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Expectations of Macroeconomic News Announcements: Bitcoin vs. Traditional Assets

Ivan Mužić [1] and Ivan Göžeta [2,*]

1 Bayes Business School, City University of London, London EC1V 0HB, UK; ivan.muzic@bayes.city.ac.uk
2 Faculty of Economics and Business, University of Rijeka, 51000 Rijeka, Croatia
* Correspondence: ivan.grzeta@efri.hr

Abstract: Research on cryptocurrencies has proliferated in recent years. Our research objective was to answer the question of whether macroeconomic news from the U.S. affects Bitcoin in the same way it affects other common investment assets such as gold, the S&P 500, 2-year Treasury bills, and 10-year Treasury bills. Following previous research, seven macroeconomic news announcements from the U.S. were selected, and an empirical analysis of the daily returns, volatility, and volume of the selected assets was conducted. The results show that while Bitcoin is the most volatile (i.e., riskiest) of all the assets, the expected direction of movement is visible after the official announcement of the macroeconomic news on that day, and is comparable to that of the 2-year Treasury bills. It is also evident that the trading volume of Bitcoin does not change, unlike other assets, suggesting that the price of Bitcoin is always moved by the same players, indicating the closed and, therefore, riskier nature of cryptocurrency markets. Finally, we found evidence that the impact of macroeconomic announcements on Bitcoin returns is stronger when the announcements are negative but, interestingly, the returns of Bitcoin, unlike those of other assets, are more volatile after positive announcements.

Keywords: U.S. macroeconomic news; Bitcoin; traditional assets; risks

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1. Introduction

Since their introduction, cryptocurrencies have attracted a great deal of interest from investors and the public. Unlike fiat money, which is tied to the economy of the issuing country, cryptocurrencies are fully decentralized. This type of decentralized currency raises questions about market value, i.e., whether the currency is driven by supply and demand (Ciaian et al. 2016), investor sentiment (Khuntia and Pattanayak 2018; López-Cabarcos et al. 2021), the market movements of stock indices/gold/oil (Bayramoğlu and Başarır 2019; Teker et al. 2020), or other financial variables. Some previous studies tended to consider cryptocurrencies to be a highly profitable speculative asset (Fry and Cheah 2016; Fry 2018; Corbet et al. 2019; Sajter 2019), while other authors believe that cryptocurrencies can be used as a hedge (Dyhrberg 2016; Chemkha et al. 2021; Choi and Shin 2021; Cocco et al. 2022). Some authors argue that investing in cryptocurrencies can provide long-term sustainability and resilience against geopolitical risks (Aysan et al. 2021), and that the returns have been increasing throughout the COVID- pandemic 19 (Yan et al. 2022), acting similarly to the S&P 500 index (Allen 2022).

Our main motivation was to find similarities between the crypto market and the traditional market, i.e., to find out whether the price of Bitcoin is affected by the same macroeconomic announcements as the prices of stock indices, gold, or Treasury bonds. In this way, we aimed to answer the question of whether Bitcoin behaves like other traditional assets in the context of macroeconomic news. Our main hypothesis was therefore as follows: Bitcoin is affected by the expectations of macroeconomic news announcements in the same way as other traditional assets. In this paper, we examine the impact of macroeconomic announcements in the U.S. on Bitcoin, gold, the S&P 500, 2-year Treasury bills, and 10-year Treasury bills.

Even though there is a lot of research on cryptocurrencies, it is still difficult to determine the causes of price/volume/volatility changes in the market, because cryptocurrencies have no intrinsic value. One possible measure is to calculate the impact of macroeconomic news that has been shown to affect other asset classes. Along with other asset classes, Bitcoin can be placed in the same context to find similarities with traditional assets, and potentially provide an answer to the reasons for its price movements in the market.

After defining our research objective, a comprehensive analysis of the literature and previous research was conducted. Based on the previous literature review, a hypothesis was defined, and secondary data were collected, which are available online for free, facilitating possible replication of the data for future research. The widely used GARCH method was used to conduct an analysis, and hypotheses were tested, based on which the results were interpreted and conclusions were drawn.

Previous research has already considered the impact of specific macroeconomic news on various asset classes, as covered in more detail in the Literature Review. This work complements previous research by examining the impact of macroeconomic announcements (i.e., positive or negative shocks) on the returns, volatility, and trading volume of cryptocurrencies—in our case Bitcoin—compared to more traditional assets.

We found that macroeconomic announcements affect Bitcoin's returns, but not its trading volume. Since there is no adequate measure of cryptocurrency valuation, we can say that announcements can be used as price setters for Bitcoin, but they do not change the trading volume, indicating that this market is still closed and moved by the same players—unlike the stock market, whose returns and volume are changed by macroeconomic announcements.

This paper consists of six sections: After the introduction and literature review, Section 3 describes the data and methodology. Section 4 discusses the empirical results, and provides an economic interpretation of the results, while Section 5 provides discussion on the results as well as comparison with previous research. Section 6 draws conclusions, formulates implications, and provides recommendations for further research.

2. Literature Review

The impact of macroeconomic indicators and news is widely used in the financial world. There are many studies and different methods to calculate the impact of different announcements on the stock market (Syed and Bajwa 2018; Lyócsa et al. 2019; Beckmeyer et al. 2020; Funashima et al. 2020), bonds (Mutize and Gossel 2018; Afonso et al. 2020; Kenourgios et al. 2020; Sever et al. 2020), commodities (Aharon and Qadan 2018; Cai et al. 2020; Liang et al. 2021; McKenzie and Ke 2021), and foreign exchange rates (Bauwens et al. 2005; Chen and Gau 2010; Marshall et al. 2012; Boudt et al. 2019; Ayadi et al. 2020).

The implications are many, but the research problem for cryptocurrencies is more complex, as there is an ongoing debate about whether cryptocurrencies are a medium of exchange or a store of value (Baur et al. 2018; Mattke et al. 2020; Baur and Dimpfl 2021; Pernice et al. 2021).

The popularity of trading cryptocurrencies is constantly increasing. The reason for this is their availability to non-professional investors—unlike stocks, bonds, and other traditional assets, whose availability can be limited. In addition, Dyhrberg et al. (2018) provided evidence that the average quoted and effective spreads for Bitcoin are lower than the spreads on major exchanges, suggesting that Bitcoin is highly investable for retail investors.

Previous research has attempted to find numerous reasons for the movement of cryptocurrencies in the market. From the commonly used Google Trends (Urquhart 2018; Aalborg et al. 2019; Dastgir et al. 2019)—which essentially proves that Google searches do not influence price, but price influences Google searches—to the influence of news about the currencies themselves (Corbet et al. 2020; Ben Omrane et al. 2021), investor sentiment (Khuntia and Pattanayak 2018), hacker attacks (Lyócsa et al. 2020), and policy uncertainty (Demir et al. 2018; Shaikh 2020; Haq et al. 2021).

Our work focuses only on the U.S. macroeconomic announcements, adding to the existing literature on the impact of U.S. macroeconomic announcements on bitcoin returns/volatility/volume compared to those of other financial assets.

Since cryptocurrencies are traded all over the world throughout the day, some authors, such as Al-Khazali et al. (2018), have analyzed the impact of macroeconomic surprises beyond the borders of the U.S., including Canada, the Eurozone, the U.K., and Japan. However, traditional currencies have been shown to be more influenced by news from the U.S. than by news from the country of the currency pair (Ranaldo and Söderlind 2010). Following this idea, Corbet et al. (2018, 2020) and Lyócsa et al. (2020) only used news/macroeconomic announcements from the United States of America when analyzing cryptocurrencies. It should be noted that Dyhrberg et al. (2018) have demonstrated that the highest trading activity, volatility, and spreads coincide with the trading hours of the U.S. market; thus, we use their conclusions for our analysis, where only U.S. macroeconomic announcements are considered relevant.

Although Bitcoin has been around for over 10 years, cryptocurrencies are a novelty in mainstream investing for both retail investors and institutions. As a result, market volatility is high, with some short periods of stability. Any adjustment to the observed period can have a significant impact on results. Therefore, the entire period for which data are available should be considered, including both periods of stability and periods of high volatility. For example, Lyócsa et al. (2020) and Pyo and Lee (2020) observed prices through 2018, while Corbet et al. (2020) observed prices through 2019, leaving the volatile period after 2019 unexplored. In addition, Nguyen (2021) showed how shocks from the stock market affect Bitcoin volatility during periods of high uncertainty, while the stock market has no effect on Bitcoin during periods of low and medium uncertainty. Since such periods of uncertainty occurred after 2019, it makes sense to study the impact of macroeconomic news on the cryptocurrency market after 2019.

We are aware of the fact that Bitcoin is influenced by various elements—both general market movements/decisions (regulation, macroeconomic trends, etc.) and crypto-specific ones (hacker attacks, newspaper articles related to the specifics of cryptocurrencies, etc.)—but the aim of this work is to focus on macroeconomic news announcements and their impact. We try to contribute to the theoretical debates on the relationship between announcements and crypto returns/volatility/volume compared to those of traditional assets. Table 1 provides an overview of the main findings and a dataset of the influential studies on the impact of macroeconomic news/announcements on cryptocurrencies.

Table 1. Studies of the impact of macroeconomic news/announcements on cryptocurrencies.

Authors	Period	Dataset	Main Findings
Al-Khazali et al. (2018)	2010–2017	U.S.A., Canada, Eurozone, U.K., and Japan	Macroeconomic news differently affected gold and BTC returns and volatility
Ben Omrane et al. (2021)	2016–2019	U.S.A., Germany, and Japan	U.S. news releases were more associated with jumps than German and Japanese news
Corbet et al. (2020)	2010–2019	U.S.A.	Positive news about unemployment and durable goods, unlike for equity returns, had negative impacts on BTC
Gurrib et al. (2019)	2017–2018	U.S.A., U.K., and Europe	Selected macroeconomic news announcements were important factors that did not affect the volatility observed in the cryptocurrencies' prices
Lyócsa et al. (2020)	2013–2018	U.S.A.	Volatility of bitcoin was not influenced by most scheduled U.S. macroeconomic news announcements

Table 1. *Cont.*

Authors	Period	Dataset	Main Findings
Pyo and Lee (2020)	2010–2018	USA	Bitcoin's price dropped on the day of announcements because it increased on the day before, and independently moved after that; claiming that macroeconomic announcements have a significant effect on the price of Bitcoin is difficult

Source: authors.

3. Materials and Methods

The dataset contains two types of data: The first is the prices of 5 assets (Bitcoin, gold, the S&P 500 index, 2-year Treasury bills, and 10-year Treasury bills) in the period from 01/01/2015 to 29/11/2021, with a daily frequency. The second type of data is release dates and information on seven types of U.S. macroeconomic announcements (non-farm payrolls, retail sales, inflation rates, core inflation rates, durable goods orders, personal spending, and personal income). In (McQueen and Roley 1993; Flannery and Protopapadakis 2002; Galati and Ho 2003; Kim et al. 2004), these seven macroeconomic announcements were shown to have an impact on stock prices, exchange rates, and bond yields. The reason for choosing the seven-year period was the robustness of the results. All of the data analyzed in this study are available online for free, which contributes significantly to the quality of the study and to the possibilities of future studies. The year 2015 was chosen as the baseline year, because that is when Bitcoin began to enter the mainstream media and make significant market movements, even though it was not yet traded by major traders. Based on our research objective to investigate whether the crypto market and the other traditional markets respond to macroeconomic news in different ways, the aforementioned announcements were used for comparison.

Specifically, we wanted to investigate whether macroeconomic announcements from the U.S. have a significant impact on Bitcoin's returns, volatility, and trading volume compared to more traditional assets. Gold, for example, is generally perceived as a safe haven. Therefore, we do not expect significant changes in the price of gold in response to positive macroeconomic news. Similarly, we do not expect the yield on 10-year T-bills to react to macroeconomic announcements but, on the other hand, we do expect 2-year T-bills to react to macroeconomic news. The maturities (10-year and 2-year T-bills) were chosen because the difference (spread) between the yields on the 10-year and 2-year Treasury bills is widely used to assess the differences between short/medium-term and long-term investor expectations. Therefore, macroeconomic announcements are not expected to affect long-term expectations, but short- and medium-term expectations are. Overall, we expect Bitcoin to be more responsive to macroeconomic announcements compared to traditional financial assets (see Table 2 for summary statistics).

Table 2. Summary statistics of the 5 assets.

	Bitcoin *	Gold *	S&P 500 *	2Y T-Bill **	10Y T-Bill **
Mean	0.0021	0.0004	0.0005	0.0000	−0.0004
St Dev	0.0402	0.0264	0.0114	0.0288	0.0465
Min	−0.4973	−0.1708	−0.1277	−0.2048	−0.3040
Max	0.2408	0.1413	0.0897	0.1376	0.3490

* Delta-log transformation (log returns), ** differences. Source: authors.

It is important to note that the summary statistics for Treasury bills are not comparable to those for Bitcoin, gold, and the S&P 500, because the statistics for Treasury bills are calculated based on return differences, while the statistics for Bitcoin, gold, and the S&P 500 are calculated based on log-returns. For example, the maximum value for Bitcoin in Table 2 corresponds to a 24% price increase over the previous day, while the maximum value for 2-year Treasury bills corresponds to a 0.14% increase in yield over the previous day. Nevertheless, valuable information can be derived from Table 2.

The mean of the daily log-returns (or the mean of the differences for bonds) is expected to be zero for all financial assets. However, the mean for Bitcoin, gold, and the S&P 500 is slightly positive, because these assets have a long-term upward trend. For example, the price of Bitcoin has increased 300-fold in the period from 01/01/2015 to 29/11/2021, and it is therefore not very surprising that its mean daily return is 0.2%. On the other hand, the 2-year Treasury bill has the expected mean value, i.e., zero, while the 10-year Treasury bill has a negative mean value, indicating a long-term downward trend. This negative trend is not a surprise, as it can be seen even for years before the observed period.

The most volatile asset in the analysis was Bitcoin (standard deviation of daily log returns = 4%), while the most stable was the S&P 500 (standard deviation of daily log returns = 1%). Bitcoin had the sharpest daily decline (−50%) on 12 March 2020 (during the COVID-19 market crash), while the S&P 500 had the mildest crash compared to other assets (only −13%). This is consistent with common sense—the riskier (i.e., more volatile) assets have greater downside potential, but also greater upside potential. Accordingly, Bitcoin had the largest return in one day (24%), while the S&P 500's largest return in one day was nearly three times lower than that of Bitcoin (9%). Gold's volatility is between that of Bitcoin and the S&P 500; thus, its minimum and maximum values are always in between those of the latter two. Therefore, the extreme values and standard deviations of Bitcoin, gold, and the S&P 500 are fully consistent with the mean variance theory.

Even though the standard deviation of the 2-year Treasury bills is lower compared to the 10-year Treasury bills, this does not mean that the 10-year Treasury bills are more volatile than the 2-year Treasury bills. The daily differences are absolute values (not relative), and since the 10-year yield is always higher than the 2-year yield, the standard deviation and extreme values are also larger.

To examine the impact of the news on asset prices, we needed the announcements data, which we took from Trading Economics forecasts[1]. As mentioned earlier, we used data from seven types of macroeconomic announcements, as summarized in Table 3.

Table 3. Summary about US macro announcements used in the analysis.

Announcement	Frequency	Number	Positive Shock	Negative Shock
Non-Farm Payrolls	Monthly	83	45	38
Retail Sales	Monthly	83	38	45
Inflation Rate	Monthly	83	53	30
Core Inflation Rate	Monthly	83	57	25
Durable Goods Orders	Monthly	83	46	37
Personal Spending	Monthly	82	49	33
Personal Income	Monthly	82	60	22

Source: authors.

Since the release frequency for all announcements is monthly, there were 83 releases for all announcements except for personal spending and personal income (82 releases each). However, looking at the number of positive shocks (i.e., when the actual value is larger than the expected value) and the number of negative shocks (i.e., when the actual value is smaller than the expected value), the proportions of each announcement are very different.

Multiple announcements on the same dates can potentially cause the problem of multicollinearity, which makes it impossible to estimate the parameters because the data matrix would not have the full rank. The multicollinearity problem is even more likely when very similar announcements are released on the same day, such as inflation rate and core inflation rate, or personal income and personal spending. Nevertheless, this was not a problem in our analysis, because similar events do not always have the same signs after separation into positive and negative shocks. When we look at the first inflation announcement in our sample (16 January 2015), core inflation was lower than expected, while the total inflation rate was higher than expected. This is possible because energy and food prices do not necessarily move in the same direction as the subcomponents of core inflation. Moreover, the personal spending announcements had a negative shock 33 times (out of 82) in our sample, while similar announcements on personal income had a negative shock only 22 times (out of 82). Thus, it is important to point out that different signs of similar announcements are a normal situation rather than an exception.

Methodology

On the announcement date, we define announcement surprise or shock S_t as the difference between the actual value Z at time t and the expectation of Z at $t-1$:

$$S_t = Z_t - E_{t-1}(Z_t) \tag{1}$$

To account for the possible asymmetric effect of shocks (e.g., that negative shocks have a stronger impact on returns, volatility, and asset volume than positive shocks), we partitioned positive and negative shocks using two dummy variables for each announcement, as described by Kim et al. (2004). When the shock is positive, the positive dummy variable for each announcement takes the value of 1 on that day, while it takes the value of 0 on any other day. On the other hand, if the shock is negative, a separate dummy variable takes the value -1 on the day of the negative shock, and 0 on all other days. Thus, there were a total of 14 dummy variables for announcements (7 for positive announcements and 7 for negative announcements).

Since we wanted to test the significance of both returns and volatility, the GARCH model of Bollerslev (1986) was appropriate. Following in the footsteps of Flannery and Protopapadakis (2002); Kim et al. (2004); Pyo and Lee (2020), we also used dummy variables for events as external regressors in GARCH. To control for possible effects of specific days in a week, we also used weekly dummy variables for Monday through Thursday, as was done by Flannery and Protopapadakis (2002); Galati and Ho (2003) in the case of stocks and exchange rates, and by Corbet et al. (2020) in the case of Bitcoin.

Following the efficient market hypothesis (i.e., that price changes are a random process and past returns are not useful for predicting future returns), we assumed that the underlying process was ARMA (0, 0).

To account for the stylized features of financial series (i.e., fat tails and asymmetry), we also used innovations from the skewed GED distribution. In addition, asymmetry in volatility clustering was also expected (i.e., higher autocorrelation in volatility after negative news than after positive news); therefore, GJR-GARCH (1, 1) was most appropriate, as it accounts for asymmetric effects in the volatility equation.

More formally, the mean equation is as follows:

$$\Delta ln(P_t) = \mu + \sum_{i=MON}^{THU} \beta_{1,i} d_i + \sum_{i=ANN1}^{ANN7} \beta_{2,i} S_{i,t}^{P} + \sum_{i=ANN1}^{ANN7} \beta_{3,i} S_{i,t}^{N} + u_t \tag{2}$$

$$u_t = \sigma_t e_t,$$

where $e_t \sim i.i.d\ skewed\ GED\left(\mu_p, \sigma_p, \lambda_p, p\right)$.

Meanwhile, the volatility equation is as follows:

$$\sigma_t^2 = \omega + \alpha e_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma e_{t-1}^2 I_{t-1} + \sum_{i=MON}^{THU} \beta_{1,i} d_i + \sum_{i=ANN1}^{ANN7} \beta_{2,i} S_{i,t}^{P} + \sum_{i=ANN1}^{ANN7} \beta_{3,i} S_{i,t}^{N} \tag{3}$$

Notation:

P_t—Price of the asset;

$S^P_{i,t}$ and $S^N_{i,t}$—Positive and negative dummy variables, respectively, for announcement *i*;

d_i—Weekly dummy variables (Monday to Thursday);

I_{t-1}—Indicator variable with a value of 1 if $e_{t-1} \leq \mu$ and a value of 0 if $e_{t-1} > \mu$;

μ, ω, γ—Mean return, mean volatility, and asymmetry parameter (of volatility), respectively.

We expected the assets to react to the announcements and, therefore, to have significant changes in daily log-returns and volatility during announcement dates. Therefore, under the null hypothesis, β coefficients were expected to be statistically equal to zero:

$$H_0 : \beta = 0 H_1 : \beta \neq 0$$

4. Results and Discussion

The returns and volatility of a total of five assets, and the volume of three assets (due to missing data), were analyzed on a daily basis during the period from 01/01/2015 to 29/11/2021. In addition, seven types of U.S. macroeconomic announcements were observed during the same period, and divided into positive and negative shocks. After each table, our main results are presented, and at the end of the chapter, the results are compared with those of previous research.

4.1. Impact of U.S. Macroeconomic Announcements on Returns and Volatility

The results of Equation (2)—i.e., the impact of U.S. macroeconomic announcements on asset returns—are summarized in Table 4. In general, we can draw conclusions by simply counting the number of asterisks in the table. As expected, most announcements affected Bitcoin returns (12 significant coefficients, and most of them at the 1% significance level), while the S&P 500 had the lowest response to U.S. macroeconomic announcements (5 significant coefficients). Gold had seven significant coefficients, and 10-year Treasury bills had six coefficients. Just like Bitcoin, the 2-year Treasury bills had 12 significant coefficients (but with a slightly lower number of announcements at the 1% level). As expected, the 2-year Treasury bills responded significantly more (similar to Bitcoin) than the 10-year Treasury bills.

Table 4. Impact of the U.S. announcements on the observed assets' returns.

	Bitcoin	Gold	S&P 500	2Y T-Bill	10Y T-Bill
μ	0.0023 (0.0001) ***	−0.0003 (0.0002)	0.0002 (0.0001) ***	−0.0008 (0.0001) ***	−0.0041 (0.0023) *
Monday	−0.0012 (0.0001) ***	0.0002 (0.0005)	0.0002 (0.0001) ***	0.0024 (0.0005) ***	0.0076 (0.0032) **
Tuesday	−0.0013 (0.0003) ***	−0.001 (0.0004) **	−0.0005 (0.0001) ***	0.0026 (0.0006) ***	0.0037 (0.0031)
Wednesday	−0.0018 (0.0004) ***	0.0003 (0.0003)	−0.0001 (0.0002)	0.0019 (0.0003) ***	0.0055 (0.0031) *
Thursday	−0.0023 (0.0001) ***	−0.0004 (0.0014)	0.0001 (0.0001)	−0.0002 (0.0001)	0.0014 (0.0032)
Non-Farm Payrolls_P	0.0015 (0.0002) ***	−0.0054 (0.0013) ***	0.004 (0.0007) ***	0.0057 (0.0007) ***	0.0285 (0.0072) ***
Retail Sales_P	0.0009 (0.0008)	−0.0074 (0.0011) ***	0.0001 (0.0003)	0.0019 (0.0008) **	0.0033 (0.0068)
Core Inflation Rate_P	−0.0028 (0.0006) ***	0.007 (0.0012) ***	0.0007 (0.0008)	−0.0006 (0.0003) **	−0.0025 (0.0056)
Inflation Rate_P	0.0002 (0.0001) ***	0.0044 (0.0025) *	0.0004 (0.0006)	−0.0039 (0.0005) ***	−0.0116 (0.006) *
Durable Goods Orders_P	0.0078 (0.0005) ***	−0.0017 (0.0042)	0.0003 (0.0004)	0.0059 (0.0029) **	0.0122 (0.0057) **
Personal Spending_P	0.0033 (0.0003) ***	0.0001 (0.0019)	0.0006 (0.0007)	−0.0061 (0.0006) ***	−0.0101 (0.0058) *
Personal Income_P	0.0004 (0.0001) ***	−0.0006 (0.0035)	−0.0006 (0.0002) ***	−0.0062 (0.0006) ***	−0.0055 (0.0058)
Non-Farm Payrolls_N	−0.0059 (0.0004) ***	−0.0045 (0.0046)	−0.0017 (0.0007) **	−0.0001 (0.0035)	−0.0012 (0.0079)
Retail Sales_N	0.0032 (0.0015) **	−0.0027 (0.0025)	0.0003 (0.0007)	0.0065 (0.0038) *	0.0118 (0.0055) **
Core Inflation Rate_N	−0.0015 (0.0006) **	−0.0044 (0.0012) ***	−0.0003 (0.0005)	0.0107 (0.0015) ***	0.028 (0.0077) ***
Inflation Rate_N	0.0019 (0.001) *	−0.0127 (0.0012) ***	−0.0011 (0.0008)	0.01 (0.0007) ***	0.0124 (0.0087)
Durable Goods Orders_N	−0.0002 (0.0027)	0.0011 (0.0006) *	0.0024 (0.0005) ***	−0.0006 (0.0003) **	0.0034 (0.0065)
Personal Spending_N	−0.0057 (0.0009) ***	0.0079 (0.0065)	0.001 (0.0004) ***	0.0031 (0.001) ***	−0.004 (0.0079)
Personal Income_N	−0.0047 (0.0018) **	0.0017 (0.0054)	−0.0005 (0.0007)	0.0036 (0.004)	0.0056 (0.0082)

Note: standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: authors.

Overall, all assets had a mean return that was different from zero, which is almost entirely consistent with the summary statistics in Table 2. When we looked at the significance of the days of the week, the results were not consistent across assets. In the case of Bitcoin, all weekly dummies were significant, meaning that historically there are differences in returns on certain days of the week. Moreover, in the case of Bitcoin, the sign was negative for all days, meaning that the highest returns are usually on Fridays. The interpretation is as follows: Compared to Friday, the return on Monday is lower by 0.12% on average. A very similar conclusion was drawn for the 2-year Treasury bills, but the sign was the opposite, meaning that the lowest returns on average were on Fridays. Unlike bitcoin and 2-year Treasury bills, gold had only one day with significantly different returns—Tuesday.

Positive shocks regarding non-farm payrolls increased Bitcoin log-returns by 0.15% on average, while negative shocks regarding non-farm payrolls did not affect Bitcoin returns. Announcements of higher-than-expected retail sales negatively affected Bitcoin returns, while lower-than-expected retail sales positively affected Bitcoin returns. This is not what was expected, but such a paradox can be explained by investors believing that most of the funds will then flow into the real sector, affecting the value of companies in the market; hence, the concern about withdrawing funds from the crypto portfolio.

Next, for inflation and core inflation rate, if the realized value is greater than expected (which is bad news in principle, but marked with _P in the appendix in our analysis), the price of Bitcoin reacts with mixed movements (unlike gold), which is not consistent with the results of Choi and Shin (2021), who confirmed the inflation-hedging properties of Bitcoin claimed by investors.

Higher personal income and higher personal spending than expected did not affect the price of Bitcoin, while lower personal income and lower spending than expected negatively affected the price of Bitcoin, indicating concerns about further investment in such a volatile market. There is also the possibility of a symmetric reaction, regardless of whether the shock is positive or negative. For example, both positive and negative shocks to non-farm payrolls negatively impacted the price of gold.

We can see that Bitcoin moves in some ways independently of other traditional assets. Interestingly, most of the similarities between Bitcoin and other traditional assets in the event of negative macroeconomic news are not, as expected, between Bitcoin and gold, but between Bitcoin and 2-year Treasury bills. Both asset classes are most influenced by macroeconomic news from the U.S., with the main difference being personal spending and personal income announcements, where they both move significantly—but in opposite directions—for both positive and negative news. Even if the signs for Bitcoin and 2-year Treasury bills are in most cases opposite, those two assets actually react in the same direction. The sign is opposite because the dependent variable for Bitcoin is the price, while for Treasury bills the dependent variable is the yield (which moves in the opposite direction to the price). Therefore, in most cases, Bitcoin and 2-year Treasury bills react in the same direction.

The results of the Equation (3) are summarized in Table 5. As can be seen, there is no significant coefficient of any announcement to any asset. Therefore, we can conclude there is no effect of U.S. macroeconomic announcements on volatility of the assets.

However, the results from Table 5 are important because of the other parameters in our model. The significance of the coefficient's alpha, beta, and gamma from Equation (3) means that GJR-GARCH is a well-chosen model specification. Gamma is non-significant only for gold, which means that there is no difference in the accumulation of volatility after positive and negative shocks. In the case of the S&P 500 and the 2- and 10-year Treasury bills, volatility is higher and more consistent after negative shocks than after positive shocks, which is to be expected. However, in the case of Bitcoin, the opposite is the case, even though the maximum daily decline is higher than the maximum daily increase. This difference may possibly be due to the huge media exposure and the relatively closed crypto community, which is more active during the uptrend than during the downtrend (commonly known as the "HODL" strategy, which can provide investors with more security, as they are not exposed to short-term volatility and can avoid the risk of buying high and selling low).

In addition, the coefficients for skewness and shape show that the GED distribution (of innovations) is positively skewed (i.e., values ranging from 0.8 to 0.99) and leptokurtic (i.e., values less than 2) for all assets.

Table 5. Impact of the U.S. announcements on the observed assets' volatility.

	Bitcoin	Gold	S&P 500	2Y T-bill	10Y T-bill
Alpha1	0.1138 (0.0132) ***	0.0277 (0.0071) ***	0.0657 (0.0018) ***	0.0393 (0.0003) ***	0.0484 (0.0037) ***
Beta1	0.8902 (0.0000) ***	0.9642 (0.0000) ***	0.756 (0.0004) ***	0.9253 (0.0000) ***	0.9195 (0.0000) ***
Gamma1	−0.0283 (0.0157) *	0.0097 (0.0131)	0.3328 (0.0021) ***	0.0737 (0.0027) ***	0.0579 (0.0076) ***
Monday	0.0000 (0.0003)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Tuesday	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Wednesday	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0000)
Thursday	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Non-Farm Payrolls_P	0.0000 (0.0004)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Retail Sales_P	0.0000 (0.0007)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Core Inflation Rate_P	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Inflation Rate_P	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Durable Goods Orders_P	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Personal Spending_P	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Personal Income_P	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Non-Farm Payrolls_N	0.0000 (0.0003)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0000)
Retail Sales_N	0.0000 (0.0003)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0001)	0.0000 (0.0001)
Core Inflation Rate_N	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0002)	0.0000 (0.0001)
Inflation Rate_N	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0002)	0.0000 (0.0001)
Durable Goods Orders_N	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0003)	0.0000 (0.0001)
Personal Spending_N	0.0000 (0.0002)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0004)	0.0000 (0.0001)
Personal Income_N	0.0000 (0.0004)	0.0000 (0.0001)	0.0000 (0.0000)	0.0000 (0.0005)	0.0000 (0.0001)
Skew	0.999 (0.0069) ***	0.9798 (0.019) ***	0.8279 (0.0188) **	0.8891 (0.028) ***	0.9781 (0.0349) ***
Shape	0.8925 (0.0431) ***	1.1761 (0.0498) ***	1.3173 (0.0278) **	1.2844 (0.0567) ***	1.5428 (0.0725) ***

Note: standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: authors.

For all assets, there were no major problems with the diagnostic tests. The null hypothesis of serial correlation in the residuals and squared residuals (weighted Ljung–Box test) was rejected for all estimates. Similarly, the null hypothesis of no autoregressive conditional heteroskedasticity in the residuals (Engle's ARCH LM test) was not rejected, indicating that GARCH (p, q), where $p = 1$ and $q = 1$, was sufficient to remove all ARCH effects for all assets. The null hypothesis that the coefficients are constant over time (Nyblom stability test) was not rejected in most cases. There was only a small specification error in the sign and bias test (by Engle and NG) for the S&P 500, meaning that the squared residuals can be predicted by other variables (i.e., past values) not included in the model. For the other four assets, there was no misspecification with respect to the sign and bias test. Moreover, in most cases, the null hypothesis that there is no difference between the empirical and theoretical distribution of the residuals (adjusted Pearson goodness-of-fit test) was not rejected.

4.2. Impact of U.S. Macroeconomic Announcements on the Trading Volume

To get a complete picture of the different responses of Bitcoin and traditional assets to macroeconomic announcements, it was essential to also include the trading volume of the assets as a dependent variable, which was missing in previous studies. It seems logical that significant price changes are also supported by higher trading volume.

The impact of macroeconomic announcements on trading volumes was examined in a similar manner, except that we excluded 2-year and 10-year Treasury bills because reliable data on fixed-income trading volumes were not available. Therefore, we used the same specification from Equation (2) for Bitcoin, the S&P 500, and gold, with delta-log volume as the dependent variable. However, some modifications were required due to serial correlation—periods of low trading volume are usually followed by low volume, and after a significant increase in volume, higher volume is also expected in the next few days. Therefore, the underlying model was ARMA (1, 1) (and not ARMA (0, 0), as in the case of return and volatility) to account for "volume clustering". For the S&P 500, it was not sufficient to remove the serial correlation itself with the specification $p = 1$, $q = 1$; therefore, the underlying process for the S&P 500 was ARMA (2, 1). In addition, the innovations were assumed to come from a skewed normal distribution (since it is known that the distribution of returns is not normal, the GED distribution was used; however, the distribution of log-volume is normal, which can be determined by performing any normality test for volume data). For significant variables, we expected positive coefficients because the rule of thumb is that there is higher trading activity during announcements.

The results of the mean equation are shown in Table 6.

Table 6. Impact of the U.S. announcements on the observed assets' volume.

	Bitcoin	**Gold**	**S&P 500**
μ	−0.0602 (0.0103) **	−0.0004 (0.0213) **	−0.0007 (0.0085) ***
AR(1)	0.3567 (0.0346) **	0.3423 (0.0294) **	0.4202 (0.0358) **
AR(2)	–	–	0.1104 (0.0263) **
MA(1)	−0.8237 (0.0178) **	−0.8808 (0.0163) **	−0.9148 (0.0189) **
Monday	0.2905 (0.0282) **	0.0496 (0.0305) **	−0.0527 (0.0118) **
Tuesday	0.1038 (0.0272) **	0.0488 (0.0299) **	0.0431 (0.0112) **
Wednesday	0.0845 (0.0264) **	−0.0239 (0.0294) **	0.0222 (0.0112) **
Thursday	0.0036 (0.0279) **	−0.029 (0.0313) **	−0.0061 (0.014) **
Non-Farm Payrolls_P	−0.0071 (0.0471)	−0.0654 (0.0413)	−0.0512 (0.0167) ***
Retail Sales_P	−0.0231 (0.0514)	0.0371 (0.0479)	0.0281 (0.0198)
Core Inflation Rate_P	0.0327 (0.0452)	−0.0595 (0.0377)	−0.0233 (0.0162)
Inflation Rate_P	0.0354 (0.0467)	−0.0442 (0.0393)	−0.0159 (0.0161)
Durable Goods Orders_P	−0.0475 (0.0480)	−0.0374 (0.0497)	0.0733 (0.0198) ***
Personal Spending_P	0.0383 (0.0704)	−0.0338 (0.0405)	0.0459 (0.0182) **
Personal Income_P	−0.0487 (0.0632)	−0.0406 (0.037)	0.0314 (0.0184) *
Non-Farm Payrolls_N	0.1911 (0.0735) ***	0.0499 (0.0422)	0.0865 (0.015) ***
Retail Sales_N	−0.0009 (0.0485)	−0.0634 (0.0385) *	−0.0126 (0.0164)
Core Inflation Rate_N	−0.0106 (0.0526)	0.0574 (0.0393)	−0.0032 (0.0198)
Inflation Rate_N	0.0396 (0.0462)	0.0369 (0.0472)	0.023 (0.021)
Durable Goods Orders_N	−0.0072 (0.0511)	0.037 (0.0455)	−0.013 (0.0157)
Personal Spending_N	0.0722 (0.0477)	0.1046 (0.0384) ***	−0.002 (0.0177)
Personal Income_N	−0.0232 (0.0736)	0.1391 (0.0482) ***	−0.0278 (0.0213)

Note: standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: authors.

As can be observed from the table, the terms AR and MA were significant for all three assets, suggesting a correct specification. Second, looking at the differences in trading days, we can see that the trading volumes of all three assets differ significantly on weekdays. The greatest regularity can be seen in the case of gold. Monday and Friday are the days with the highest trading volume, as traders usually want to open their positions at the beginning of the week, but also close them before the weekend to avoid any unexpected turn of events over the weekend. In the case of the S&P 500, this relationship is weaker but still valid. However, in the case of Bitcoin, this argument does not hold, since Friday is the day with the lowest trading volume. The reason for this is that Bitcoin can be traded around the clock, and traders can close their positions whenever they want (not necessarily on Friday).

More importantly, Table 6 shows that hardly any macroeconomic announcements have a significant impact on Bitcoin's trading volume. Knowing that most macroeconomic announcements have a significant impact on daily returns, but no significant impact on trading volatility and volume, we can conclude that the price is always moved by the same agents. This suggests that the cryptocurrency markets are very closed compared to the markets for gold and, in particular, for the S&P 500, which are not affected in terms of volatility, but are affected in terms of trading volume.

5. Discussion

Since cryptocurrencies are still a new topic in research, there is not much previous literature that can be used to compare the results. However, there are some works that partially overlap with our research. For instance, Pyo and Lee (2020) investigated whether macroeconomic announcements about the Consumer Price Index, employment, and Producer Price Index affect the price of Bitcoin. Even though the models were similar (both from the GARCH family of models), the results were contradictory. Specifically, we found that inflation rate news affects the price of Bitcoin, while Pyo and Lee (2020) did not reach the same conclusion. A possible reason for this could be that Pyo and Lee (2020), unlike us, did not divide the shocks into positive and negative shocks, as was pointed out as an important step by Kim et al. (2004), because the combination of positive and negative shocks in one variable can blur the relationship between the announcement and the price movement.

In addition, the GARCH model was also used by Al-Khazali et al. (2018). Although they did not use specific announcements, they divided macroeconomic news surprises into positive and negative. They concluded that gold and Bitcoin do not have the same direction of movement, which is consistent with our results, as well as the conclusion that negative news has a stronger impact on Bitcoin returns than positive news. Lyócsa et al. (2020) also used the index as a measure of macroeconomic news, and concluded that Bitcoin's volatility is not affected by economic fundamentals, which is consistent with our results. However, the lack of impact on Bitcoin jumps highlights the importance of monitoring individual macroeconomic news announcements instead of the index, as we obtained significant results of the impact on Bitcoin's returns. Ben Omrane et al. (2021) used macroeconomic news to calculate the impact on intraday jumps. They concluded that macroeconomic news is a trigger for positive and negative price jumps in the crypto market. However, unlike us, they did not find a significant impact of macroeconomic news such as non-farm payrolls, personal income, or durable goods orders on the price of Bitcoin, which we found to be significant. In this case, their results could be more beneficial for intraday traders, while our results are more beneficial for day traders. Shaikh (2020) found empirical evidence that uncertainty policy affects the bitcoin market using the Economic Policy Uncertainty Index. In addition, the author used macroeconomic data to conclude that uncertainty associated with planned macroeconomic announcements negatively affects Bitcoin returns, similar to our finding that negative news negatively affects Bitcoin. It should be emphasized that the objective of Shaikh (2020) was to uncover the information context of the announcement itself—i.e., uncertainty—while we analyzed the announcements based on the differences between expectations and actual values and, accordingly, whether the shock is positive or negative, which provided us with more detailed information.

However, our results are almost completely consistent with those of Corbet et al. (2020), who examined whether news about gross domestic product, Consumer Price Index, unemployment, and durable goods orders can affect the price of Bitcoin. They found that news about real economic activity, prices, and employment was significant, while durable goods orders had no significant effect on the price of Bitcoin. Similarly, we also found that real activity and prices were significant, while negative news about durable goods orders did not significantly affect the price of Bitcoin. Therefore, our results are consistent with theirs, even though Corbet et al. (2020) additionally controlled for the business cycle, which we did not.

As for the volatility equation results, for which we did not find any significant macroeconomic announcements, none of the other researchers published a volatility equation table.

When we compare the results of the effects of macroeconomic announcements on more traditional assets, there is a larger pool of literature for comparison. As with McQueen and Roley (1993), inflation rate (Consumer Price Index) announcements were found to be important for the 10-year Treasury bills' yield trend, while they were unimportant for the S&P 500's price trend. Like McQueen and Roley (1993), we found that non-farm payroll announcements affected 10-year Treasury bill yields, but we found that they also affected S&P 500 price movements, which was not found by McQueen and Roley. However, our results are quite consistent with theirs, even though the sample period was completely different. Moreover, our results are similar to those of Kim et al. (2004), who also divided the shocks into positive and negative shocks. In both sets of results, positive inflation shocks affected bonds negatively, while negative inflation shocks affected bonds positively. Moreover, retail sales shocks turned out to be insignificant for the stock market in both results, which is also consistent with the results of Flannery and Protopapadakis (2002). The results on the impact of the Consumer Price Index on stocks are not entirely consistent—Kim et al. (2004) found that positive inflation shocks have a negative impact on stocks, while we found no impact of inflation shocks on stocks. More important is the consistency of the variance equation. In our results, all macroeconomic announcements were non-significant for the variance movements of the assets, which is not significantly different from the findings of Kim et al. (2004), who concluded that there was only one significant announcement for the volatility of bond returns. Finally, as in the work of Flannery and Protopapadakis (2002), most weekly dummy variables appeared to be significant for all assets.

6. Conclusions

In this paper, we examined the impact of U.S. macroeconomic news on the returns and volatility of Bitcoin, gold, the S&P 500, 2-year Treasury notes, and 10-year Treasury notes, as well as the impact of U.S. macroeconomic news on the volume of Bitcoin, gold, and the S&P 500. To draw conclusions about the similarities, we used the GARCH model, and created dummy variables for macroeconomic news that is better or worse than expected. In addition, we controlled for the days of the week, which also yielded interesting results. Consistent with previous literature, we found that macroeconomic news affects returns, but its impact on volume is limited, while impacts on volatility were shown not to depend on macroeconomic news. Contrary to expectations, we found most similarities in the impact on returns between Bitcoin and 2-year Treasury notes. We also found no significant similarities between Bitcoin and gold, suggesting that Bitcoin cannot be considered digital gold in terms of sensitivity to macroeconomic news. With the obtained results, we can fully accept the previously stated hypothesis that Bitcoin is affected by the expectations of macroeconomic news announcements in the same way as other traditional assets. However, it should be emphasized that these movements are visible and statistically significant, but are not in the same direction as those of traditional assets, which certainly leaves enough room for future research.

Since there is no system for valuing the real price or market price of Bitcoin (as there is for stocks, where discounted cash flow valuation can be used), we can say that crypto traders trade mainly based on news and emotions. In Bitcoin, the news affects the returns to a large extent, but the volumes remain almost the same—unlike the S&P 500, where returns react less to news, but with higher volume. This means that the crypto market is more closed and riskier compared to the stock market.

The relevance and significance of this paper lies in the fact that it offers cryptocurrency investors insight into the causes of Bitcoin price movements in the market. As mentioned earlier, there is no adequate method for estimating the price and causes of price movements for cryptocurrencies, and this paper complements the existing literature in the context of detecting these causes. Furthermore, the results show the riskiness of the investment itself for end investors, and have strong significance in terms of policy implications—not just practical implications for investors.

With this work, we have contributed to the existing literature by expanding the knowledge of the impact of macroeconomic announcements on a market novelty such as Bitcoin and comparing it to the traditional assets. Our largest contribution is the impact of macroeconomic announcements on Bitcoin's volume. To best of our knowledge, volume has not been previously studied by researchers. Therefore, this study adds to the current literature with such an analysis, and by comparison with Bitcoin's return and volatility, leading to the interesting conclusion that the market for cryptocurrencies is very closed and, therefore, riskier.

We also contribute to the implications of investing in this new and exciting area. The implications of this work should be seen primarily in the context of investors and risk management. If individual macroeconomic announcements are found to be incorrectly predicted, then the investor can predict the price movement based on a better- or worse-than-expected announcement. If announcements do affect Bitcoin prices, then investors might consider the conclusions of this study to prepare for price changes. However, one should be cautious, because claiming that macroeconomic announcements have a significant impact on the price of Bitcoin is still difficult to say at this time, as Pyo and Lee (2020) already mentioned. Our findings will help investors to develop more in-depth understanding of the impact of macroeconomic announcements on Bitcoin's prices compared to those of other assets, and to build successful strategies in a more mature digital assets ecosystem. As Bitcoin is affected by macroeconomic news that also affects traditional assets, one should be very cautious when investing, as it shows signs of being a risky asset class, but with possible predictable movements based on macroeconomic news. The findings suggest that given Bitcoin's high risk as an asset class, it should be regulated in a way that protects the end investor, who is not necessarily a professional investor, but wants to be part of this new and exciting investment opportunity.

This work has certain limitations. First, only one currency was chosen to represent cryptocurrencies, as Bitcoin is the leader of prices in the entire crypto market. Second, although the macroeconomic news was selected based on previous research, it was limited and only available on a monthly basis. Therefore, the impact of the announcements could not be observed on a daily basis, meaning that we have 30 times more observations of daily movements of the observed assets than we do announcements.

More cryptocurrencies and news announcements are promising topics for future studies. Since cryptocurrencies are a novelty, a broader range of announcements should be considered, both from the U.S. and from other countries. On top of that, a wider range of cryptocurrencies should be compared to other traditional assets such as cash, assets, and commodities. The main idea of our work was to choose traditional assets that are mentioned in the literature as being similar to cryptocurrencies; however, due to the constant spread and innovation of cryptocurrencies, it would be interesting to do research in comparison with other traditional assets. Our results suggest that this evolving cryptocurrency market continues to mature through interactions with macroeconomic news.

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Note

[1] The expected value for the announcements is obtained from a survey among a representative group of economists about their expectations, but in addition to surveys about analysts' projections, Trading Economics additionally uses models to make more accurate predictions.

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