NORTHERN ILLINOIS UNIVERSITY

Monetary Policy and the VIX

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Abstract

The relationship between the Federal Reserve monetary policy and the CBOE volatility index, VIX, is examined. Volatility plays a crucial role in pricing derivatives; therefore, an understanding of how macroeconomic factors affect asset prices and volatility is important to market participants. Daily trading data is examined from January 2nd, 1990 to February 29th, 2008. A significant relationship is identified between measures of monetary policy and the VIX, which suggests that the volatility implicit in derivatives is influenced by monetary policy. In particular, volatility is shown to be significantly higher (lower) when the Federal Reserve is following an expansive (restrictive) monetary policy.
I. Introduction

Volatility plays a central role in asset pricing, especially on options, and in making key financial decisions. The observed volatility of options reflects the market consensus regarding expected fluctuations. This information becomes an additional tool for money managers to evaluate risk and reward. Money managers can change a fund’s allocation from equities to fixed income if there is more perceived risk than desired. Moreover, portfolio managers use derivatives (options and futures) to limit their exposure or to enhance returns. To assess the fair value of an option or to hedge market risk, money managers need to identify expected future volatility. The Chicago Board of Exchange volatility index, VIX, represents the market’s forecast of the volatility of the Standard and Poor’s 500 Index. Hence, the ability to forecast financial market volatility is important for portfolio selection and asset management as well as for the pricing of primary and derivative assets. In addition, higher volatility yields wider bid and ask spreads, thereby reducing liquidity (Naterberg 1994). Furthermore, understanding volatility should be of interest to regulators, given their influence on investment and risk management.

Former Fed chairman, Alan Greenspan, noted the increasing importance of financial asset pricing. He stressed the need for a better understanding of financial asset price determination, and the connection between financial asset prices and macroeconomic performance (Wong, Khan, Du 2006). In this paper we investigate the relationship between monetary policy and the VIX. Given the strong influence that monetary policy has on financial markets, we expect a significant relationship between monetary policy and the VIX. The paper is organized as follows: Section II briefly reviews the relevant literature. Section III discusses the sample and methodology. Section IV presents the empirical findings and interprets results. Finally, in the last section, a summary and conclusions are provided.

II. Literature Review

Although there have been relatively few studies of equity volatility and monetary policy, there have been numerous studies of monetary policy and equity returns. A significant number of these studies have indicated that equity returns respond to changes in monetary policy instruments. The results obtained by using multiples monetary policy measures such as nonborrowed reserves innovations, changes in the federal funds rate, and the Boschen and Mill Index indicate that expansionary (restrictive) monetary policy causes stock returns in general to increase (decrease) (Thorbecke 1997).

Many studies have scrutinized the impact of macroeconomic announcements on financial markets. Ederington and Lee (1993) observed a higher than usual volatility in interest rates and exchange rate futures markets due to major macroeconomic announcements such as the PPI and the CPI. Furthermore, most of the price volatility occurred within one minute before the announcement and a higher volatility was maintained during the following fifteen minutes than the volatility on days without announcements. Engle and K.Ng (1993) find that negative shocks have a greater impact on volatility than positive shocks. Schwert (1990) shows that the volatility of individual stock returns is driven by market volatility, with individual stock return premiums affected by predictable market volatility. Hence, volatility indexes, such as the VIX, are important because of the link identified between asset prices and volatility.
Using OLS regression, Kearney and Lombra (2004) show a significant positive relationship between change in the VIX and unanticipated changes in employment. For instance, if an announced increase in employment is greater than expected by market participants, this leads to an upward revision of the federal funds rate. The expected result of higher interest rates, reflected by a higher federal funds rate, leads to higher volatility (higher VIX). Claessen and Mittnik (2002) compare the volatility measures obtained from GARCH models using historical data to the observed option implied volatility of the DAX-Index options—Germany equity index—and conclude that the GARCH models do not add information to what is already reflected in the DAX-Index option prices. They also find implied volatility to be the best indicator of future volatility.

Gulley and Sultan (2003) comment that monetary policy appears to have uncertain effect on asset prices and that this uncertainty implies that the volatility of asset prices can be affected by information concerning Fed policy. In an effort to understand the dynamics of monetary policy decisions and the integration of global markets, Bredin, Gavin, and O’Reilly (2005) look at the effects of U.S. monetary policy announcements on Irish stock returns and volatility. They find a decrease in the volatility of the Irish stock market before FOMC meetings and an increase after the meetings. Furthermore, negative surprises such as lower than expected policy rate changes, reduce Irish stock market volatility significantly more than positive surprises. It is worth noting that this study uses historical rather than implied volatility; therefore, it fails to account for market expectations because it focuses on actual stock returns. Another study indicates that volatilities in the US and UK stock index futures market react in a similar fashion to shocks from other markets, which suggests a volatility spillover (Booth, Chowdhury, Martikainen, and Tse 1997).

Given the immense volume of literature in this area, we find it rather surprising that an effort has not been made to document the behavior of the VIX relative to changes in monetary conditions. The present study attempts to fill this gap in the literature.

III. Data and Methodology

Our study employs daily data; this allows the impact of monetary policy on the VIX index to be measured more accurately than is possible when using monthly or even weekly data. The use of weekly or monthly data may aggregate away, at least to some extent, any monetary policy effect. The data covers the period of January 2nd, 1990, through February 29th, 2008. We chose this time frame because, during this period, the federal funds rate and the federal discount window rate became the best signal to mark changes in monetary policy (Bernanke and Blinder 1992; Jones 1994). Federal funds rates and discount window rates are taken from the Board of Governors of the Federal Reserve System, and the closing prices of the estimated “new” VIX from the Chicago Board of Exchange. In contrast to the “old” VIX, the “new” VIX uses calculations that are independent from any options pricing model and it is derived from the thirty-day weighted average of the S&P 500 options volatility. These adjustments yield a more robust measure of expected volatility because the new method takes into account the options volatility skew and use the S&P 500 instead of the S&P 100 options (CBOE 2003).

We explore the relationship between the VIX and monetary policy using two alternatives measures of monetary policy. The first measure is designed to identify changes in the stringency of the Federal Reverse monetary policy and is measured as a one-day lag of the change in the
overnight federal funds rate. Stringency takes a value of 1 if there is an increase from the previous one-day lag federal funds rate and a value of 0 if there is a decrease from the previous one-day lag federal funds rate. Thus, Fed stringency becomes more restrictive with increasing the federal funds rate and becomes more expansive following a decrease in the rate. The second measure, stance, is designed to identify a broad shift in the Fed monetary policy stance. Stance takes a value of 1 if there is an increase in the discount window rate and retains a value of 1 until there is a decrease; it takes a value of 0 if there is a decrease in the discount window rate, retaining a value of 0 until there is an increase. We investigate the relationship between the VIX and the two monetary policy variables, both independently and in conjunction. The models are as follows:

\[
VIX_t = \alpha + \beta \times \text{Stringency} + \varepsilon_t 
\]

(1)

\[
VIX_t = \alpha + \beta \times \text{Stance} + \varepsilon_t 
\]

(2)

\[
VIX_t = \alpha + \beta_1 \times \text{Stringency} + \beta_2 \times \text{Stance} + \varepsilon_t 
\]

(3)

In addition to the models, we examine the prevailing trend of the average VIX three months before a shift in Fed monetary policy stance and three months after. The paper focuses on four issues. First, can the VIX be predicted using a monetary policy stringency indicator, in particular changes in the lag federal funds rate? Second, can the VIX be predicted using shifts in monetary policy stance, in particular changes in the Fed discount window? Third, we combine the two monetary indicators to see if either of the first two models is improved using a multiple regression model. Finally, we inspect any VIX trends before and after restrictive and expansive changes in monetary stance.

IV. Empirical Findings and Results

Table 1 reports the summary statistics for the VIX, stringency and stance (Panel A) and the degree of correlation across those variables (Panel B). The VIX is very volatile, as is shown by its standard deviation of 6.373. Furthermore, it has more extreme values than a normal distribution, which is shown by its 0.736 excess kurtosis (0 is considered normal.) The standard deviation and excess kurtosis imply high risk. We also observe a high excess skewness of 0.947 (0 is considered normal). This is favorable for investors who take a long position on the VIX.

In addition, we observe that during this period there are an approximately equal number of increases and decreases in the federal funds rate, which is shown by its mean of 0.50. The relative absence of extreme values in stringency is indicated by its negative kurtosis of -1.996. Moreover, the skew is slightly positive (0.072). Monetary policy stance indicates a longer period of expansive monetary policy within this period than restrictive; this is shown in its mean of 0.342. Its observations largely cluster around the mean, which is implied by its -1.559 kurtosis.

In Panel B it can be observed that the VIX has a slight positive correlation with stringency. More importantly, the VIX has a relatively strong negative correlation with stance. The correlation between VIX and stance is -0.40. The correlation between stance and stringency is positive, though small (0.016).
Table 1 (Summary Statistics)

<table>
<thead>
<tr>
<th>Panel A: Descriptive Statistics</th>
<th>VIX</th>
<th>Stringency</th>
<th>Stance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>19.020</td>
<td>0.482</td>
<td>0.342</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.095</td>
<td>0.007</td>
<td>0.007</td>
</tr>
<tr>
<td>Median</td>
<td>17.81</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mode</td>
<td>11.65</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.373</td>
<td>0.500</td>
<td>0.475</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>40.617</td>
<td>0.250</td>
<td>0.225</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.736</td>
<td>-1.996</td>
<td>-1.559</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.947</td>
<td>0.072</td>
<td>0.665</td>
</tr>
<tr>
<td>Range</td>
<td>36.43</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Minimum</td>
<td>9.31</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>45.74</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sum</td>
<td>86272.86</td>
<td>2185</td>
<td>1553</td>
</tr>
<tr>
<td>Count</td>
<td>4536</td>
<td>4532</td>
<td>4536</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Correlation between the VIX, Stringency and Stance</th>
<th>VIX</th>
<th>Stringency</th>
<th>Stance</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIX</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stringency</td>
<td>0.021</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Stance</td>
<td>-0.400</td>
<td>0.016</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2 reports the results of the regression analysis with the VIX as the dependent variable and the monetary variables as independent variables. Results are reported for three models. Model 1 includes stringency on the independent variable. The p-value tells us that the regression is significant at the 0.158 level, which is above the conventional .05. Therefore, we are 74 percent confident that the interval for the slope coefficient does not contain the value of zero. A small p-value is expected because of the high volatility of the VIX. The slope coefficient of 0.268 implies that the predicted increase in VIX is about 0.268 for an increase in stringency. Note also that the R squared of this regression is 0.00044, which informs us that stringency explains about 0.044 percent of the variation in the VIX. The remaining 96 percent is attributed to other components. We conclude that the regression is positive, but not statistically significant in explaining the VIX.

The second model in table 2 includes stance on the independent variable. The t-test informs us that the regression is highly statistically significant, which is also reflected by the miniscule p-value of 1.60 E-174. The slope coefficient of -5.381 implies that the predicted decrease in VIX is about 5.381 during a change from expansive to a restrictive monetary policy stance. This suggests that the monetary policy stance is considered by market participants to be a contrarian indicator of future volatility. For instance, if the current monetary policy stance is
expansive and is expected to become restrictive, then market participants will expect lower future volatility levels. The R squared of this regression is 0.161, which implies that about 16 percent of the variation in the VIX is explained by Fed monetary policy stance. The remaining 84 percent is attributed to other factors. We conclude that the regression is negative and statistically significant in explaining the VIX.

Our last model in table 2 reports the regression of VIX with both stringency and stance as independent variables. The regression is highly statistically significant, as shown by its F-test of 1.84 E-173 (not shown). The slope coefficient of stringency is 0.274 which implies that an increase in stringency will increase the VIX by 0.274, holding stance constant. The stance coefficient is -5.384, which implies that a shift in stance will decrease the VIX by 5.384, holding stringency constant. We also observe that the independent variables T-tests remain relatively unchanged from their previous individual regressions. We use the adjusted R squared of 0.161 to mitigate the increasing explanatory power by simply adding another variable. We conclude that the regression is highly significant in explaining the VIX and we notice that adding the stringency variable does not improve our second model.

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept</th>
<th>Coefficient</th>
<th>Coefficient 2</th>
<th>T-stat</th>
<th>T-stat 2</th>
<th>R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIX_t = α + β stringency</td>
<td>18.89</td>
<td>0.27(0.158)</td>
<td>-</td>
<td>1.41</td>
<td>-</td>
<td>0.000</td>
</tr>
<tr>
<td>VIX_t = α + β stance</td>
<td>20.86</td>
<td>-5.38(1.6E-174)</td>
<td>-</td>
<td>-29.44</td>
<td>-</td>
<td>0.1605</td>
</tr>
<tr>
<td>VIX_t = α + β_stringency + β_stance</td>
<td>20.73</td>
<td>0.27(0.115)</td>
<td>-5.38(1.5E-174)</td>
<td>1.57</td>
<td>-29.45</td>
<td>0.1607*</td>
</tr>
</tbody>
</table>

* Adjusted R squared

Figure 1 shows the average VIX level three months before and after a shift from restrictive to expansive monetary policy stance. The observable pattern in the last two expansive changes is a decrease in the average VIX level after the announcement. Figure 2 shows the average VIX level three months before and after a shift from expansive to restrictive monetary policy stance. We observe the same pattern than in an expansive change in the last two restrictive changes, a decrease of the VIX after the announcement. In addition, we notice an increase in the average VIX level before the announcement. This implies that the equity market expects higher volatility on the monetary policy stance announcement day. This conclusion is consistent with the results of Ederington and Lee (1993).
V. Summary and Conclusion

A large and growing body of empirical literature investigates the impact of macroeconomic announcements on asset prices. The consensus among these studies is that "news" from economic announcements has an immediate impact on both the prices of assets and their volatility. The ability of money managers to forecast volatility is crucial for the proper use of derivatives. In addition, regulators should pay close attention to the level of volatility as they set portfolio management policies. This paper assesses the predictability of the VIX using monetary policy. In particular, we study the relationship between the VIX and two alternative monetary policy measures. The first monetary variable is designed to identify changes in the stringency of the Fed policy and it is proxied by changes in the federal funds rate. The second
measure is constructed to recognize shifts in Fed monetary policy stance and it is proxied by changes in the federal discount window rate. We use three linear least square models during the time period of January 2\textsuperscript{nd}, 1990, through February 29\textsuperscript{th}, 2008. We find that the Fed monetary policy stance is negatively correlated to the VIX; stringency is positively correlated to the VIX; and the monetary policy stance and stringency are positively correlated.

In our first model we uncover that stringency is not statistically significant in explaining the variation of the VIX. The inference is that monetary policy stringency is insignificant in predicting the VIX level. The second model changes the first model by substituting monetary policy stance as the independent variable. We find that the independent variable, stance, is negative and highly statistically significant in determining the VIX level. The deduction is that the variation of the VIX is significantly predicted by shifts in Fed monetary policy stance. Moreover, volatility is shown to be significantly higher (lower) when the Federal Reserve is following an expansive (restrictive) monetary policy. Subsequently, we add stringency to our stance model to determine if there is an improvement in the model. We discover that the stance model is not significantly improved, and we conclude that stringency does not contribute significantly to the model. Finally, we observe market uncertainty, reflected as high future volatility, before a monetary policy announcement.

Taken together, these results indicate that the volatility of equity prices is critically linked to the dynamic relationship that connects monetary policy stringency and stance and that monetary policy is perceived to have a value in anticipating future volatility.
References


