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Abstract

This paper investigates the link between Bitcoin and macroeconomic fundamentals by estimating the impact of macroeconomic news on Bitcoin using an event study with intraday data. The key result is that, unlike other U.S. asset classes, Bitcoin is orthogonal to monetary and macroeconomic news. This disconnect is puzzling as unexpected changes in discount rates should, in principle, affect the price of Bitcoin even when interpreting Bitcoin as a purely speculative asset.

Key words: Bitcoin, U.S. asset prices, high-frequency data, monetary surprises, macroeconomic announcements

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"Crypto assets are highly volatile (...) They're more of an asset for speculation, so they're not particularly in use as a means of payment. It's more of a speculative asset. It's essentially a substitute for gold rather than for the dollar"

Jerome Powell
Federal Reserve chair
(March 23, 2021)

"Unbacked cryptos lack any intrinsic value, too. They are speculative assets. Investors buy them with the sole objective of selling them on at a higher price. In fact, they are a gamble disguised as an investment asset."

Fabio Panetta
(January 5, 2023)

1 Introduction

The market capitalization of cryptocurrencies has expanded rapidly in recent years. Prior to its recent decline, it reached 2.5 trillion dollars, with Bitcoin crossing the 1 trillion mark. Given their growing relevance, it is natural to study the drivers of cryptocurrencies' prices. Indeed, to the extent to which they act as speculative assets, it is important to understand their properties and how those differ from traditional assets.

As a background for our empirical analysis, we interpret cryptocurrencies as assets whose current price depends on the discounted value of expected future prices. This characterization implies that, from a macroeconomic point of view, developments that influence current and future interest rates (in a direct or indirect manner) will affect the value of cryptocurrencies.

In this paper, we study empirically how macroeconomic factors affect cryptocurrencies taking a high-frequency perspective: we choose Bitcoin as a representative cryptocurrency and study its response to a variety of broadly defined macroeconomic news. We use a novel and comprehensive intraday dataset to estimate the effects of news. The main advantage of relying on high-frequency data is that, in a short enough

window around a macro announcement, the data release is (most likely) the only information systematically hitting the market. Hence, by looking at the response of asset prices in a 30-minute window around various announcements, this paper performs the closest thing that can be obtained in empirical finance to a natural experiment.

Our empirical strategy consists of several elements. First, we collect different macro news: news on the real economy (payroll, initial jobless claim, industrial production, retail sales, unemployment, and trade balance); news on inflation (PPI and CPI); and news on forward-looking indicators (confidence and ISM manufacturing), where the Bloomberg consensus forecast serves as a proxy for market expectations. For monetary policy news, we follow Swanson (2021) in disentangling three distinct indicators. The first factor, Target, captures unanticipated changes in the current federal funds rate target. The second factor, Path, captures unanticipated changes in the future path of policy. The third factor, $LSAP$, captures unanticipated announcements of future large-scale asset purchases (hence, "LSAP"). Given the relatively recent development of cryptocurrencies' exchanges, we restrict our sample to the period going from 2017 to 2022, starting from the period in which Bitcoin arguably reached a more mature stage.

Then, we estimate the response of US asset prices to news. The main result is that Bitcoin is orthogonal to all macro news that we consider except CPI. This is in stark contrast with the other assets that we use for comparison (gold, silver, S&P 500, various bilateral exchange rates). All other traditional assets respond to macroeconomic news with an economically large and significant coefficient.

Our analysis also points out a puzzle in terms of how Bitcoin responds to monetary news. Given our interpretation of Bitcoin as an asset with no intrinsic value whose current value depends on the discounted value of its future price, we should expect Bitcoin to respond to monetary policy news as it is reflected in changes in current and future real interest rates. Our analysis instead shows that, while other US asset prices respond to both the target and the path of monetary policy news, Bitcoin is unresponsive to unexpected changes in the short-term rate while its reaction to news about the future path of policy is not robust.

The main contribution of this paper relative to the related literature is the use of intraday data to identify the effects of monetary and macroeconomic news on Bitcoin. Few papers have studied the return, volatility, and correlation of cryptocurrencies. Pyo and Lee (2020) investigate whether FOMC and macroeconomic announcements

affect Bitcoin prices by employing daily data, focusing on the impact of selected macroeconomic announcements and using dummy variables. Another study by Corbet et al. (2020) also analyzes the impact of macro news on Bitcoin using daily data. This differs from the high-frequency approach that allows us to focus on a short enough window around the announcement to estimate more precisely the impact of news.

Another strand of literature has analyzed the risk and return characteristics of cryptocurrencies. For instance, Liu and Tsyvinski (2021) establish that cryptocurrency returns are exposed to cryptocurrency network factors, which capture the user adoption of cryptocurrencies but not to production factors, which proxy for the costs of cryptocurrency production. Liu and Tsyvinski (2022) find that three factors – cryptocurrency market, size, and momentum – capture the cross-sectional cryptocurrency returns. We contribute to this literature by analyzing the conditional, as opposed to the unconditional, response of Bitcoin.

Finally, there are numerous studies that analyze the response of US assets to macroeconomic news (see, inter alia, Andersen et al. (2003) and Andersen et al. (2007); Faust et al. (2007), and the reference therein). This paper complements these studies by using a longer sample period that includes the financial crisis and comparing the response of developed economies' exchange rates with those of emerging markets and other assets. A related strand of the literature has examined the effect of US macro news on precious metal prices (e.g., Christie–David et al. (2000); Pukthuanthong and Roll (2011); and Smales (2015)). This paper also looks at silver and gold spot prices and goes one step further by comparing the response of precious metal prices with Bitcoin.

The rest of this paper is organized as follows. Section 2 presents a stylized model of Bitcoin as a stochastic bubble that serves as a background framework for our empirical analysis. In Section 3, we describe the dataset. Section 4 contains a discussion of the main empirical findings about the effects of US macroeconomic and monetary policy announcements on Bitcoin and other asset prices. Section 5 examines the robustness of the results. Finally, Section 6 summarizes the findings and concludes.

2 A Simple Speculative Asset Model

In this section, we interpret Bitcoin as a speculative asset with no intrinsic value in which its value depends on the appreciation of the asset itself. We denote with b_t as the value of the asset at time t and we consider the following law of motion:

$$b_t = \frac{q_t b_{t+1}}{1+r_t} + \frac{(1-q_t)}{1+r_t}\varepsilon_{t+1} \tag{1}$$

where $1-q_t$ is the probability that the value of the asset drops in expected value to zero (i.e. $E_t[\varepsilon_{t+1}] = 0$) and $R_t = 1 + r_t$ is the gross real interest rate. In the terminology of Blanchard and Fischer (1989) b_t is a stochastic bubble. We make the following assumptions.

Assumption 1: The probability q_t is endogenous and depends on current and future real interest rates:

$$q_t = q_t\left(R_t, R_{t+1}, R_{t+2}, ...\right)$$

and

$$q_{t+1} = q_{t+1}\left(R_{t+1}, R_{t+2}, R_{t+3}, ...\right)$$

with $q_{t,R_t} = \frac{\partial q_t}{\partial R_t} < 0$, $q_{t,R_{t+1}} = \frac{\partial q_t}{\partial R_{t+1}} < 0$ and so on.

Assumption 2: The sensitivity of the probability of the bubble bursting is stronger for current as opposed to future interest rates:

$$q_{t,R_t} < q_{t,R_{t+1}} < 0$$

We now solve (1) forward from time $t = 0$. By applying the law of iterated expectations we obtain:

$$E_t b_{t+i} = b_t \left(\prod_{j=0}^{i-1} \frac{q_{t+j}}{R_{t+j}}\right)^{-1}$$

If b_t is positive then the expected value of the speculative asset is a function of the current and future probabilities associated with the value of the asset being different than ε. The anticipation that the price of the asset will be positive in the future sustains indeed its current value.

We use this simple framework to derive some testable implications. Since there is no intrinsic value the only macro determinants for this speculative asset are movements in interest rates. In a simple model in which the probability of the asset

bursting is exogenous, the dependence on changes in the interest rate would be relatively simple and common to any forward-looking variable. In our formulation, in which the probability is endogenous and depends on present and future real interest rates, we have also the interesting property that changes in future rates have bigger effects on the asset's value than changes in the current rates.

Property 1: The elasticity of the speculative asset to future changes in the interest rates is higher than current changes.

We define the elasticity of the value of the asset at a time t, b_t, with respect to the interest rate at a generic time $t+i$, R_{t+i}, as $(\varepsilon_{b_t,R_{t+i}})$, representing the percentage change of the asset price to changes in the gross interest rate:

$$\varepsilon_{b_t,R_{t+i}} \equiv \frac{\partial b_t}{\partial R_{t+i}} \frac{R_{t+i}}{b_t}$$

By taking the conditional expectation on time t of Equation (1), it follows that:

$$\varepsilon_{b_t,R_t} = \frac{\partial b_t}{\partial R_t} \frac{R_t}{b_t} = (\varepsilon_{q_r,R_r} - 1)$$

and

$$\varepsilon_{b_t,R_{t+1}} = \frac{\partial b_t}{\partial R_{t+1}} \frac{R_{t+1}}{b_t} = \left(\varepsilon_{q_{r+1},R_{r+1}} + \varepsilon_{q_r,R_{r+1}} - 1\right)$$

Thus, as long as $q_{t,R_t} = \frac{\partial q_t}{\partial R_t} < 0$, $q_{t,R_{t+1}} = \frac{\partial q_t}{\partial R_{t+1}} < 0$, the response of the asset price to future changes in interest rates tends to be bigger than its response to current changes.

Given the way we have characterized Bitcoin as an asset with no intrinsic value, from a macroeconomic point of view the only direct determinants of Bitcoin are present and future interest rates. In our empirical analysis, we examine the response of Bitcoin to different types of macroeconomic news: news on inflation, news on the real economy, and monetary policy news. To highlight the link between our set of news and the price of Bitcoin, we model the current interest rate as controlled by the monetary policy authority to react to inflation deviations from the target and real macroeconomic development as captured by the output gap.

$$R_t = \Phi(\Pi_t, Y_t), \tag{2}$$

where $\Phi(.,.)$ is a generic reaction function with $\Phi_\Pi > 0$, and $\Phi_Y > 0$ as in the

standard Taylor-rule. In this setup, news about inflation and real activity influence indirectly the price of the speculative asset through the reaction function of the monetary policy authority.

The simple structural framework described above allows us to formulate the following empirical hypotheses about the relationship between monetary and macroeconomic news and the price of a speculative asset:

- **Hypothesis 1**: Monetary news affects negatively the value of the speculative asset through an interest-rate channel.
- **Hypothesis 2**: Monetary news about the future path of policy have larger effects than those about the current target rate.
- **Hypothesis 3**: Macroeconomic news affects the price of speculative assets through a monetary policy reaction function channel. The sign associated with inflation and real macroeconomic news is negative as long as $\Phi_{\Pi} > 0$ and $\Phi_{Y} > 0$ in Equation 2.

3 Data

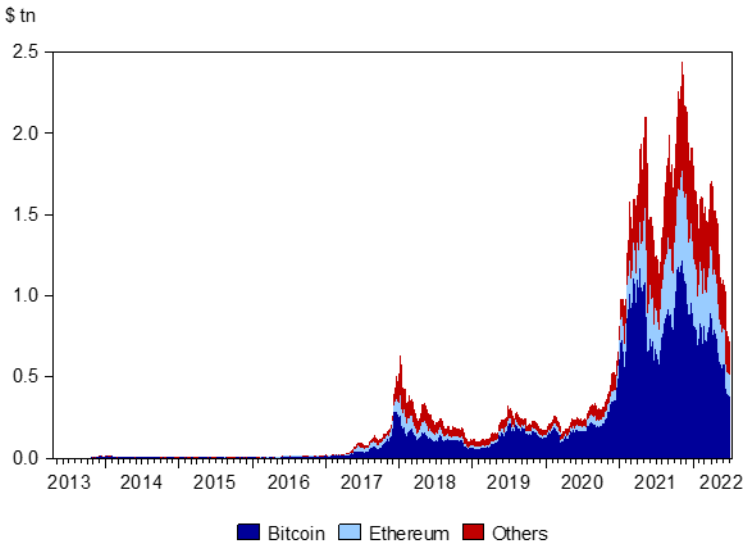
This section briefly describes the asset price data, monetary and macroeconomic surprises.

3.1 Asset price data

The asset price data include high-frequency data on Bitcoin, US dollar exchange rates against both developed and emerging market currencies, precious metal prices and US stock prices. This paper focuses on Bitcoin because it is the most popular cryptocurrency and it is also more accessible and liquid than other cryptocurrencies. Figure 1 displays the market capitalization of Bitcoin, Ethereum, and 21 other digital currencies, where market capitalization is calculated by multiplying the total number of coins in circulation by their price. Of note, Bitcoin market capitalization increased from approximately one billion US dollars in 2013 to over $1 trillion market capitalization mark in early 2021 and then less than $400 million in December 2022. In addition, Bitcoin represents between 60% and 80% of the overall digital currency market.

Figure 1: Market capitalization of digital currencies

This figure plots the market capitalization of Bitcoin, Ethereum, and 21 other digital currencies (i.e., Aave, BinanceCoin, Cardano, ChainLink, Cosmos, CryptocomCoin, Dogecoin, EOS, Iota, Litecoin, Monero, NEM, Polkadot, Solana, Stellar, Tether, Tron, Uniswap, USDCoin, WrappedBitcoin, and XRP). The dashed line on the right axis displays the market capitalization of Bitcoin relative to those 23 digital currencies. The sample period is from April 2013 to December 2022.



We study the properties of Bitcoin and compare it with other traditional asset classes. The first class of assets is represented by various bilateral US dollar exchange rates. The inclusion of exchange rates is motivated by the fact that Bitcoin and other digital currencies are usually thought of as alternatives to fiat money. The exchange rates consist of 5-minute interbank spot exchange rates for the US dollar versus the euro (EUR), the British pound (GBP), the Japanese yen (JPY), the Swiss franc (CHF), the Mexican peso (MXN), and the South African Rand (ZAR).[1] The specific choice of the exchange rate data is motivated by several factors. According to the Bank for International Settlements (2019) latest triennial survey of foreign exchange market activity, the exchange rates considered in this paper are among the most actively traded currencies and represent a sizable and growing share of the average daily foreign exchange market turnover. The exchange rate pairs comprise

[1]For instance, Bandi and Russell (2008) argue that 5-minute returns provide a reasonable balance between sampling too frequently (and confounding price reactions with market microstructure noise, such as the bid-ask bounce, staleness, price discreteness, and the clustering of quotes) and sampling too infrequently (and blurring price reactions to news).

of both developed and emerging market currencies, with underlying economies that are economically important, open to international trade, and use a floating exchange rate regime. Furthermore, the countries are geographically distributed, covering four different continents. Throughout the paper, exchange rates are measured in units of US dollars needed to buy one unit of foreign currency, such that a positive change implies a depreciation of the US dollar.

We then compare Bitcoin with precious metals. Bitcoin shares most of the features of a store of value, such as gold. The number of units is finite and it can be used to hold and transfer value. Ultimately, whether Bitcoin behaves like precious metals is an empirical issue. We use the 5-minute gold and silver prices, quoted in US dollars per ounce.

Finally, we examine the properties of equities. Key differences exist between Bitcoin and stocks. For instance, Bitcoin is not a regulated financial product, it does not trade on traditional stock exchanges, it does not pay dividends, etc. Since Bitcoin may represent an alternative asset class, from an investor's perspective comparing its dynamics to that of stocks is interesting. The S&P 500 E-Mini futures data serves as a proxy for US stock prices. These mini-sized futures contracts have lower notional values, and are more liquid, than the standard futures contracts, and are traded on the Chicago Mercantile Exchange's Globex electronic trading platform.[2] A continuous series is constructed by considering the front-month contract and rolling over to the next contract on the expiration date.

The sample covers the period January 2000 to December 2022 for all assets, except Bitcoin (available from January 2012). The choice of the start date is determined by data availability. For Bitcoin, we restrict the sample to the period starting in 2017 to focus on the period in which it became more widespread and the volatility of its returns was smaller relative to its early days. The data used in this work are novel in several respects, such as the simultaneous high-frequency data for 10 asset prices and a calendar span of over 20 years for traditional assets, thus providing an update of several related studies.

Table 1 presents the summary statistics of 5-min returns. The mean and the median are close to zero for all asset prices. However, these figures mask a sharply

[2]S&P 500 is a stock market index that measures the stock performance of 500 large companies listed on stock exchanges in the United States. The notional value of one E-mini S&P 500 contract (ticker ES) is 50 times the value of the S&P 500 stock index, instead of 250 times for the standard futures (ticker SP).

different performance. In about ten years, Bitcoin experienced rapid growth going from $5 in 2012 to above $60,000 in March 2021, for a compound annual growth rate of about 270% per year. The compound annual growth rate in the full sample is, however, 220% per year because of its recent decline. During the same sample period, the S&P 500 grew about 11% per year between 2012 and 2022, while gold and silver prices remained flat. The 5-min standard deviation is about 0.04% for developed economies' exchange rates, which corresponds to about 10%-15% annualized volatility. The standard deviation for emerging markets currencies is 0.06% for MXN and 0.08% for ZAR. Gold and the S&P 500 have similar volatility at about 0.07%, which is about half that of silver. Of note, Bitcoin has a 5-min standard deviation of about 0.4%, an order of magnitude larger than that of exchange rates. The higher volatility of Bitcoin is confirmed by looking at the size of the minimum and maximum 5-min returns, respectively -31% and 84%, compared with those of other asset returns. Although all returns except Bitcoin are approximately symmetric, the large kurtosis indicates that returns have thicker tails than a normal distribution. In fact, the "Probability" row, which reports the p-value of the Jarque-Bera test, indicates the strong rejection of the null hypothesis that 5-minute returns are normally distributed.

Table 1: Summary statistics of 5-min asset price returns

The Table reports the summary statistics for the 5-min asset price returns in percentage points. The sample period is from January 2000 to December 2022 (or determined by data availability). "Probability" reports the probability of the null hypothesis of the Jarque-Bera test that 5-minute returns are normally distributed. Exchange rates are defined in units of US dollars needed to buy one unit of the foreign currency, such that a positive change implies a depreciation of the US dollar.

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	2.83	2.34	3.1	2.69	4.59	3.19	3.1	6.23	4.42	84.20
Minimum	-1.34	-2.83	-1.68	-4.27	-3.47	-2.33	-2.91	-5.27	-2.92	-30.85
Std. Dev.	0.04	0.04	0.04	0.04	0.06	0.08	0.07	0.14	0.08	0.40
Skewness	0.54	-0.5	1.26	-0.28	0.57	0.16	-0.01	-0.17	0.41	17.45
Kurtosis	53	95	111	154	163	29	42	36	64	3,479
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1,610,777	1,599,204	1,608,314	1,596,463	1,301,595	1,382,744	1,283,282	1,161,298	1,460,120	734,105
Start Sample	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/3/2000	1/5/2012

3.2 Monetary surprises

We use principal components analysis to extract the two most important factors in intraday changes in money market forward rates in a thirty-minute window bracketing

every schedulued FOMC announcement. Following the same methodology developed by Gurkaynak et al. (2005), we use five non-overlapping futures contracts to pin down the expected path of the federal funds rate over the next year: the current-month and three-month-ahead federal funds futures contracts (with a scale factor to account for the timing of FOMC meetings within the month) and the two-, three-, and four-quarter-ahead eurodollar futures contracts. Then, we orthogonalize these two factors, so that the loading on the first one, defined Target (in short, TS), corresponds to unanticipated changes in the current federal fund target, whereas the second factor, defined Path (in short, PS), corresponds to unanticipated changes in futures rates out to horizons of one year, and can be interpreted as a "future path of policy" factor.

In 2008 the Federal Reserve responded to the accelerating economic downturn by substantially cutting its policy rate, culminating on December 16, 2008, with a federal funds target rate set to a range of 0-25 basis points. Despite reaching the zero lower bound on its main operating instrument, the Federal Reserve further eased financial conditions by purchasing large volumes of assets, such as agency mortgage-backed securities (MBS) and longer-term Treasury securities. To measure this additional dimension of monetary news, we define the large-scale asset purchases (in short, LSAP) surprise as the residual of regressing the change in long-term forward rates around the release of the FOMC statement on the Target and Path factors. More formally, the LSAP surprise is defined as the residual of the following regression:

$$\Delta f_{2,8,t} = \gamma_0 + \gamma_T Target_t + \gamma_P Path_t + \gamma_L LSAP_t \tag{3}$$

where $\Delta f_{2,8,t}$ stands for the change in the 2-by-8 forward Treasury rate (that is, the 8-year rate beginning 2 years ahead) in a narrow, 30-minute, window around the release of the FOMC statement. The sample period is December 2008 to December 2022, since the post-2008 period is when LSAPs were implemented.[3]

Table 2 presents a selection of descriptive statistics for the federal fund target rate changes and monetary policy surprises on scheduled FOMC meetings.[4] The

[3]In recent work, Swanson (2021) identifies three indicators of monetary policy surprises, as we do in this study. This paper complements his work along a few dimensions. First, the identification of LSAP surprises is different because we use only the post-2008, rather than the full sample, period to extract LSAP surprises. Second, we focus on explaining Bitcoin returns, rather than Treasury yield changes. Third, the sample period ends in December 2022, rather than in June 2019, thus allowing us to study the effects of monetary policy during the COVID-19 crisis.

[4]The dates of scheduled FOMC meetings are set far in advance, and thus they can be viewed

sample is from January 2000 to December 2022 and covers two full interest rate cycles (tightening and easing). The mean of the three monetary surprises is zero by construction. Each target rate change occurs in increments of 25 basis points. The largest target rate decreases correspond to policy rate cuts of 75 basis points, which occurred on March 18, 2008, and December 16, 2008. The largest target rate hike corresponds to the policy rate increase that occurred on June 15, 2022. The Target surprise was roughly zero between 2009 and 2015. Market participants correctly anticipated no change, and the standard deviation of the Target surprise was just one basis point. The large negative LSAP surprise of 50 basis points – about 10 standard deviations – corresponds to the FOMC meeting of March 2009, when the FOMC decided to inject another $1 trillion into the financial system by purchasing Treasury bonds and mortgage securities to aid the economy.

Table 2: Summary statistics of monetary surprises

The table reports summary statistics for the federal fund target rate changes and monetary surprises on scheduled FOMC meeting days. The sample is from January 2000 to December 2022. The variable Target measures unanticipated changes in the current federal funds rate target. The variable Path measures changes in futures rates out to horizons of one year that are independent of changes in the current fund rate target. The variable LSAP measures unanticipated changes in large-scale asset purchases. "Jarque-Bera p-value" reports the p-value of the null hypothesis of the Jarque-Bera test that policy surprises or stock returns are normally distributed.

	Target Rate Change	Target	Path	LSAP
Mean	-0.01	0.01	-0.01	0.00
Median	0.00	0.01	0.00	0.00
Maximum	0.75	0.15	0.41	0.10
Minimum	-1.50	-0.19	-0.39	-0.50
Std. Dev.	0.29	0.04	0.1	0.04
Skewness	-1.81	-1.70	-0.11	-7.43
Kurtosis	10.7	13.58	6.53	83.15
Probability	0	0	0	0
Observations	183	183	183	183

as exogenous and widely known. On the other hand, the timing of unscheduled meetings arises endogenously. Since the context of the rate decision is different, we focus only on scheduled meetings.

3.3 Macroeconomic surprises

The selection of macroeconomic announcements includes those that have been singled out as important in the international finance literature (e.g., Andersen et al. (2007), and Faust et al. (2007)). Since asset markets are forward-looking and hence tend to incorporate any information about anticipated macroeconomic changes, it is important to isolate the unexpected component of the macroeconomic announcement from the raw macroeconomic data release as the conditioning explanatory variables. To construct the surprise component of each macroeconomic data release, we define macroeconomic news as the difference between the realized value of the macroeconomic data release on the day of the announcement and the financial markets' expectation for that realized value. Since units of measurement differ across variables, to facilitate the economic interpretation of the econometric results and allow a meaningful comparison of different types of news, we standardize each macroeconomic news event by dividing the surprise component of the announcement by its sample standard deviation. Hence, the standardized news associated with the macroeconomic indicator i at time t is computed as:

$$MacroNews_{i,t} = \frac{MacroAnn_{i,t} - E_{t-\varepsilon}[MacroAnn_{i,t}]}{\hat{\sigma}_i} \tag{4}$$

where $MacroAnn_{i,t}$ is the announced value of indicator i on day t, $E_{t-\varepsilon}[MacroAnn_{i,t}]$ represents a proxy for market participants' expected value conditional on the information available immediately before the release at $t-\varepsilon$, and $\hat{\sigma}_i$ is the sample standard deviation of the macro news, i.e., $MacroAnn_{i,t} - E_{t-\varepsilon}[MacroAnn_{i,t}]$. Since $\hat{\sigma}_i$ is a constant, this standardization does not affect either the significance of the estimated response coefficients or the fit of the regressions compared to the results based on the "unstandardized" surprises. Real-time data on realized macro figures and the respective median response poll are available from Bloomberg News Service.[5] The set of US macro news can be grouped into three broad categories:

1. News about the current real side of the economy: economic indicators regarding industrial production, retail sales (less autos), labor market conditions, and net exports. The monthly Employment Report contains data from both the household survey and the establishment survey. Consistent with the existing

[5]Balduzzi et al. (2001) and Andersen et al. (2003) are some of the many previous studies that have verified that these survey data pass standard tests for unbiasedness and efficiency.

literature, we separate the Report surprises into two parts: the unemployment rate and nonfarm payrolls. This separation is possible because their correlation coefficient is close to zero. Initial unemployment claims are released weekly, while all other news items are released monthly.

2. News about forward-looking indicators of real activity: Conference Board's consumer confidence and Institute for Supply Management's Manufacturing Report on Business, in short, ISM index.

3. News about prices: Producer Price Index (in short, PPI), and Consumer Price Index (CPI), both indices excluding the volatile food and energy categories.

Since our sample includes the COVID-19 pandemic, we filter out extreme macro news. Indeed, during the COVID-19 crisis, some macro announcements, such as nonfarm payrolls or initial jobless claims, were more than one hundred times their in-sample standard deviation, making those observations particularly influential in a regression framework. To avoid the excessive influence of these outliers on the regression fit, we filter out all macro news whose absolute value is larger than five times its in-sample standard deviation. Table 3 provides descriptive statistics for all news variables, including the number of observations, the agency reporting the news, and the frequency and the time of the release (Eastern Time).

4 Empirical results

4.1 Specific announcement days

As a preliminary illustration of the financial market impact of news, Figure 2 displays the response of several US asset prices around the release of two types of news: news about the real economy, such as the labor market report (Panel A), and news about monetary policy associated with the FOMC statement (Panel B). Nonfarm payrolls came in lower than expected in the June 2016 Employment report. Consequently, the dollar immediately depreciated, stock prices declined by about 0.5% and gold price increased by 2%. In contrast, Bitcoin moved sideways. At the June 2021 Fed meeting, the FOMC signaled that rates needed to rise sooner and faster than market participants anticipated. Again, the dollar, gold and stock prices immediately responded to the release, but Bitcoin did not. Having illustrated the

Table 3: Summary statistics of US macroeconomic news

The Table reports a selection of descriptive statistics for US macroeconomic news used in this paper, including release time (Eastern Time), units of measure, and Bloomberg ticker. The sample period is from January 2000 to December 2022 (or determined by data availability). "Obs." stands for the total number of observations in the announcements and expectations data sample. "Std. Dev." stands for the standard deviation of the macroeconomic news surprise before being standardized. The acronym "s.a." stands for seasonally adjusted; "m-m" and "q-q" indicate from month to month, and from quarter to quarter respectively. "FRB" stands for the Federal Reserve Board, "BC" for the Bureau of the Census, "BLS" stands for the Bureau of Labor Statistics, "ETA" for Employment and Training Administration, "BEA" for Bureau of Economic Analysis, "CB" for Conference Board, and "ISM" for Institute of Supply Management. Macroeconomic news that are larger than five times its in-sample standard deviation are filtered out.

	Mean	St. Dev	Max	Min	Non-zero obs.	Obs.	Release time	Units of measurement	Agency
Real activity									
Industrial Production	0.0	0.4	1.1	-2.0	249	275	9:15	% m-m	FRB
Retail Sales	0.0	0.6	3.4	-2.8	233	256	8:30	% m-m	BC
Change in Nonfarm Payrolls	-5.0	172	1570	-734	274	275	8:30	Thousands	BLS
Unemployment Rate	0.0	0.2	0.6	-1.4	198	275	8:30	% of labor force	BLS
Initial Jobless Claims	1.4	31	481	-255	1164	1196	8:30	No. of claims	ETA
Trade Balance	0.9	295	1060	-970	268	276	8:30	$ Billions	BEA
Forward-looking									
Consumer Confidence	0.3	5.1	12.8	-14	273	276	10:00	Index	CB
ISM Manufacturing	0.2	1.9	7.4	-6	271	276	10:00	Index	ISM
Prices									
PPI Ex Food & Energy	0.0	0.3	1.1	-1	212	276	8:30	% change m-m	BLS
CPI Ex Food & Energy	0.0	0.1	0.5	-0.3	170	274	8:30	% change m-m	BLS

muted response of Bitcoin to two large surprises, we now turn to a more systematic analysis of the relationship between surprises and high-frequency asset price changes.

4.2 The response of asset prices to monetary surprises

In this section, we test Hypotheses 1 and 2, i.e., that monetary news affects negatively the value of Bitcoin through its effects on interest rates. Hypothesis 1 states the dependence of Bitcoin on changes in interest rates. Given the construction of our monetary news, this hypothesis would suggest negative coefficients on all monetary news that we have constructed (i.e. Target, Path, and LSAP to the extent to which LSAP affects interest rates). Hypothesis 2 instead suggests that the coefficient on the Path coefficient should be larger compared to that of the Target surprise. If correct, these hypotheses indicate that monetary policy surprises are a driver of Bitcoin prices. To that end, we run a regression to estimate the following regression on scheduled FOMC meeting days:

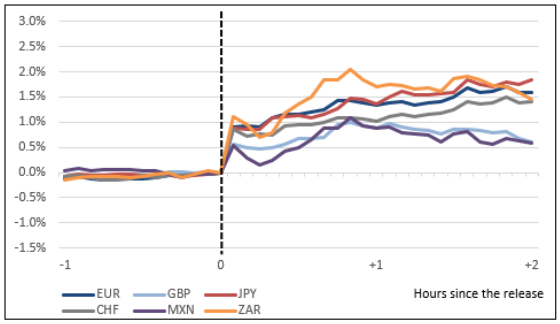
$$R_{[t-5min,t+25min]} = \alpha + \beta_T Target_t + \beta_P Path_t + \beta_L LSAP_t + \varepsilon_t \tag{5}$$

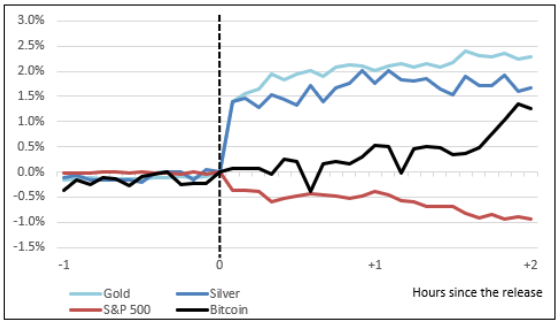
where $R_{[t-5min,t+25min]}$ is the 30-minute percentage changes in exchange rates,

Figure 2: Asset price responses on specific days

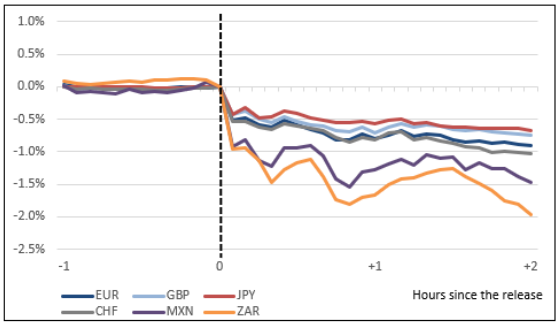
Intradaily plots of exchange rates (denominated by USD), precious metals, US stock prices, and Bitcoin around the release of the June 3, 2016 Employment report and June 16, 2021, FOMC statement. Nonfarm payrolls in the June 2016 report were lower-than-expected. The June 2021 FOMC statement was more hawkish than anticipated.

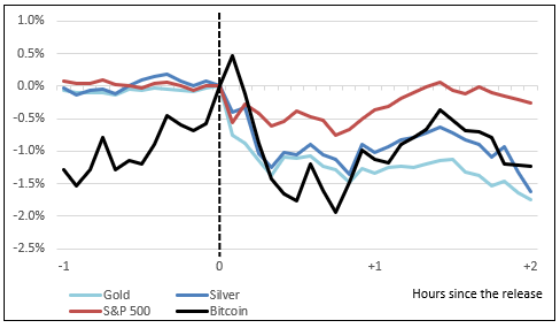
(A) The Response Around the Release of the Unemployment Report Announcement on June 3, 2016





(B) The Response Around the Release of the FOMC Statement on June 16, 2021





precious metal prices, stock prices, and Bitcoin from five minutes before the event to twenty-five minutes after. In separate analysis (available upon request), we also consider a one-hour interval, from five minutes before the event to fifty-five minutes after, and the main results continue to hold. Table 4 displays the estimation results of Equation 5 for the sample period from January 2000 to December 2022 for all assets except Bitcoin, which is based on the sample January 2017 - December 2022.

The econometric method is ordinary least squares (OLS) with White t statistics to account for heteroskedasticity in the residuals. We find that news about the target rate and the path of future monetary policy have highly statistically significant effects on all asset prices. For instance, a one percentage point surprise easing in the federal funds rate increases the S&P 500 equity index by 3.7% in the half-an-hour around the event, significant at the 5% level. This magnitude is like that reported in Bernanke and Kuttner (2005), who find a 4.7% effect for the one-day CRSP value-weighted equity return over the period June 1989 to December 2002.

The effect of Path and LSAP surprises are also negative, and significantly different from zero. Of note, the impact of LSAP should be interpreted as a lower bound of the overall effect of asset purchases since some LSAP announcements were made outside scheduled FOMC meeting days and besides stock effects, there are also flows effects, as documented by D'Amico and King (2013).

The most novel aspect of Table 4 is, however, the estimates of the effects of monetary surprises on Bitcoin. The coefficients of the Target and LSAP surprises are negative but insignificant. The coefficient of the Path surprise is negative and significant at 5%. The goodness of fit, measured by the adjusted R^2, is about 24%, and it has a similar magnitude to that of the S&P 500 regression and emerging markets exchange rates but it is lower than those of developed economies exchange rates.

This evidence provides mixed support to our Hypothesis 1: the responses of Bitcoin to monetary policy shocks are always negative. However, the coefficients are never significant at the 1% level, and only in one case out of three is the coefficient significantly different from zero at the 5% percent level.

Our Hypothesis 2 suggests that the effects of Path and LSAP surprises should be larger than those of Target surprises. Since the units of measure of monetary news are different (cf. Table 2), we normalize its effects by multiplying the regression coefficient for the standard deviation of the monetary surprise. A one standard deviation surprise

Table 4: The response of asset prices to monetary surprises

The table reports the results from a regression of intraday percentage changes in exchange rates, precious metal prices, US stock prices, and Bitcoin (from five minutes before the event to twenty-five minutes after) on a constant, Target, Path, and LSAP factors. The sample is from January 2000 to December 2022 and January 2017 to December 2022 for Bitcoin. Exchange rates are defined as units of US dollars needed to buy one unit of foreign currency, such that a positive change implies a depreciation of the US dollar. The variable Target measures unanticipated changes in the current federal funds rate target. The variable Path measures changes in futures rates out to horizons of one year that are independent of changes in the current fund rate target. The variable LSAP measures the unanticipated announcement about asset purchases. The econometric method is ordinary least squares with heteroskedasticity-consistent standard errors. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Constant	0.02	0.02	0.01	0.03	0.05**	0.02	0.11***	0.18***	0.00	0.37*
Target	-1.88***	-1.64***	-0.7	-1.32*	-1.02*	-1.91***	-2.95**	-2.69**	-3.71**	-15.06
Path	-1.99***	-1.60***	-1.65***	-1.93***	-1.34***	-2.16***	-3.25***	-3.93***	-1.91***	-5.91**
LSAP	-3.26***	-2.91***	-3.60***	-2.98***	-1.94***	-2.08***	-5.74***	-5.61***	-2.36**	-0.29
R^2	0.461	0.47	0.535	0.427	0.223	0.269	0.463	0.294	0.256	0.239
Observations	183	183	183	183	183	176	154	153	182	47

in the Target and Path is associated with about 0.6% change in Bitcoin, while the effect of LSAP surprises is close to zero. Thus, we find that news about the future path of policy does not have consistently larger effects than those about the current target rate.

4.3 The response of asset prices to macroeconomic news

From a theoretical standpoint, the effects of economic news on asset prices are a priori uncertain. The direction in which news moves the exchange rate depends on the model of exchange rate determination and on the way in which monetary authorities respond to new information (Almeida et al. (1998)). An unexpected increase in US inflation may lead to higher input costs for exports, which then makes a nation's exports less competitive in the global markets. A widening of the trade deficit may cause the currency to depreciate. However, if the Federal Reserve follows a Taylor-type reaction function, it may raise short-term interest rates to curb inflationary pressures, which in turn may imply an appreciation of the dollar.

Turning to stock prices, according to a dividend discount model, a company's stock price equals the expected present discounted value of its future dividends. As discussed by Pearce and Roley (1985), an unexpected increase in US real economic activity may cause a revision in the expectation of discounted future dividends (cash-flow effect) and future excess returns (discount rate effect), again affected by the

central bank's response to the news. Which effect dominates in practice is an empirical issue.

Although there is no fully developed asset pricing model for Bitcoin, our structural framework described above suggests that Macroeconomic news affects the price of speculative assets through a monetary policy reaction function channel.

Having discussed the mechanisms through which a link may exist between macroeconomic news and US asset prices, we conduct a standard event study to examine the financial market impact of major US macro news. Specifically, we estimate the following linear regression model separately for each asset price and macroeconomic announcement using only announcement days:

$$R_{[t-5min,t+25min]} = \alpha_i + \beta_i MacroNews_{i,t} + \varepsilon_{i,t} \tag{6}$$

where the notation is the same as before. To facilitate the interpretation of the coefficients, the signs of the announcement surprises in the countercyclical indicators (unemployment rate and initial jobless claims) have been flipped. α_i and β_i are regression coefficients, and the error term $\varepsilon_{i,t}$ represents other factors that affect asset prices around the event. These factors are assumed orthogonal to the explanatory variable of the regression.

Table 5 displays the estimation results of Equation 6 for the response of asset prices to macroeconomic news. The sample for all assets is from January 2000 to December 2022, with the exception of Bitcoin, whose sample is from January 2017 to December 2022. Rather than commenting on each individual regression, in the interest of brevity, we summarize the most salient aspects of the empirical results.

Most macroeconomic surprises, including retail sales, nonfarm payrolls, trade balance, PPI, and CPI, have a statistically significant effect on all asset prices (e.g., US dollar exchange rates, precious metal prices, and US stock prices) except Bitcoin. The sign of the estimated coefficients is, as expected, negative.

Better-than-expected job growth is associated with an appreciation of the US dollar, while a lower-than-expected US trade balance is associated with a depreciation of the dollar. The magnitude of these effects is in line with the estimated effects reported in previous studies, such as Andersen et al. (2007)) for developed economies exchange rates and Cai et al. (2009) for emerging markets currencies. For instance, a one-standard-deviation surprise of nonfarm payrolls influences the EUR exchange rate

by about 0.2%. This magnitude is sizable given that the 5-min standard deviation of EUR is 4 basis points. Consistent with the literature on the response of the US asset prices to US macro news (e.g., Faust et al. (2007)), the R^2 statistics is small. This finding indicates that the surprise component of the macro news explains only a small share of asset price returns, even in such a narrow 30-minute interval around the release.

Our Hypothesis 3 suggests that macroeconomic news affects the price of Bitcoin through a monetary policy reaction function channel. Furthermore, the sign associated with inflation and real macroeconomic news is negative as long as $\Phi_\Pi > 0$ and $\Phi_Y > 0$. To test Hypothesis 3 formally, we should expect that the coefficient estimates of inflation and real macroeconomic news are significantly negative.

The last column of Table 5 reports the effects of macro news on Bitcoin. The R^2 statistics is usually smaller than that of other assets, ranging between 0 (for retail sales, unemployment rate, jobless claims, trade balance, and consumer confidence) and 16% (for CPI excluding food and energy). Moreover, the CPI is the only significant coefficient, but only at the 5% level.[6] In stark contrast to other US assets and our Hypothesis 3, these findings indicate that Bitcoin does not systematically respond to news about US macroeconomic fundamentals.

5 Robustness checks

We examine the robustness of the estimation results of Section 3 along several dimensions: (i) we investigate whether the effects of monetary and macroeconomic surprises are sensitive to the sample starting date; (ii) we look at the effects of potential influential observations on the baseline empirical results; (iii) we consider longer event windows, such as one-hour and one day rather than 30 minutes. We show that the main results of the previous Section are robust for all assets but Bitcoin. Hence, this sensitivity analysis suggests that we need additional evidence to determine whether a link exists between macroeconomic data and Bitcoin.

While the sample for exchange rates, precious metals, and US stock prices starts in 2000, the sample for Bitcoin begins in 2017. One concern is whether the effects of monetary and macroeconomic surprises is sensitive to the sample starting date. To

[6] If we restrict the sample to the period 2017-2021, the CPI coefficient is no longer significant for Bitcoin, but it remains significantly different from zero for other assets.

Table 5: The response of asset prices to US macroeconomic news

The table reports the results from a regression of intraday percentage changes in exchange rates, precious metal prices, US stock prices and Bitcoin (from five minutes before the event to twenty-five minutes after) on monetary news (Panel A) and (standardized) macroeconomic news (Panel B). The sample is from January 2017 to December 2022. Exchange rates are defined as units of US dollars needed to buy one unit of foreign currency, such that a positive change implies a depreciation of the US dollar. The signs of the announcement surprises in the countercyclical indicators (unemployment rate and initial jobless claims) denoted with the † symbol have been flipped. Macroeconomic news that are larger than five times its in-sample standard deviation are filtered out. The econometric method is ordinary least squares with heteroskedasticity-consistent standard errors. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Industrial Production	-0.01	-0.01	-0.02***	-0.02**	0.01	0.04	0.01	0.01	0.05**	-0.02
R^2	0.3	0.2	3.4	2.3	0.9	2.4	0.1	0.1	4.2	0.1
Retail Sales	-0.04***	-0.03***	-0.08***	-0.06***	0.03**	-0.02	-0.07***	-0.07	0.10***	-0.01
R^2	4.0	3.3	14.6	8.1	1.4	0.3	4.0	1.2	10.7	0.0
Change in Nonfarm Payrolls	-0.11**	-0.08**	-0.13***	-0.13**	0.02	-0.06	-0.17***	-0.16***	0.10***	-0.06
R^2	7.6	7.1	9.4	8.3	0.3	1.4	6.7	3.3	3.9	0.3
Unemployment Rate†	-0.03*	-0.02*	-0.04**	-0.04**	0.03	0.02	-0.04	-0.06	0.04*	0.01
R^2	0.7	0.6	0.8	0.9	0.5	0.1	0.5	0.4	0.7	0.0
Initial Jobless Claims†	-0.01*	0.00	-0.02***	-0.02***	0.01***	0.01*	-0.04***	-0.04*	0.04***	-0.01
R^2	0.1	0.0	1.8	0.8	0.4	0.2	1.8	0.7	1.8	0.0
Trade Balance	-0.05***	-0.02**	-0.04***	-0.05***	0.00	-0.01	-0.02	-0.04	0.02*	-0.01
R^2	5.1	2.3	4.4	4.1	0.0	0.1	0.4	0.5	1.0	0.0
Consumer Confidence	-0.04***	-0.02*	-0.06***	-0.05***	0.03	0.01	-0.03	-0.02	0.16***	-0.01
R^2	4.5	1.7	13.0	7.2	1.8	0.1	0.9	0.2	16.4	0.0
ISM Manufacturing	-0.08***	-0.05***	-0.11***	-0.11***	0.02	-0.01	-0.11***	-0.10***	0.15***	-0.08
R^2	13.1	7.5	31.1	24.6	1.1	0.1	12.1	4.0	12.9	1.8
PPI Ex Food & Energy	-0.02*	-0.03***	-0.04***	-0.02**	-0.02*	-0.08***	-0.05**	-0.09***	-0.03**	0.07
R^2	1.3	3.7	4.7	1.8	1.1	9.1	3.4	2.9	1.7	1.0
CPI Ex Food & Energy	-0.09***	-0.09***	-0.10***	-0.07***	-0.13***	-0.17***	-0.10***	-0.16***	-0.24***	-0.66**
R^2	12.2	14.3	12.9	10.5	16	20.2	6.4	5.7	22.3	16.1

address this question, we re-estimate Equations 5 and 6 for the sample period January 2017-December 2022. Table 6 reports the estimation results for monetary news (in Panel A) and for macroeconomic news (in Panel B) and shows that the results of Section 4 continue to hold. All asset prices respond significantly to monetary policy surprises. In terms of macroeconomic news, we find that about half of the time one coefficient is significant at the 10% level of more. This figure compares with just one in ten for the case of Bitcoin. Hence, the fact that Bitcoin does not respond significantly to the Target and LSAP surprises and to most macroeconomic news is not an artifact of the sample start date.

Most monetary policy surprises are small, but a few are large, and these observations may significantly influence the baseline empirical results of Section 4. In addition, Table 1 shows that Bitcoin returns are volatile, on average about 0.5% in a 5-minute window, and display fat tails, with a kurtosis of above 1,000. To examine to what extent the regression results are robust to influential observations, we re-estimate Equations 5 and 6 using a quantile (median) regression (Koenker and

Table 6: The response of asset prices to monetary and macroeconomic news: Sample 2017 - 2022

The table reports the results from a regression of intraday percentage changes in exchange rates, precious metal prices, US stock prices, and Bitcoin (from five minutes before the event to twenty-five minutes after) on a constant and the (standardized) macroeconomic news. The row aligned with the macroeconomic news reports the estimated slope coefficient and the row below reports the regression R^2 (in %). The sample is from January 2000 to December 2022, and from January 2017 to December 2022 for Bitcoin. Exchange rates are defined as units of US dollars needed to buy one unit of the foreign currency, such that a positive change implies a depreciation of the US dollar. The signs of the announcement surprises in the countercyclical indicators (unemployment rate and initial jobless claims) denoted with the † symbol have been flipped. Macroeconomic news that are larger than five times its in-sample standard deviation are filtered out. The econometric method is ordinary least squares with heteroskedasticity-consistent standard errors. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The response of asset prices to monetary news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500
Constant	0.11***	0.09***	0.11***	0.11***	0.15***	0.23***	0.25***	0.43***	0.12**
Target	-6.37***	-5.96***	-6.04***	-6.94***	-5.53	-11.58**	-9.00**	-15.55***	-6.61**
Path	-2.62***	-2.44***	-2.91***	-2.73***	-3.17***	-4.86***	-4.77***	-6.19***	-3.81***
LSAP	-3.68*	-2.45	-4.90***	-4.65***	-7.50**	-8.37*	-10.37***	-11.55***	-0.7
R^2	0.445	0.523	0.651	0.548	0.384	0.466	0.544	0.467	0.583
Observations	47	47	47	47	47	47	47	47	47

Panel B: The response of asset prices to macroeconomic news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500
Industrial Production	0.00	0.00	0.01	0.00	-0.01	0.02	0.00	0.03	-0.02
R^2	0	0.1	0.3	0.3	0.6	1.8	0	0.6	0.7
Retail Sales	-0.02	0.00	-0.04**	-0.03*	0.05	0.03	-0.02	0.04	0.09*
R^2	1.1	0.0	3.5	2.8	3.1	1.1	0.3	0.5	9.1
Change in Nonfarm Payrolls	-0.05	-0.04	-0.09**	-0.06*	0.02	-0.02	-0.14**	-0.21**	0.05
R^2	4.3	3.1	9.3	5.2	0.5	0.4	9.3	6.2	1.7
Unemployment Rate†	-0.02	-0.02	-0.03*	-0.02	0.04	0.00	-0.06	-0.09	0.05
R^2	0.7	0.8	1.4	0.8	1.9	0.0	1.9	1.1	1.6
Initial Jobless Claims†	-0.01	0.01**	-0.01*	-0.01*	0.02*	0.03***	-0.05**	-0.04	0.02**
R^2	0.1	0.4	0.4	0.4	0.6	1.9	3.1	0.8	0.5
Trade Balance	-0.02**	-0.01	-0.02	-0.01	-0.03*	0.00	-0.02	-0.02	-0.02
R^2	3.7	0.2	1.4	0.6	2.3	0.0	0.8	0.2	0.6
Consumer Confidence	-0.02*	-0.02**	-0.03**	-0.02	-0.01	-0.04	-0.04	-0.09**	0.09**
R^2	3.9	4.0	7.5	3.3	0.2	1.8	3.0	4.9	8.5
ISM Manufacturing	-0.04**	-0.05***	-0.09***	-0.06***	-0.07**	-0.03	-0.13***	-0.18***	0.09**
R^2	7.3	8.3	26.0	16.0	10.4	1.7	19.8	18.6	6.0
PPI Ex Food & Energy	-0.02	0.00	-0.02	-0.03**	-0.03	-0.04	-0.04	-0.08	-0.02
R^2	2.4	0.0	2.8	7.6	2.3	4.0	2.6	2.4	0.3
CPI Ex Food & Energy	-0.18***	-0.18***	-0.21***	-0.14***	-0.23***	-0.29***	-0.19**	-0.26*	-0.45***
R^2	23.4	23	25.3	24.5	34.9	33.7	15.6	9.3	27.2

Bassett (1978)), rather than OLS. Median regressions are more robust to outliers (in the same way that the median is less sensitive than the mean to outliers in the sample) and are more efficient than OLS estimators over a wide class of non-Gaussian error distributions. Table 7 reports the regression results for monetary news (in Panel A) and macroeconomic news (in Panel B). Importantly, the estimation results remain similar when the median regression estimator is used. The effects of monetary and macroeconomic news remain highly significant for exchange rates, precious metals and stock prices, but not for Bitcoin. This finding confirms that Bitcoin has different conditional time series dynamics compared with other US asset prices, and that these results of are not driven by outliers.

Table 7: The response of asset prices to monetary and macroeconomic news: Median regression

The table reports the results from a regression of intraday percentage changes in exchange rates, precious metal prices, US stock prices and Bitcoin (from five minutes before the event to twenty-five minutes after) on a constant, Target, Path and LSAP factors (in Panel A), and on a constant and the (standardized) macroeconomic news (in Panel B). The sample is from January 2000 to June 2022 for all assets but Bitcoin that is from January 2017 to June 2022. Exchange rates are defined in units of US dollars needed to buy one unit of the foreign currency, such that a positive change implies a depreciation of the US dollar. Macroeconomic news that are larger than five times its in-sample standard deviation are filtered out. The row aligned with the macroeconomic news reports the estimated slope coefficient and the row below reports the regression R^2. The signs of the announcement surprises in the countercyclical indicators (unemployment rate and initial jobless claims) denoted with the † symbol have been flipped. The econometric method is quantile regression. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively, and are based on robust (Huber) standard errors.

Panel A: The response of asset prices to monetary news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Constant	0.05**	0.04**	0.04**	0.05**	0.04	0.04	0.12***	0.18***	0.06	0.21
Target	-3.06***	-1.82***	-1.44**	-1.69**	-0.84	-1.22*	-4.21***	-3.23**	-2.94	-2.26
Path	-1.91***	-1.53***	-1.47***	-2.00***	-0.69**	-1.76***	-2.90***	-3.93***	-2.05***	-5.65*
LSAP	-3.65***	-3.37***	-3.57***	-3.02***	-1.49	-1.79***	-6.31***	-6.19***	-3.28***	1.74
R^2	0.228	0.213	0.258	0.216	0.064	0.116	0.244	0.165	0.141	0.081
Observations	183	183	183	183	183	176	154	153	182	47

Panel B: The response of asset prices to macroeconomic news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Industrial Production	-0.01	-0.01*	-0.01*	-0.02***	0.02	0.03	-0.02	-0.03	0.04*	-0.04
R^2	0.3	0.8	1.6	1.6	0.3	0.6	0.4	0.2	1.6	0.3
Retail Sales	-0.03*	-0.04***	-0.08***	-0.04*	0.02**	0	-0.07**	-0.06*	0.09***	0.07
R^2	1.7	2.7	8.7	2.6	1.1	0	2.5	1.4	5.7	0.5
Change in Nonfarm Payrolls	-0.15**	-0.10**	-0.17***	-0.16**	0.03	-0.03	-0.21*	-0.11**	0.12	-0.04
R^2	3.8	3.2	5.4	4.1	0.1	0.1	3.2	1.4	2.4	0
Unemployment Rate†	-0.03	-0.03	-0.03**	-0.02	0.03	0.02	-0.04	-0.07	-0.01	0.03
R^2	0.3	0.4	1.2	0.4	0.4	0.3	0.4	0.8	0	0.1
Initial Jobless Claims†	-0.01	0	-0.02***	-0.02***	0.01***	0.02***	-0.05***	-0.07**	0.03***	0.03
R^2	0.1	0	1.2	0.5	0.4	0.3	1.5	0.8	1.4	0
Trade Balance	-0.04**	-0.02	-0.03***	-0.03*	0	-0.02	-0.02	-0.01	0.01	0.02
R^2	2.1	0.5	2.3	1.2	0	0.3	0.1	0.1	0.5	0.2
Consumer Confidence	-0.02**	-0.02	-0.04***	-0.03***	0.01	0	-0.02	0	0.10***	-0.02
R^2	1.2	1	5.7	2.6	0.2	0	0.5	0	4.1	0
ISM Manufacturing	-0.07***	-0.05***	-0.11***	-0.10***	0.02	-0.02	-0.11***	-0.11***	0.13***	-0.06
R^2	7.7	7.1	18.7	12.6	0.5	0.1	6.7	2.3	6.5	0.9
PPI Ex Food & Energy	-0.01	-0.03***	-0.03***	-0.02**	-0.02*	-0.07***	-0.03	-0.05	-0.03**	-0.09
R^2	1.1	1.8	2.4	1.8	1.2	5.1	1.2	0.8	1.8	2.1
CPI Ex Food & Energy	-0.06***	-0.04***	-0.06***	-0.06***	-0.07***	-0.12***	-0.06**	-0.15***	-0.09***	-0.35*
R^2	4.6	2.5	3.3	4.4	6.6	6	1.8	2.2	6.8	3.6

The jump in asset prices in a small window around the announcement reflects the causal impact of the news, and likely little else (see, e.g., Gurkaynak and Wright (2013)). With longer windows, other shocks may matter as well, and thus the regression coefficients are estimated less precisely. If the window size is too small, however,

it may not capture the complete effect of the news. To check the sensitivity of the estimation results to the window size, we consider longer event windows, namely one-hour and one day rather than 30 minutes. Table 8 displays the estimation results of Equation 5 in Panel A and Equation 6 in Panel B in one-hour window around the release (from five minutes before the event to fifty-five minutes after)[7]. The sample period is from January 2000 to December 2022 for all assets except Bitcoin, which relies on the sample January 2017 - December 2022. A key result is that the Path surprise is no longer significant for Bitcoin, but it remains significant for all assets except MXN. Results for macro news are, however, not sensitive to the window size. These findings cast some doubts on the significance of monetary news on Bitcoin returns and suggest that we need additional evidence to determine whether a link exists between macroeconomic data and Bitcoin.

[7]In the interest of brevity, the results for daily data are available in a separate Appendix. As expected (see, e.g., Corbet et al. (2020) and Pyo and Lee (2020)), the standard errors are much larger, and several of the announcement effects are no longer statistically significant.

Table 8: The response of asset prices to monetary and macroeconomic news: One-hour event-window

The table reports the results from a regression of intraday percentage changes in exchange rates, precious metal prices, US stock prices and Bitcoin (from five minutes before the event to fifty-five minutes after) on a constant, Target, Path and LSAP factors (in Panel A), and on a constant and the (standardized) macroeconomic news (in Panel B). The sample is from January 2000 to June 2022 for all assets but Bitcoin that is from January 2017 to June 2022. Exchange rates are defined in units of US dollars needed to buy one unit of the foreign currency, such that a positive change implies a depreciation of the US dollar. Macroeconomic news that are larger than five times its in-sample standard deviation are filtered out. The row aligned with the macroeconomic news reports the estimated slope coefficient and the row below reports the regression R^2. The signs of the announcement surprises in the countercyclical indicators (unemployment rate and initial jobless claims) denoted with the † symbol have been flipped. The econometric method is ordinary least squares with heteroskedasticity-consistent standard errors. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively, and are based on robust (Huber) standard errors.

Panel A: The response of asset prices to monetary news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Constant	0.04	0.03	0.02	0.05*	0.08**	0.10**	0.21***	0.37***	0.10**	0.58*
Target	-2.64***	-2.32***	-1.64**	-2.28***	-1.21	-2.21**	-5.14***	-5.95***	-5.00***	-12.01
Path	-1.87***	-1.40***	-1.27***	-1.87***	-1.13***	-2.05***	-3.10***	-3.52***	-1.66***	-1.84
LSAP	-4.49***	-3.88***	-4.46***	-3.98***	-3.62***	-4.40***	-8.27***	-9.69***	-4.28***	-4.86
R^2	0.413	0.404	0.411	0.36	0.189	0.214	0.394	0.26	0.221	0.022
Observations	183	183	183	183	183	177	143	143	182	47

Panel B: The response of asset prices to macroeconomic news

	EUR	GBP	JPY	CHF	MXN	ZAR	Gold	Silver	S&P 500	Bitcoin
Industrial Production	0	0	-0.02**	-0.02	0.01	0.07	0.05	0.06	0.06	-0.23
R^2	0	0	1.4	0.8	0.1	3.8	1.4	0.8	2	2.7
Retail Sales	-0.05***	-0.04***	-0.09***	-0.08***	0.02	-0.04*	-0.07***	-0.09*	0.09***	0.01
R^2	3.7	4.6	12.2	6.4	0.9	1.1	3.4	1.6	8.4	0
Change in Nonfarm Payrolls	-0.12***	-0.09***	-0.13***	-0.13**	0	-0.09**	-0.15***	-0.15**	0.10***	-0.01
R^2	7.2	7.4	7.4	7.2	0	2.1	3.9	2.2	3.8	0
Unemployment Rate†	-0.06***	-0.04***	-0.06***	-0.06***	0.03	-0.02	-0.05	-0.06	0.05**	-0.06
R^2	1.6	1.6	1.4	1.6	0.4	0.1	0.5	0.3	1.1	0.3
Initial Jobless Claims†	0	0	-0.02***	-0.01**	0.01	0.01	-0.03**	-0.03	0.03***	-0.07
R^2	0	0	1	0.3	0.1	0.1	0.7	0.2	1	0.4
Trade Balance	-0.05**	-0.02	-0.03*	-0.04*	0.02	0.01	-0.01	0	0.02	0.03
R^2	3	0.8	1.6	2	0.5	0	0	0	0.5	0.1
Consumer Confidence	-0.02	-0.01	-0.04***	-0.05***	0.02	0	-0.01	0.04	0.15***	0.06
R^2	1.1	0.5	4.2	4.1	0.6	0	0	0.3	8.8	0.4
ISM Manufacturing	-0.08***	-0.06***	-0.12***	-0.12***	0.04*	0.01	-0.13***	-0.10**	0.15***	-0.05
R^2	8.9	7.7	23.1	17	1.8	0.1	10.5	2.5	9.8	0.4
PPI Ex Food & Energy	-0.01	-0.03***	-0.04***	-0.02	-0.01	-0.09***	-0.02	-0.10**	-0.03*	0.1
R^2	0.3	2.6	3	0.6	0	7.4	0.4	2	1	1.3
CPI Ex Food & Energy	-0.09***	-0.10***	-0.09***	-0.08***	-0.13***	-0.18***	-0.10***	-0.17**	-0.25***	-0.74***
R^2	9.9	12.9	10.2	7.8	16.5	15.8	4.7	3.9	22.4	16.4

6 Conclusions

Is macroeconomic news driving Bitcoin? In this paper, we conduct a systematic analysis of the impact of macroeconomic and monetary policy news on Bitcoin's price. We model Bitcoin as an asset with no intrinsic value for which its current price depends on the discounted value of its future price. In our empirical analysis, we find that Bitcoin is unresponsive to both monetary and macroeconomic news. In particular, the result that Bitcoin does not react to monetary news is puzzling as it casts some doubts on the role of discount rates in pricing Bitcoin. Given the short sample used in the analysis, however, more evidence is needed to assess the disconnect between Bitcoin and macroeconomic fundamentals.

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