 22 trading days, variance could then be calculated by taking the deviations squared and dividing them by the number of trading days minus one. Once variance was calculated, standard deviation was found by taking the square root of variance, and then, finally, the realized volatility was calculated by multiplying the standard deviation by the square root of 22 trading days. As this is the classical method for computing realized volatility, it was deemed most appropriate for use in this analysis and thesis.



As Figure 3-1 depicts above, the relationship between the implied volatility of the VIX and realized volatility of the S&P 500 is quite apparent and shows as confirmed in prior research that the implied volatility remains a strong forecaster of future realized volatility. During the time period in which this data was analyzed (1990 – 2012), the correlation between the implied volatility and realized volatility was .78. This confirmed the relationship between implied and realized volatility, and shows that there is definite significance in the forecasting ability of implied volatility.

One of the focal points of this analysis was centered on the recent equity crises which saw massive spikes in VIX levels and major losses across domestic equity markets such as the S&P 500, Dow Jones Industrial Average, and NASDAQ 100. In Figure 3-2 below, the implied volatility as measured by the closing VIX levels is charted against the realized volatility for the same periods from 2007 to 2012. This time period encompasses three major periods of volatility and "crisis" in the domestic equity markets, the Financial Crisis of 2008, Fear of Greek Default in spring of 2010, and Fear of Another Greek Default and US Debt Ceiling Concerns in the summer of 2011. While the Financial Crisis is most widely known and recognizable, the other two recent crises show certain patterns in equity market volatility that were magnified during the massive equity losses of 2008.

Figure 3-2: VIX Monthly Implied vs. Realized Volatility (2007-2012)



As seen in Figure 3-2 above, the implied volatility at the onset of these crises tends to underestimate the realized volatility. As the levels of the VIX rise with the continuation of the crisis, it then switches where the VIX generally overestimates the volatility as the crisis subsides or implied volatility starts to come down. This phenomenon can be seen across the VIX's history during periods of crisis where implied volatility, and VIX readings, take large immediate jumps only to find that the realized volatility ends up being greater than originally forecast by the reading during the beginning of that crisis. In Figure 3-2, this can be seen as the implied volatility (blue line) is too slow to move higher than the realized volatility (red line). Intuitively, this makes sense as it takes a large movement to imply a crisis, and until this happens, and equity conditions get worse, many institutional investors and traders would expect volatility to mean revert to historic or normal levels. On the other hand, it is also interesting that at the peak of implied volatility, realized volatility starts to move lower than it was forecast, potentially showing that investors overestimate that length of a crisis or the spike in volatility that often accompanies a crisis.

Another point of this analysis was to examine the study of Fleming in 1998 which asserted that implied volatility was an upward biased indicator of realized volatility. After examining the data from 1990 to December 24, 2012, the analysis found that out of 5793 trading days, 4962 days resulted in the implied volatility being higher than the realized volatility over those next 22 trading days. Thus, implied volatility based on VIX levels overestimated realized volatility on 85.6% of occasions, and underestimated realized volatility on only 14.4% of occasions. One potential reason for this upward bias may be in the analysis done does not include for the potential effect of rollover of S&P 500 options as it effects the VIX reading.

In addition to examining the VIX on a whole basis, this analysis sought to assess the forecasting ability of the VIX based on different closing levels. Using the same data from 1990 to 2012, the differences in implied vs. realized volatility were measured and then compiled with different index levels as seen below in Table 3-1.

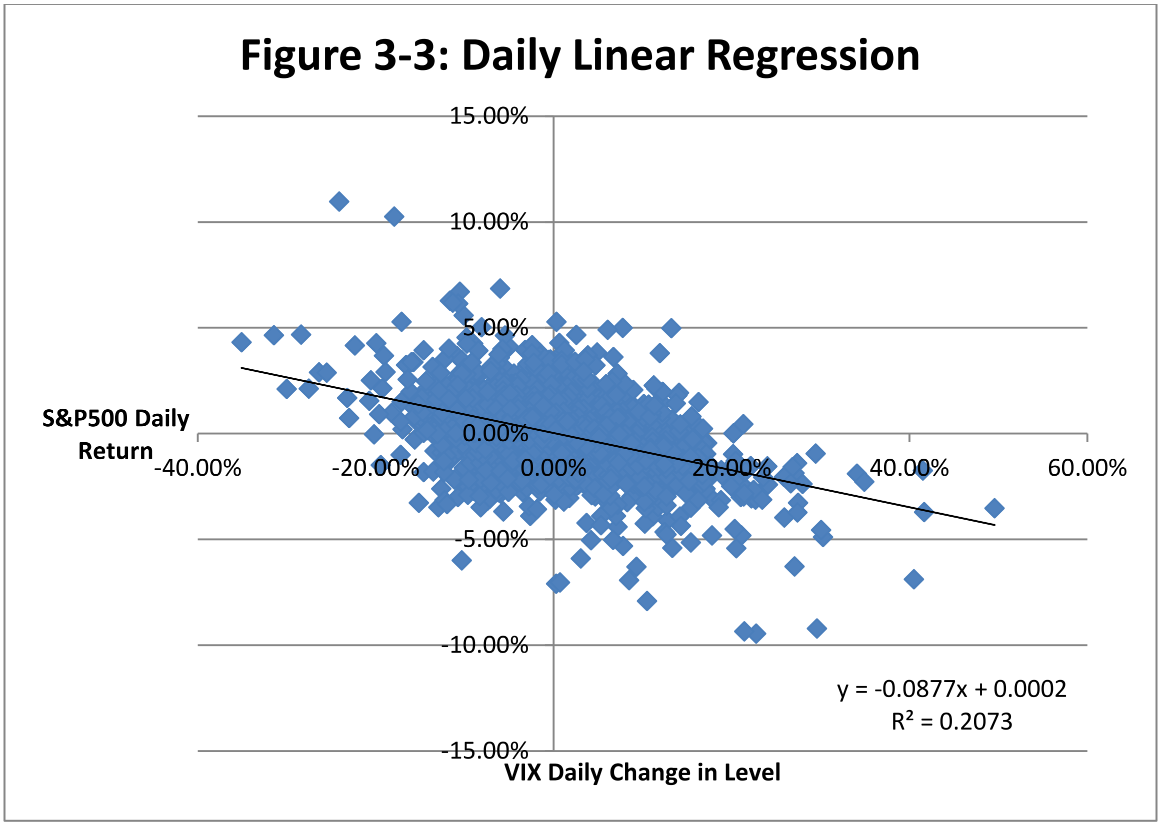
Table 3-1: Implied vs. Realized Volatility of Different VIX Levels

VIX Level	**40+**	**30-40**	**25-30**	**20-25**	**15-20**	**low-15**
Correlation	0.65	0.29	0.15	0.19	0.24	0.22
Mean	1.21%	1.53%	1.49%	1.17%	1.17%	0.89%
Median	1.61%	2.11%	1.79%	1.53%	1.38%	0.96%
Observed	168	410	629	1341	1710	1535

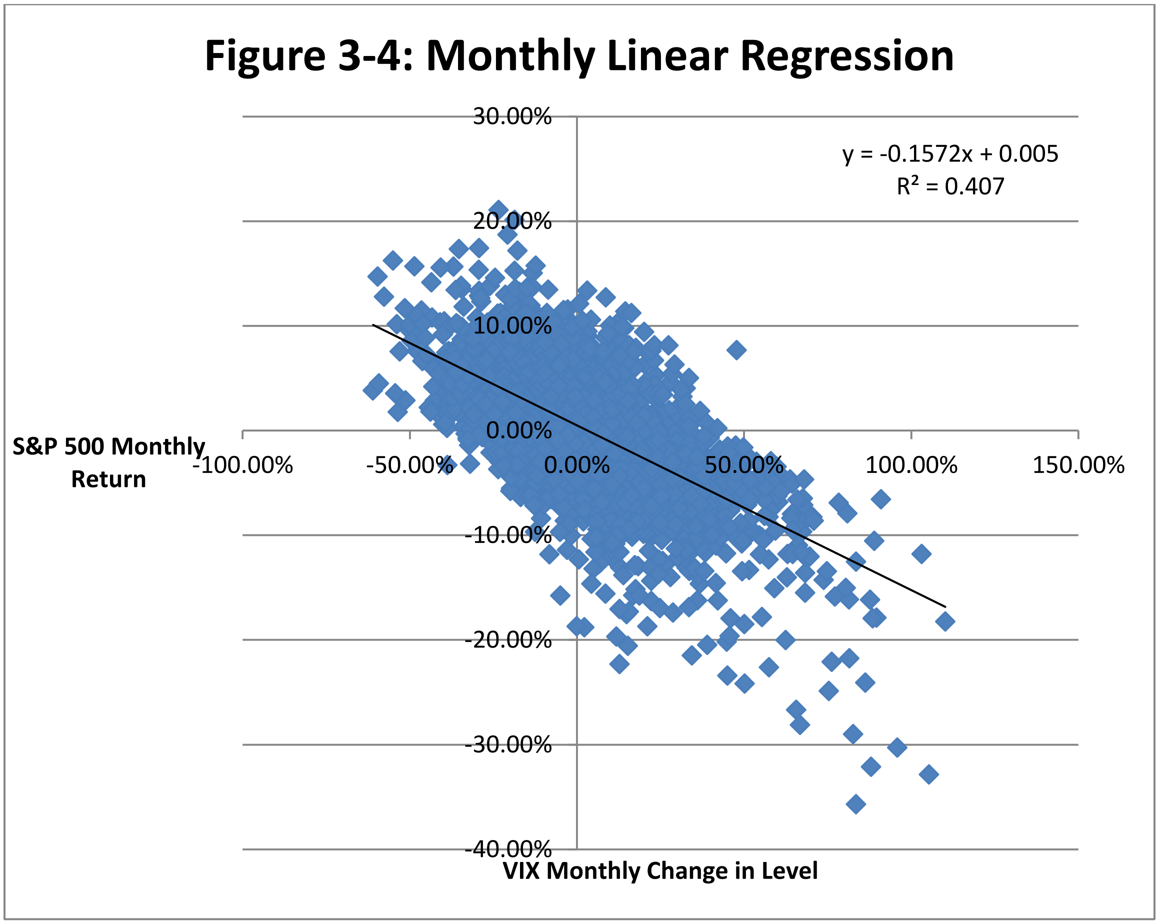
Given the information above, it is clear that the VIX is best at forecasting volatility in more normal ranges, which would be considered around 14-22. As seen in the correlations above, the VIX generally becomes a better predictor the lower the assumption of expected volatility. As you decline in VIX levels, the mean and median differences in implied versus realized volatility decreases steadily. It is important to note the observations of each level as well, which allow for the drastic differences between the levels 40 and above and between 30 and 40 as they are less commonly observed by the equity markets with only 578 daily occurrences since 1990 between the two ranges.

While the relationship between the implied and realized volatility is important, it was also a focus of this analysis to examine the relationship between the VIX and market returns based on the S&P 500 index. If there existed such a definite relationship between the VIX and market returns, than such a relationship could be exploited to prove profitable or serve as an effective equity hedge either for volatility or downside purposes.

As seen in Figure 3-3 below, a linear regression was used to examine this relationship on a daily return basis. To calculate this, the returns on the closing VIX level were regressed against the returns on the closing S&P 500 adjusted level during the time period of 1990 to 2012. As seen in the figure, there exists an inverse relationship between the VIX and the S&P 500. With this considered, one would expect that as the VIX moves higher (or implied volatility of the S&P 500 increases), the S&P 500 would move lower and vice versa. All the while, as the data shows, the VIX does not always follow this pattern as in some cases a rise in the VIX is met with market returns due to volatility surrounding major events.



While the daily linear regression depicts this relationship well, the analysis also included a monthly linear regression in order to examine if monthly returns on the VIX and S&P 500 regressed on a rolling daily time interval would display more conclusive results. In Figure 3-4 below, the linear regression shows that a much stronger relationship exists between the VIX and S&P 500 on a monthly basis verses daily. In this case the R-squared value has risen to 0.407 from 0.207 and the negative coefficient has almost doubled as well. In order to confirm these results, a simple correlation on the monthly returns was ran in addition to daily returns and this found that the monthly returns had a negative correlation of -0.64 versus -0.45 for the daily returns. In addition, both regressions show p-values that are virtually zero and t-statistics that are both above 30. The p-values determines whether or not random data would produce a coefficient as large as seen in this analysis, thus below the significance threshold of 0.05 meaning it is highly unlikely this relationship happened by chance and is statistically significant. Moreover, the t-statistics being above 2 depicts the data as highly significant. In both cases, both the p-value and t-statistic became more significant when the time horizon of the relationship was widened to monthly from daily. Thus, as expected, on a longer time horizon, the negative relationship between returns on the VIX and S&P 500 was more clearly defined.



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Considering the relationship depicted in both figures, the VIX could be effectively used as a portfolio tool for equity money managers. In this case, with a strong negative correlation relative to the S&P 500, the VIX could be used as a hedging tool for long only portfolios in order to limit downside risk. The only issue with this is that there is no way to openly trade the spot VIX, although futures and options do exist on the VIX. While these are viable options, it is possible to synthetically create the spot VIX with a basket of S&P 500 index calls and puts in order to mimic the movements of the VIX. Moreover, it remains from this analysis that the VIX serves as a strong hedging tool for equity portfolios benchmarked against the S&P 500 due to its significant negative relationship with the overall market.

Chapter 4

Conclusion

After analyzing the findings of this study, there remains strong evidence that the VIX contains significant information regarding future expected volatility and market returns. As tested on a whole and level by level basis, the VIX's embedded implied volatility is highly correlated with the actual realized volatility of the S&P 500 index over the same 30 calendar days. While it was confirmed that the implied volatility is upwardly biased, a level by level analysis shows that lower volatility assumptions and thus lower readings of the VIX contribute to more accurate VIX forecasts of future volatility. Furthermore, the VIX exhibits a pattern during times of equity crisis where volatility and VIX levels move precipitously higher. At first, realized volatility is proven to be greater than implied volatility as the market is slow to process the crisis and appears to believe the volatility will mean revert. At the same time, when realized volatility starts to come down, the implied volatility is greater than the realized volatility displaying that the market tends to have upwardly biased views of future volatility during prolonged periods of crisis. Finally, when examining VIX levels and market returns, there remains a significant negative relationship between returns on the VIX and returns on the S&P 500 index. This was confirmed during longer time horizons such as monthly rather than daily returns on both indexes. This also confirmed that the negative correlation between returns on the VIX and S&P 500 allows for portfolio managers to utilize the VIX, albeit synthetic, for hedging equity portfolios. Consequently, the VIX has significant S&P 500 volatility forecasting abilities and there remains a strong negative relationship between VIX returns and S&P 500 returns.

BIBLIOGRAPHY

Banerjee, Prithviraj, Doran, James, and Peterson, David, 2006. “Implied Volatility and Future Stock Returns.” Journal of Banking and Finance 31, 3183-3199.

Canian, L. and Figlewski, S., 1993. “The information content of implied volatility.” Review of Financial Studies 6, 659-681.

Christensen, B.J., and Prabhala, N.R., 1998. “The relationship between implied and realized volatility.” Journal of Financial Economics 50, 125-150.

Copeland, M., Copeland, T., 1999. “Market timing: Style and size rotation using the VIX.” Financial Analysts Journal 55, 73-81.

Fleming, J., 1998. “The quality of market volatility forecasts implied by S&P 100 index option prices.” Journal of Empirical Finance 5, 317-345.

Fleming, Jeff, Barbara Ostdiek, and Robert E. Whaley, 1995. "Predicting Stock Market Volatility: A New Measure." The Journal of Futures Markets 15, 265–302.

Giot, P., 2005. “Relationships between implied volatility indexes and stock index returns.” Journal of Portfolio Management 26, 12-17

Shu, Jinghong, and Zhang, Jin, 2003. “The Relation Between Implied and Realized Volatility on S&P 500 Index. Wilmott, 83-91.

Smith, Adam, and London. "The Volatility Index: A Primer." *Time*. Time, 17 Oct. 2008. Web. 14 Apr. 2012. <http://www.time.com/time/business/article/0,8599,1851343,00.html>.

Tan, Kopin. "The ABCs of VIX." Barron's, Mar 15, 2004, MW16

"VIX Futures: The Basics." *CBOE Futures Exchange - Education*. Web. 2 Apr. 2012. <http://cfe.cboe.com/education/vixprimer/Basics.aspx>.

Whaley, Robert, 2008. "Understanding the VIX". Vanderbilt University.

Whaley, Robert E., 2000. "The Investor Fear Gauge." The Journal of Portfolio Management 26, 12–17.

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

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Professional Experience

- Sales & Trading, Morgan Stanley, 2012
- Equity Analysis, Nittany Lion Fund, LLC., 2010 – 2012
- Equity Analysis, Gardner Lewis Asset Management, 2010-2011
- Private Wealth Management, Bank of America Merrill Lynch, 2010