Macroeconomic Announcements Fuel Volatility: An In-Depth Analysis

Kadir Gökhan Babaoğlu, PhD
Volmex Labs

Jérémy Pfeifer, CFA
Volmex Labs

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Abstract. This study investigates the effects of scheduled macroeconomic announcements on Bitcoin (BTC) price and implied volatility proxied by the Bitcoin Volmex Implied Volatility (BVIV) Index. The results reveal statistically significant relationships, with CPI and Fed rate decisions generating substantial increases in BTC and BVIV volatility, and that BVIV experiences significant declines after these announcements, confirming the resolution of uncertainty in the market.

Introduction

The cryptocurrency market has gained significant attention in recent years, becoming a crucial component of the global financial landscape. Among these cryptocurrencies, Bitcoin (BTC) stands out as the first and most widely recognized, often regarded as digital gold. As the market matures, understanding the factors that influence BTC price dynamics becomes increasingly important for investors, traders, and policymakers alike.

Volatility is a defining characteristic of cryptocurrency markets, with BTC frequently exhibiting price fluctuations that are more pronounced than those observed in traditional asset classes. Higher volatility of Bitcoin can be attributed to several factors, including market sentiment, regulatory developments, technological advancements, and macroeconomic factors. Among these, macroeconomic announcements play a pivotal role, particularly those related to inflation and monetary policy.

Scheduled macroeconomic announcements, such as the Consumer Price Index (CPI) and Federal Reserve interest rate decisions, provide critical information about the economic environment. These indicators not only influence investor expectations regarding inflation and interest rates but also affect broader market sentiment. Given Bitcoin's increasing correlation with traditional financial markets, the implications of these announcements on BTC volatility need a thorough examination. We investigate this relationship, specifically focusing on BTC price fluctuations and implied volatility captured by the BTC Volmex Implied Volatility (BVIV) index. By employing a regression analysis of 1-hour candle data, we quantify the impact of key macroeconomic events on both BTC and BVIV.

The significance of this research lies in its potential to provide insights into the behavior of BTC in response to economic events, which can be indicators for trading strategies and risk management systems. Moreover, gaining insight into how macroeconomic announcements affect volatility can improve our understanding of the role that cryptocurrencies play in the global financial system.

The findings of this study reveal that macroeconomic announcements, particularly CPI and Fed rate decisions, significantly influence BTC volatility. Our analysis highlights a pattern of initial fluctuations in BTC and BVIV following announcements, followed by a systematic decline in BVIV, confirming the resolution of uncertainty in the market.

Methodology

We employ a quantitative approach to analyze the effects of scheduled macroeconomic events on Bitcoin (BTC) price and implied volatility (BVIV). The methodology consists of data collection, variable definitions, regression analysis, and robustness checks.

Data

Data were sourced from two primary platforms: CoinMarketCap (CMC) for BTC price data and Volmex[1] for BVIV data. The dataset includes 1-hour candlestick data, which provides the Open, High, Low, and Close (OHLC) prices for BTC, alongside the corresponding BVIV values during the same time intervals. We focus on major scheduled macroeconomic announcements as these events are known to significantly impact market volatility.

Our analysis period spans from September 20, 2022 to September 19, 2024, covering multiple occurrences of the selected macroeconomic announcements to ensure a robust dataset. This timeframe allows for a comprehensive examination of volatility reactions to these events.

	Count
ADP Employment	24
CPI	24
Core CPI	15
FOMC Minutes	16
Fed Decision	17
GDP	24
Global Manufacturing	14
Manufacturing	24
Nonfarm Payrolls	24
PPI	15
Powell Speech	28
Retail Sales	24
Sentiment	24
Services	24

Table 1: Number of occurrences

As shown in Table 1, events such as CPI, Nonfarm Payrolls, ADP Employment, and Retail Sales announcements occurred 24 times each, while others like the FOMC Minutes and Fed rate decision appeared 16 and 17 times, respectively. These frequent announcements provide enough data points to assess their impact on both BTC price and BVIV. The dataset enables a comprehensive analysis of how different economic indicators influence the cryptocurrency market.

Table 2 presents a summary of 1-hour BTC OHLC data, demonstrating that BTC experienced a wide range of price fluctuations. The standard deviation of BTC closing prices during this period was $17,723, with a maximum price of

[1] https://rest-v1.volmex.finance/api

$73,750 and a minimum of $15,599. These statistics suggest a high level of volatility in the BTC market over this two-year period, with notable fluctuations across all price points. The 25th, 50th (median), and 75th percentiles further highlight the significant variation in BTC prices, capturing the impact of both bullish and bearish market conditions over time.

BTC	mean	std	min	25%	50%	75%	max
open	38,478.32	17,722.92	15,647.34	25,720.16	30,025.24	57,957.36	73,573.91
high	38,593.79	17,797.59	15,745.42	25,760.12	30,101.51	58,190.55	73,750.07
low	38,361.04	17,644.84	15,599.05	25,663.06	29,955.74	57,766.42	73,219.87
close	38,480.78	17,723.36	15,652.83	25,721.83	30,029.02	57,957.70	73,577.80

Table 2: Summary of 1-hour BTC price candlestick data

Table 3 summarizes the 1-hour Bitcoin Volmex Implied Volatility (BVIV) candlestick data for the same period. The mean closing value for BVIV was 57.44, with a standard deviation of 11.16, reflecting substantial variation in implied volatility levels. The minimum and maximum values of BVIV were 33.68 and 111.89, respectively, indicating that the market experienced periods of both low and high volatility. The 25th, 50th, and 75th percentiles show that implied volatility frequently remained between 49.90 and 63.61, with extreme values occurring less frequently.

BVIV	mean	std	min	25%	50%	75%	max
open	57.44	11.16	33.77	49.90	56.87	63.61	109.67
high	57.68	11.23	34.09	50.10	57.08	63.90	111.89
low	57.20	11.10	33.68	49.72	56.65	63.34	107.01
close	57.44	11.16	33.77	49.90	56.87	63.61	109.67

Table 3: Summary of 1-hour BVIV candlestick data

Variable definitions

We run regressions to capture the effects of macroeconomic announcements on volatility. The dependent and independent variables are defined as follows::

- **Dependent Variables**:
  - **BTC Price Range**: The log difference between the High and Low prices within the 1-hour candlestick period, annualized, serving as a proxy for realized volatility.
  - **BVIV Range**: The difference between the High and Low values of BVIV within the same 1-hour period, annualized, also representing realized volatility of implied volatility.
  - **BVIV Change**: The difference between the closing and opening values of BVIV for each 1-hour period, indicating the change in implied volatility.

- **Independent Variables**:
  - **Event Dummies**: Binary variables representing the occurrence of macroeconomic announcements (CPI and Fed rate decisions). A value of 1 is assigned to the hour of the announcement and 0 otherwise.

Regression Analysis

The core of the analysis involves regressing the defined dependent variables on the event dummy variables. The model is specified as follows:

$$Y_t = \beta_0 + \sum_{i \in E} \beta_i \times 1_i + \epsilon_t$$

where Y_t represents the dependent variable (BTC price range, BVIV range, or BVIV change) at time t, β_0 is the intercept/constant, E is the set of scheduled macroeconomic events, β_i is the coefficient associated with the event i, 1_i values are event dummies, and ϵ_t is the error term.

Regression analysis is conducted to estimate the coefficients of the event dummies and assess the significance of the independent variables. A significance level of 99% is employed to ensure robust findings.

Results

In this section, we present the results of our regression analysis, which aims to quantify the impact of key macroeconomic announcements on both realized and implied volatility in the cryptocurrency market. We evaluate the effects on the price range of BTC as proxies for realized volatility and examine the changes in BVIV to assess shifts in implied volatility. The results are analyzed across multiple time windows (2-hour, 4-hour, 8-hour, 12-hour, and 24-hour) in addition to 1-hour and for ETH to ensure robustness and capture the temporal dynamics of market responses.

BTC Price Range

First, we regress, BTC price range, the log differences between BTC's high and low prices—used as a proxy for realized volatility—on macroeconomic event dummies. Table 4 presents the regression results, showing the variables with statistically significant impacts at the 99% confidence level. The results clearly indicate that CPI announcements and Fed rate decisions have the largest magnitudes of impact on BTC price volatility.

	coef	std err	t	P>|t|	[0.025	0.975]
const	50.7702	0.369	137.649	0.000	50.047	51.493
CPI	107.2970	9.904	10.834	0.000	87.885	126.709
Fed Decision	115.2896	11.767	9.798	0.000	92.226	138.354
Services	57.3667	9.895	5.797	0.000	37.971	76.763
Nonfarm Payrolls	52.6700	9.895	5.323	0.000	33.274	72.066
Powell Speech	46.1499	9.172	5.032	0.000	28.173	64.127
Sentiment	39.0505	9.895	3.946	0.000	19.655	58.446
Manufacturing	37.6664	9.895	3.806	0.000	18.271	57.062
Retail Sales	28.8900	10.028	2.881	0.004	9.233	48.547
Global Manufacturing	33.8619	12.952	2.614	0.009	8.474	59.250

Table 4: Regression on 1-hour BTC price range, only significant values at 99%

Following a CPI release, BTC's realized volatility increases by 107.3 points in the subsequent 1-hour window. Similarly, a Fed rate decision results in a 115.3-point rise in volatility during the same timeframe. These findings indicate that macroeconomic events, particularly CPI and Fed decisions, have strong influences on short-term volatility in the cryptocurrency market.

Other significant factors include announcements such as Services, Nonfarm Payrolls, Powell Speeches, and Sentiment, each contributing to variations in BTC realized volatility, albeit to a lesser degree compared to CPI and Fed decisions.

BVIV Range

Next, we analyze the impact of macroeconomic events on the fluctuations in implied volatility by regressing the BVIV range, defined as the difference between BVIV's high and low prices, on the macroeconomic event dummies. Table 5 presents the results, highlighting only the variables that are statistically significant at the 99% confidence level.

The results show that CPI announcements and Fed rate decisions have the most substantial effects on BVIV realized volatility. Following a CPI release, BVIV's range increases by 104.3 points within the 1-hour window. Similarly, a Fed rate decision raises BVIV volatility by 103.0 points. Other announcements, such as Nonfarm Payrolls, Sentiment, and Retail Sales, also contribute to increases in BVIV, though their impacts are smaller in magnitude.

	coef	std err	t	P>|t|	[0.025	0.975]
const	44.9894	0.424	106.228	0.000	44.159	45.820
CPI	104.3081	11.370	9.174	0.000	82.021	126.595
Fed Decision	103.0343	13.509	7.627	0.000	76.555	129.514
Nonfarm Payrolls	39.4001	11.361	3.468	0.001	17.132	61.668
Sentiment	34.7188	11.361	3.056	0.002	12.451	56.987
Retail Sales	33.0021	11.513	2.866	0.004	10.435	55.570

Table 5: Regression on 1-hour BVIV range, only significant values at 99%

These findings confirm that macroeconomic events, particularly CPI and Fed decisions, have a profound influence on implied volatility in the cryptocurrency market. This volatility suggests heightened uncertainty and market reaction to potential future BTC price fluctuations, further emphasizing the role of key economic indicators in shaping market expectations.

BVIV Levels

Finally, we analyze the changes in implied volatility levels by regressing the 1-hour change in BVIV (difference between the closing and opening BVIV levels within the 1-hour window) on macroeconomic event dummies. Table 6 displays the results, which shows only the significant coefficients at the 99% confidence level.

	coef	std err	t	P>|t|	[0.025	0.975]
CPI	-0.9379	0.121	-7.725	0.0	-1.176	-0.700
Fed Decision	-1.3206	0.144	-9.155	0.0	-1.603	-1.038

Table 6: Regression on 1-hour change BVIV levels, only significant values at 99%

The results indicate that only CPI and Fed rate decisions have a statistically significant effect, which are both negative, on BVIV levels. After a CPI announcement, the implied volatility decreases by approximately 0.94 points, indicating a resolution of uncertainty in the market. Similarly, after a Fed rate decision, BVIV levels drop by around 1.32 points.

These findings suggest that, while macroeconomic announcements lead to an initial spike in realized volatility (as seen in previous tables), they also result in a pullback of BVIV as market participants adjust their expectations. This reduction in implied volatilities indicates that uncertainty decreases following these announcements, with the market quickly pricing in the new information.

Robustness of the results

To ensure the reliability of the findings, we conduct robustness checks by expanding the time windows for both BTC and ETH price ranges, as well as BVIV and EVIV levels and ranges. These tests involved 2-hour, 4-hour, 8-hour, and 12-hour windows, and included an additional 1-hour ETH and EVIV windows to validate whether the observed impacts were consistent across different timeframes and assets. The results confirm the conclusions drawn from the 1-hour BTC and BVIV windows, while showing some interesting variations.

For the BTC price range, both CPI and Fed rate decisions remained statistically significant across all time windows. The magnitudes of the coefficients fell, with CPI showing a more pronounced effect in shorter windows, such as 2-hour and 4-hour, and gradually tapering off in the 8-hour and 12-hour windows. The Fed decision maintained its impact, peaked at 2-hour windows but displayed a similar diminishing effect over time, particularly in the 12-hour window.

ETH price range results from the 1-hour window yielded higher magnitudes for both CPI (123.0) and Fed decision (135.9), indicating that ETH may exhibit even greater sensitivity to these macroeconomic events in comparison to BTC. This suggests that cryptocurrency market reactions to scheduled announcements may vary slightly depending on the specific asset being observed, though the general trend holds true.

For the BVIV range, CPI and Fed decision impacts were observed to diminish as the window expands. The 2-hour and 4-hour windows exhibited strong, significant coefficients, but the 8-hour and 12-hour windows showed a notable reduction in magnitudes. By the 12-hour mark, the statistical significance of the Fed decision began to fade ($P>|t| = 0.104$), while CPI remained significant, confirming that the fluctuation triggered by CPI announcements continues beyond the immediate aftermath.

A final robustness check for BVIV levels, showed that CPI retained its statistical significance with an increasing magnitude over time. We extended the robustness analysis by including an additional 24-hour window which also showed a stronger CPI impact. This suggests that the decline in BVIV levels following a CPI release may persist for up to 24 hours. On the other hand, the Fed decision's influence faded, becoming statistically insignificant beyond the 8-hour mark.

In summary, the robustness checks confirm the initial results while highlighting that the magnitude and duration of the impacts from CPI and Fed rate decisions can vary across different windows. However, the consistent statistical significance of CPI in both price and implied volatility measures across all timeframes underscores its critical role in shaping market dynamics in cryptocurrency derivatives.

Conclusion

This study provides compelling evidence that the scheduled macroeconomic announcements, particularly CPI and Fed rate decisions, significantly impact both the realized and implied volatility of BTC in the cryptocurrency market. Through regressions of BTC price range and BVIV levels on macroeconomic event dummies, we have observed that these events consistently generate fluctuations in spot and options markets.

CPI and Fed decisions exhibit the largest impacts on BVIV levels, confirming that these events serve as key drivers of uncertainty resolution. Interestingly, while CPI triggers prolonged volatility, often lasting up to 24 hours, the effects of Fed decisions dissipate more quickly, particularly in implied volatility metrics.

The robustness checks using multiple time windows and the inclusion of ETH prices further validate these findings. As a result, traders and market participants may find opportunities in crafting strategies that anticipate price fluctuations arising from these key macroeconomic releases, particularly in the cryptocurrency derivatives space.

Appendix

Regression Results

Below are the full set of regression results

Model:	OLS	Adj. R-squared:	0.019
Dependent Variable:	BTC_1h_price_range_annual	AIC:	185862.7803
Date:	2024-09-20 18:00	BIC:	185979.3596
No. Observations:	17535	Log-Likelihood:	-92916.
Df Model:	14	F-statistic:	25.58
Df Residuals:	17520	Prob (F-statistic):	4.42e-67
R-squared:	0.020	Scale:	2346.8

	Coef.	Std.Err.	t	P>|t|	[0.025	0.975]
const	50.7702	0.3688	137.6490	0.0000	50.0472	51.4931
ADP Employment	9.4175	9.9289	0.9485	0.3429	-10.0440	28.8791
CPI	107.2970	9.9037	10.8340	0.0000	87.8847	126.7092
Core CPI	11.8960	12.5135	0.9507	0.3418	-12.6317	36.4237
FOMC Minutes	18.4913	12.1165	1.5261	0.1270	-5.2582	42.2409
Fed Decision	115.2896	11.7668	9.7979	0.0000	92.2256	138.3537
GDP	12.8321	9.9289	1.2924	0.1962	-6.6294	32.2936
Global Manufacturing	33.8619	12.9523	2.6143	0.0089	8.4741	59.2498
Manufacturing	37.6664	9.8954	3.8065	0.0001	18.2705	57.0624
Nonfarm Payrolls	52.6700	9.8954	5.3227	0.0000	33.2741	72.0659
PPI	12.2405	12.6714	0.9660	0.3341	-12.5967	37.0777
Powell Speech	46.1499	9.1715	5.0319	0.0000	28.1727	64.1270
Retail Sales	28.8900	10.0284	2.8808	0.0040	9.2334	48.5466
Sentiment	39.0505	9.8954	3.9463	0.0001	19.6546	58.4464
Services	57.3667	9.8954	5.7973	0.0000	37.9708	76.7627

Omnibus:	15131.457	Durbin-Watson:	0.953
Prob(Omnibus):	0.000	Jarque-Bera (JB):	713245.989
Skew:	3.950	Prob(JB):	0.000
Kurtosis:	33.229	Condition No.:	35

Table A1: Regression on 1-hour BTC price range

Model:	OLS	Adj. R-squared:	0.009
Dependent Variable:	BTC_1h_vol_range_annual	AIC:	190651.4046
Date:	2024-09-20 18:00	BIC:	190767.9797
No. Observations:	17530	Log-Likelihood:	-95311.
Df Model:	14	F-statistic:	12.76
Df Residuals:	17515	Prob (F-statistic):	1.77e-30
R-squared:	0.010	Scale:	3093.3

	Coef.	Std.Err.	t	P>|t|	[0.025	0.975]
const	44.9894	0.4235	106.2276	0.0000	44.1592	45.8195
ADP Employment	-11.0246	11.3992	-0.9671	0.3335	-33.3681	11.3189
CPI	104.3081	11.3703	9.1737	0.0000	82.0212	126.5950
Core CPI	-4.3420	14.3666	-0.3022	0.7625	-32.5020	23.8179
FOMC Minutes	4.8416	13.9108	0.3480	0.7278	-22.4249	32.1081
Fed Decision	103.0343	13.5093	7.6269	0.0000	76.5547	129.5138
GDP	3.2944	11.3992	0.2890	0.7726	-19.0491	25.6379
Global Manufacturing	3.3293	14.8704	0.2239	0.8228	-25.8182	32.4767
Manufacturing	12.6237	11.3607	1.1112	0.2665	-9.6445	34.8919
Nonfarm Payrolls	39.4001	11.3607	3.4681	0.0005	17.1320	61.6683
PPI	-16.4085	14.5478	-1.1279	0.2594	-44.9237	12.1067
Powell Speech	5.5603	10.5297	0.5281	0.5975	-15.0790	26.1996
Retail Sales	33.0021	11.5134	2.8664	0.0042	10.4346	55.5696
Sentiment	34.7188	11.3607	3.0560	0.0022	12.4506	56.9869
Services	13.6420	11.3607	1.2008	0.2298	-8.6262	35.9102

Omnibus:	32215.776	Durbin-Watson:	1.095
Prob(Omnibus):	0.000	Jarque-Bera (JB):	138277275.336
Skew:	13.247	Prob(JB):	0.000
Kurtosis:	437.294	Condition No.:	35

Table A2: Regression on 1-hour BVIV range

Model:	OLS	Adj. R-squared:	0.008
Dependent Variable:	BTC_1h_vol_retCO	AIC:	31493.2539
Date:	2024-09-20 18:00	BIC:	31609.8290
No. Observations:	17530	Log-Likelihood:	-15732.
Df Model:	14	F-statistic:	10.90
Df Residuals:	17515	Prob (F-statistic):	2.82e-25
R-squared:	0.009	Scale:	0.35268

	Coef.	Std.Err.	t	P>|t|	[0.025	0.975]
const	0.0022	0.0045	0.4815	0.6302	-0.0067	0.0110
ADP Employment	0.0702	0.1217	0.5770	0.5640	-0.1684	0.3088
CPI	-0.9379	0.1214	-7.7248	0.0000	-1.1758	-0.6999
Core CPI	0.0233	0.1534	0.1517	0.8794	-0.2774	0.3240
FOMC Minutes	-0.0582	0.1485	-0.3916	0.6954	-0.3493	0.2330
Fed Decision	-1.3206	0.1442	-9.1552	0.0000	-1.6034	-1.0379
GDP	0.1526	0.1217	1.2541	0.2098	-0.0859	0.3912
Global Manufacturing	-0.1896	0.1588	-1.1940	0.2325	-0.5008	0.1216
Manufacturing	-0.0786	0.1213	-0.6478	0.5171	-0.3164	0.1592
Nonfarm Payrolls	-0.1808	0.1213	-1.4907	0.1361	-0.4186	0.0569
PPI	-0.1609	0.1553	-1.0359	0.3003	-0.4654	0.1436
Powell Speech	0.0611	0.1124	0.5433	0.5869	-0.1593	0.2815
Retail Sales	0.0082	0.1229	0.0665	0.9470	-0.2328	0.2491
Sentiment	-0.0462	0.1213	-0.3806	0.7035	-0.2839	0.1916
Services	-0.1663	0.1213	-1.3712	0.1703	-0.4041	0.0714

Omnibus:	11585.260	Durbin-Watson:	1.843
Prob(Omnibus):	0.000	Jarque-Bera (JB):	3277702.588
Skew:	2.051	Prob(JB):	0.000
Kurtosis:	69.863	Condition No.:	35

Table A3: Regression on 1-hour change in BVIV levels