Assessing the VIX's Impact on SPY Returns in Response to the Federal Reserve's 2022 Rate Hike

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Abstract. This study examines the relationship between the CBOE Volatility Index (VIX) and the returns of the SPDR S&P 500 ETF (SPY) before and after the Federal Reserve's first interest rate hike in 2022. The analysis covers an eight-month period, centered on the date of interest rate changes. The reason to use this period because it is the first hike after the pandemic. A time series approach is used, constructing multi-linear regressions to evaluate the pre-hike and post-hike periods. The pre-hike model did not find any significant predictors, suggesting that market dynamics and the role of VIX were not aligned with SPY returns. However, after the interest rate hike, the VIX rate became significant indicators, reflecting the market's increased sensitivity due to the new interest rate environment. This transformation highlights the crucial role of the VIX as a gauge of market sentiment and risk perception in response to significant monetary policy actions.

Keywords: VIX, S&P 500, return rate, interest rate.

1. Introduction

The VIX has been a widely discussed topic in modern financial markets. This index, launched by the Chicago Board Options Exchange, measures the implied volatility of the S&P 500 as a benchmark to predict potential risks in the market, and is also known as the "market fear index". Thousands of financial practitioners and institutions closely follow the VIX and its related research, so it is important to conduct new research on it. In mainstream research, researchers have focused on the VIX's ability to predict market returns and financial instability [1]. Some researchers also focus on the application and analysis of VIX itself, they will examine the VIX’s futures or other derivatives [2]. All of these studies laid the foundation for VIX research, paved the way for future research, and had a profound impact on financial markets. However, most of these studies lack of consider the impact and prediction of VIX on other variables before and after policy implementation or unusual events in time series.

This paper investigates the relationship between the Volatility Index (VIX) and the returns of the SPDR S&P 500 ETF (SPY) in the context of the Federal Reserve's first interest rate hike of 2022 [3]. This period is significant as it marks the initial rate increase since the onset of the pandemic era. To capture the effects surrounding this monetary policy event, the paper analyzes the data from four months prior to and following the hike. The study constructs two multi-linear regression models to examine periods before and after the interest rate adjustment. The models aim to explain any changes in the statistical significance of the VIX's impact on SPY returns due to the rate hike. The paper intends to explore and clarify the factors contributing to the observed differences in statistical significance between the two models in relation to this key economic event.

2. Data

In this paper, it has 5 different variables. The response variable is daily return rate of the SPDR S&P 500 ETF Trust (SPY). The explanatory variables are the Chicago Board Options Exchange Volatility index (VIX) daily open and close rate. The control variables are the daily trading volume of SPY ETF, the daily Secured Overnight Financing Rate (SOFR), and the Dow Jones Industrial Average index (DJIA) closing price.

The time interval of all 5 variable is chosen from the 2021/11/17 to 2022/7/17. The reason why the paper chose from this time interval is because 2022/3/17 is the first Federal Reserve's interest hike since 2018 to trying to prevent the economy from overheating as inflation soars. In that day, Fed increase the Federal Fund from 0.25% to 0.50%. Since this first interest hike, Federal Reserve begins the new round of interest hike. Therefore, this is the reason the paper wants to set March 17, 2022, as a middle point in the time interval, so that the research could find what factors influenced the volatility and performance of the SPY a season (4 month) before and a season after the change of the monetary policies and economic events.

First, for the response variable The SPDR S&P 500 ETF Trust (SPY) is the Exchange Traded fond from State Street. This ETF correspond generally to the price and yield performance of the S&P 500 Index. The daily return rate and daily volume of the SPY are collected from the Bloomberg terminal. In the time interval the paper chooses, the SPDR S&P 500 ETF Trust (SPY) experienced a period marked by fluctuating returns. The minimum daily return rate hit a low of -4.3%, signaling at least one day of significant market drop within this timeframe. Despite the extreme, the average (mean) and midpoint (median) daily returns hovered around a slight decline of -0.1%, reflecting a subtle downtrend in the ETF's performance. However, the presence of a maximum daily return of 3.2% indicates there were days when the market makes good performance.

Second, for the explanatory variable Chicago Board Options Exchange Volatility index (VIX)The VIX, known as the market's "fear gauge," reflects the volatility expectations of market participants for the next 30 days [4]. It is calculated from the implied volatilities of a wide range of S&P 500 index options and provides a measure of market risk and investors' sentiments [5]. For VIX Open rate, the minimum opening value was 16.57, The median opening value was 26.82, The mean opening value was similar to the median at 26.57. The maximum opening value reached 37.50, representing the highest expected volatility at the market open during the observed period. For VIX Close, the minimum closing value closely followed the opening minimum at 16.60, showing that the lowest volatility expectations at market close were similar to the opening. The median closing value was 26.68 and the average closing value is 26.22. The maximum closing value reached 36.45.

The first control variable is the daily trading volume of SPY ETF, which also collected from the Bloomberg terminal., this variable exhibited a substantial range, The minimum daily volume recorded was 55,329,040 shares, suggesting a day with relatively low trading activity. On the contrary, the maximum volume is up to 252,496,720 shares, highlighting a day of exceptionally high trading interest. The median daily volume, amounting to 95,913,960 shares, provides a central tendency of trading activity, around which half of the trading days saw higher volumes and the other half saw lower. The average volume was somewhat higher, at 104,830,801 shares, showing at days with intense trading that could have driven the average above the median.

The second control variable is the Secured Overnight Financing Rate (SOFR), which is a benchmark interest rate that reflects the cost of borrowing cash overnight collateralized by Treasury securities. SOFR rate considered to reflect the general funding conditions in the overnight Treasury repo market and plays a pivotal role in the financial markets, impacting the pricing of various financial instruments, including loans, mortgages, and derivatives [6]. Thus, this is the reason why the paper chooses it as control variable. In the dataset, the minimum SOFR goes to low as 0.04%, The median SOFR, situated at 0.28%, However, the average rate observed was higher, at approximately 0.4768%, suggesting that while many days featured lower rates, there were enough instances of higher rates to push the average above the median. The maximum SOFR is 1.54%. This maximum points to sporadic spikes in the borrowing rate, which could be associated with tighter liquidity conditions or market reactions to policy changes or economic updates.

The last control variable is the Dow Jones Industrial Average (DJIA) closing price, it shows a range from a low of 29,889 to a high of 36,800, with the central 50% of values between 32,217 and 34,796, suggesting moderate variability. The mean is 33,531, which is close to the median of 33,851.

Fig. 1 shows the distributions of variables. The SPY return histogram suggests a symmetric distribution centered around zero, which is quite close to normal distribution. The VIX open and close

histograms show distributions with a slight right skew, which may correlate with days with higher volatility. The SPY volume histogram exhibits a right-skewed distribution, indicating few of days have significantly high trading volumes. The SOFR rate's histogram has a distribution with a concentration of values around the lower end, but with a tail extending towards higher rates, which reflects the variability in the SOFR distribution, with a higher frequency of lower rates and fewer occurrences of elevated rates. And lastly, the DJIA histogram portrays a relatively symmetrical distribution, suggesting stable closing values with no strong bias towards higher or lower ends. Each histogram encapsulates different aspects of market behavior, from volatility and trading activity to interest rates and overall market valuation.

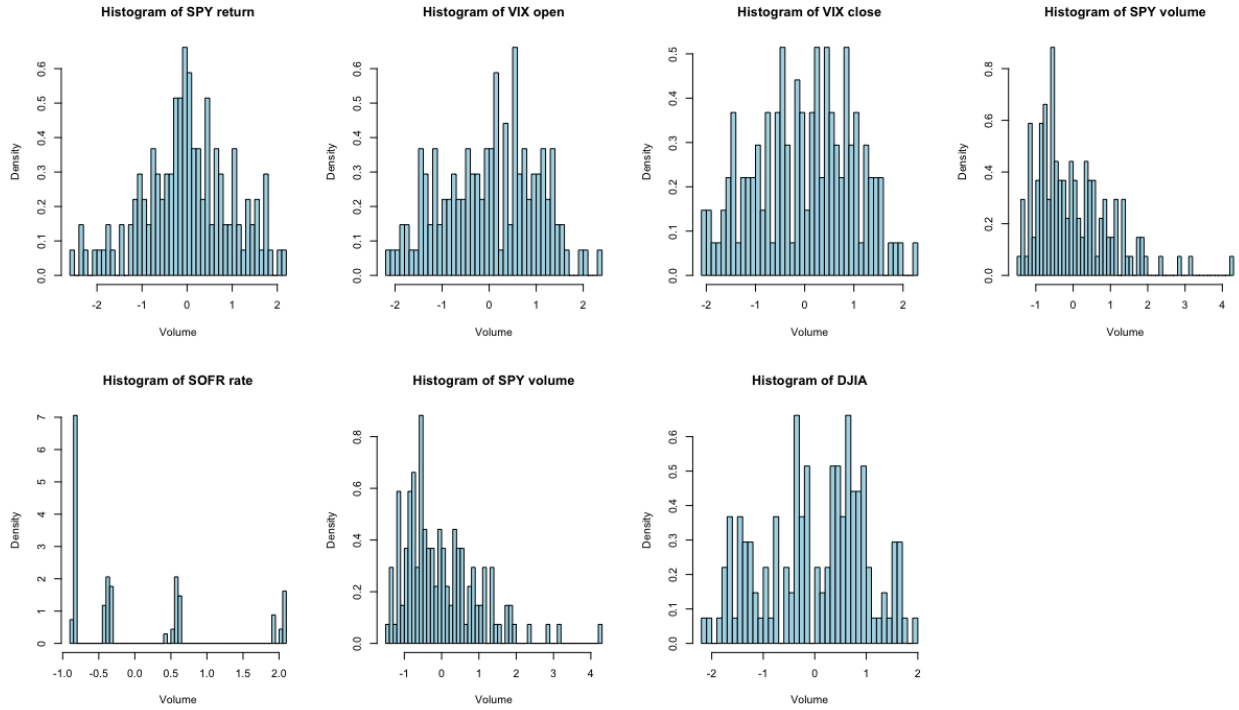


Fig. 1 Distribution of variables

3. Method and Results

3.1. Method

To find out the impact of VIX rate on SPY's return 4 months before and after March 17, 2022, which is the first Fed Rate Hike after the pandemic, this paper builds a multi-linear regression model to analyze it, here is the following formula.

$$\text{SPY_Return} = \beta 0 + \beta 1 \times \text{VIX_Open} + \beta 2 \times \text{VIX_Close} + \beta 3 \times \text{SOFR_Rate} + \beta 4 \times \text{SPY_Volume} + \beta 5 \times \text{DJIA_Close} + \varepsilon \quad (1)$$

Where β0 is the intercept of the model. β1 is the coefficient for the VIX_Close variable. β2 is the coefficient for the VIX_Close variable. β3 is the coefficient for the SOFR_Rate variable. β4 is the coefficient for the SPY_volume variable β5 is the coefficient for the DJIA_Close variable. ε represents the error term of the model, capturing the variation in SPY_Return not explained by the model.

3.2. Results

The below Tables 1 and 2 show the result of the multi linear regression before and after the Fed interest hike. From the result, the paper found it have vast difference on statistic significant between two model in different time intervals.

Table 1. Before Hike

Term	Estimate	Std. Error	t value	p value	Model Statistic	Value
Intercept	2.6346	11.7718	0.224	0.824	Residual Std Error	0.8489
VIX_Open	0.3430	0.2775	1.236	0.222	Degrees of Freedom	5, 47
VIX_Close	-0.3009	0.4737	-0.635	0.528	Multiple R-Squared	0.1033
SOFR_Rate	3.2216	14.2963	0.225	0.823	Adjusted R-Squared	0.007859
SPY_Volume	-0.1541	0.1502	-1.026	0.310	F-Statistic	1.082
DJIA_Close	0.1457	0.6365	0.229	0.820	p-value (F-Stat)	0.3824

In the table before the Fed interest hike, none of the coefficients are statistically significant at the conventional 0.05 level, as indicated by the p-values. This means there is not enough evidence to suggest that any of the independent variables have a significant linear relationship with SPY returns in the period before the rate hike. The residual standard error is 0.8489, which is quite high, indicating that there is substantial variability in the SPY returns that the model is not capturing. The model have a F-statistic value of 1.082 and a p-value of 0.3824, thus there is not enough evidence to reject the null hypothesis that all regression coefficients are equal to zero collectively. In other words, this model does not provide a statistically significant fit to the data. In summary, this model does not appear to provide a robust explanation for the daily returns of the SPY ETF in the timeframe before the rate hike.

Table 2. After hike

Term	Estimate	Std. Error	t value	p value	Model Statistic	Value
Intercept	-0.1494	0.1715	-0.871	0.3872	Residual Std Error	1.008
VIX_Open	-0.7620	0.3271	-2.329	0.0233*	Degrees of Freedom	59
VIX_Close	0.9770	0.4100	2.383	0.0204*	Multiple R-Squared	0.2439
SOFR_Rate	0.7244	0.3004	2.411	0.0190*	Adjusted R-Squared	0.1799
SPY_Volume	-0.3041	0.2338	-1.300	0.1985	F-Statistic	3.807
DJIA_Close	1.0075	0.3978	2.533	0.0140*	p-value (F-Stat)	0.004685

In the model for the period after the rate hike, the situation is different. The VIX Open rate has a negative coefficient with a p-value of 0.0233, and the VIX Close rate has a positive coefficient with a p-value of 0.0204. Both are statistically significant at the 5% level. The model has a F-statistic value of 3.807 and a p-value of 0.004685, which is less than the standard threshold of 0.05, which reject the null hypothesis, indicating that the model provides a statistically significant fit to the data. Therefore, according to the model after the rate hike, there is a significant relationship between VIX rate and SPY's daily returns.

In conclusion, the shift from a model lacking statistical significance before the rate hike to one with significant predictors after the hike indicates VIX this factor became more predictive of SPY returns following the Fed's policy change. The paper will explain the potential reasons cause this change.

4. Analysis

The change in statistical significance of the VIX from the pre-hike to the post-hike period can be due to several reasons in market conditions and investor sentiment.

This paper assume financial markets are forward-looking and tend to incorporate expectations about future events into current asset prices. This anticipatory behavior is known as "pricing in." When it comes to anticipated rate hikes by the Federal Reserve, people in the market will adjust their portfolios based on their predictions about the hike's timing, magnitude, and economic implications. Once the Fed enacts the rate hike, the market shifts from anticipation to response. The VIX then becomes a measure of how investors reassess risk considering the actual rate increase and the Fed's

forward guidance. From Bekaert and Hoerova's research, an increase in the Federal Reserve's interest rates typically elevates market uncertainty, as reflected in a higher VIX. This heightened uncertainty affects investor behavior, leading to more pronounced reactions to the VIX's movements [1]. Thus, if the hike meets with expectations, the VIX may stabilize; if the hike deviates from market predictions, the VIX can fluctuate more dramatically as the market resets to the new interest rate standard. The VIX's behavior encapsulates this transition from speculative anticipation to informed assessment post-rate hike.

On top of that, A rate hike typically raises borrowing costs, potentially squeezing corporate profits of companies within the S&P 500 and leading investors to reassess the risk of holding stocks. This reassessment is reflected in the VIX, which measures expected market volatility. In the period after the hike, an elevated VIX indicates that investors anticipate greater volatility in S&P 500 returns, expecting higher risks and possibly adjusting their investment strategies accordingly. Essentially, the VIX serves as a barometer for shifts in market sentiment, with its predictive power for S&P 500 returns increasing in a post-rate hike environment as investors navigate the new economic landscape. Complementing this, Ozcelebi and Pérez-Montiel analyze the VIX's impact on stock indices under immediate interest hikes, further confirming the VIX's role as a barometer of market risk in response to interest rate changes [7].

5. Conclusion

The Research into the VIX's influence on SPY returns around the Federal Reserve's first interest rate hike in 2022 reveals a marked contrast in results from before to after the hike. Pre-hike, the regression model demonstrates no statistically significant relationships between the VIX and other control variables with SPY returns. Conversely, in the post-hike, the model significantly improves, which capturing meaningful relationships with VIX open and close rates significantly affecting SPY returns. The change suggests that post-hike, the VIX not only becomes a stronger predictor for SPY returns, due to increase of market sensitivity to interest rate change; but also confirms the role of the VIX as a measure of market risk in response to interest rate changes. Still, it has some limitation of this paper. The study's timeframe focused solely around the first interest rate hike since the pandemic, limits the generalizability of the findings across different economic cycles or monetary policy environments. Additionally, the model does not account for all potential influencing factors, such as global economic events, market liquidity, or structural changes within the economy, which could also significantly affect SPY returns. Future research should consider these factors, potentially employing more sophisticated models to capture the dynamic relationships within financial markets.

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