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Factors affecting Bitcoin Prices

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I. Background

Cryptocurrencies becoming a global phenomenon these days, are emerging as a better alternative to fiat currencies these days, especially with the increasing scope of metaverse. One such cryptocurrency with about 80% trade by volume is Bitcoin. It is an encrypted digital currency known which is created, distributed, traded, and stored with the use of a decentralized ledger system, known as a blockchain. Decentralised cause only the people who are a part of the network runs the whole system, there is no central authority involved, which is one of their most striking features. Bitcoin miners run complex computer rigs and verify groups of transactions called blocks. Upon success, these blocks are added to the blockchain record, and the miners are rewarded with a small number of bitcoins. Trading participants in the Bitcoin market can buy or sell tokens through peer-to-peer network, which marks a change of era from e-finance to p2p finance. The bitcoin balances are maintained on a public ledger called blockchain which helps to prevent double counting and ensures authenticity as the large amount of computing power required to falsify(change) a block, eventually decreases the scope for committing fraud. These coins can be purchased over an exchange where their prices are quoted alongside the market prices of other cryptocurrencies or can be purchased from an individual. The miners, traders, service providers and the exchange more or less constitute the entire of the bitcoin ecosystem.

The emergence of the core ideas behind blockchain technology dates back to the late 1980s and early 1990s when Leslie Lamport was the first to throw light into this concept in by developing the Paxos protocol, in his paper- 'The Part-Time Parliament to ACM Transactions on Computer Systems' which was published in a 1998 journal. The paper talks about a model for reaching to a consensus on a result in a network of computers where the computers or network itself may be unreliable. In 1991, an electronic ledger came into picture, using list of signed information in it for digitally signing documents, without changing the structure of any of the signed documents.

Both of these concepts, combined were eventually applied to electronic cash and this was the foundation of bitcoins era when in 2008, Satoshi Nakamoto published a paper entitled "Bitcoin: A Peer-To-Peer Electronic Cash System". This paper described a method for peer- to-peer transfer of electronic cash that would allow online payments to be sent directly from one party to another without the need of any central body, like a financial institution. Bitcoin was the first realization of this concept. Now "cryptocurrencies" is the label that is used to describe all networks and mediums of exchange that uses cryptography to secure transactions-as against those systems where the transactions are channelled through a centralized trusted entity. Eventually an open-source program was released implementing the new protocol, beginning with the Genesis block of 50 coins. Anyone can install this open- source program to become part of this peer-to-peer network. The popularity of the Bitcoin has increased rapidly since then. Moreover, the underlying blockchain technology is now finding new range of applications beyond finance.

In this paper, we are going to study the impact of certain macroeconomic factors on bitcoin pricing and use the proxy variables to explain the impact on bitcoin pricing during various macro financial events that might have had a bearing on its prices, either in a positive or a negative way. We will also be studying the liquidity of bitcoins.

II. Literature Review

Buchholz et al. (2012), propose the supply and demand of digital currencies as the relevant factors. Kristoufek (2013), and Bouoiyour and Selmi (2015) point that the attractiveness to investors acts as a strong determinant. Using ARDL Bounds Testing approach, innovation accounting method and VEC Granger causality test, the short-run and the long-run links between Bitcoin price and its potential drivers like investors' attractiveness, exchange-trade volume, monetary Bitcoin velocity, estimated output volume, hash rate, gold price and Shanghai stock market were estimated and it was found that in the short-run, the investors attractiveness, exchange-trade ratio, the estimated output volume and the Shangai index have significant positive

effect on the Bitcoin price, while the monetary velocity, the hash rate and the gold price have no influence. In the long-run, all of these effects observed in the short term become statistically insignificant.

According to Kristoufek (2013), the price formation of Bitcoin cannot be explained by standard economic theories, such as future cash-flows model, purchasing power parity, interest rate parity, because several features of currency supply and demand, which usually form the basis of currency price, are absent on Bitcoin markets.

Baek & Elbeck (2015) examined the effect of specific macro-economic variables like CPI, Industrial production, real consumption expenditure etc. by conducting regression analysis using heteroscedasticity and auto relation consistent correlation estimator on bitcoin market returns and found out that these external factors do not have significant effect and that Bitcoin volatility is internally (supply and demand forces).

Supply and demand are traditional market forces that determine the price of all financial assets including Bitcoin (Guizani and Nafti, 2019).

Baek & Elbeck (2015) argued that the price of Bitcoins is mainly driven by the interaction of supply and demand fundamentals (as it happens with other currencies or standard commodities). In this context, the impact of mining technology – which affects the production cost structure and thus the supply side of the market – on Bitcoin prices has been investigated by Kristoufek (2013). However, the supply of Bitcoins evolves according to a publicly known algorithm and the level of demand is not fully determined by the fundamentals of the underlying economy but also depends on expectations about future price movements. Therefore, the standard economic theory might not adequately describe changes in Bitcoin prices and one should also take short-run speculative investment incentives or expectations into account. These expectations might be reflected in collective sentiment, thus raising the question of measuring public mood and studying its impact on the evolution of Bitcoin prices.

The traditional regression analysis states that the market capitalization of Bitcoin is positively associated with the value of Bitcoin and the world inflation rate and inversely related with the price of Ethereum significantly during 2019- 2021.

Van Wijk (2013) determines a number of global macro-financial developments affecting the market prices. He stresses the role of global macro financial development, captured, e.g., by stock exchange. indices, exchange rates and oil price measures, in determining BitCoin price.

For example, the Dow Jones index, the euro–dollar exchange rate and oil price have a significant impact on the value of BitCoin in the long run. Connell (2017) found that stock market does have an overall influence on the bitcoin prices. Bitcoins are considerably sensitive to exchange rate fluctuations and is useful in hedging against local currency price fluctuations, specifically USD thus helping to manage risk. (Tully & Lucey, 2007; Dyhrberg, 2016).

Polasik et al. (2015) found out that bitcoin returns are majorly driven by its popularity but also found out how various country related characterictics like governance and company related characteristics interact with the amount of bitcoin sales. They found out that company structure, payment methods, customers' knowledge base and size of economy have a significant bearing on bitcoin returns.

(Ciaian et. Al, 2015) found out that market forces of Bitcoin supply and demand have a significant impact on Bitcoin price. Secondly, speculative behavior of investors affects Bitcoin price in both short and long run. The short-run price fluctuations are driven by online information search about Bitcoin in its initial phases when it was little known. Over the years, when it became more established on financial markets, the impact of online searches became negligible. Also, their estimates did not support prior findings that macro-economic indicators are driving Bitcoin price. Also, it is important to examine different drivers of Bitcoin price simultaneously, to avoid getting biased results when looking at one factor at a time.

As we know that Bitcoin supply is exogenous, it automatically makes the demand-side variables main drivers of Bitcoin price formation. This theory is supported by Ciaian et al. (2016) estimations which states that the demand-side variables impose a significant effect on Bitcoin's price as compared to supply side variables. DeLeo and Stull (2014) uses total number of Bitcoin transactions which essentially defines demand of users for Bitcoin, and discovers that the number of Bitcoin transactions have a major impact on Bitcoin pricing.

Badev and Chen (2014) estimates the velocity of Bitcoin by checking how often Bitcoins' change addresses. Furthermore, the paper assumed that addresses that had transactions within the past week can be considered active and frequently used. However, addresses that have not been used within the past few weeks can be considered an investment. DeLeo and Stull (2014) utilizes a time series model to study the effect of Bitcoin velocity on Bitcoin's price.

The paper employs Bitcoin days destroyed, which is derived from the number of Bitcoins per transaction multiplied by the number of the days that Bitcoin has stayed in one address, as a proxy for Bitcoin velocity and discovers that it is negative and significant at the 1 percent level. Ciaian et al. (2016) and

Bouoiyour and Selmi (2015) also use Bitcoin days destroyed as a proxy for the monetary velocity of Bitcoin and find it insignificant.

The estimations given by (Georgoula et.al, 2015) revealed a negative short-run relationship between Bitcoin prices and USD-Euro exchange rate. prices. While it was found that The Standard and Poor‟s 500 index has a negative effect on Bitcoin prices in the long run, which shows investors treat Bitcoins and stocks as substitutes of each other.

Hypotheses and methodology

As discussed in the literature due to ambiguity regarding macro-economic factors affecting bitcoin prices so I have taken the null hypotheses stating that
H0- There is no effect of economic variables on Bitcoin prices

The dependent variable here is price of bitcoin and five independent variables were used for the analysis, including-
1. S&P 500 index- reflects overall health of the American economy, as a whole and is considered to act like a substitute of Bitcoins, as mentioned in the literature analysis.
2. Volume traded- Gives an idea of number of trades and thus reflects the supply- demand scenario of the market and thus can act as a good proxy.
3. Gold prices- Gold is said to be a safe haven to risky asset class, especially when the economy is in turmoil or in other words it acts a good substitute of bitcoins although many researchers have denied this relationship between gold and bitcoins.
4. Exchange rate- Since Bitcoin is a global phenomenon, this variable acts as an important determinant of state of the market, in context of individual countries. Additionally, a negative relationship has been established between USD/EUR and Bitcoin prices, as mentioned in the literature analysis as well.
5. Bond yield rate- This can be considered as the risk-free rate since bonds are a good alternative to risky assets thus technically, they are supposed to have a negative relationship with Bitcoin price.

All of the data was collected on weekly basis mainly from two databases of investing.com and World Bank for a 10-year time period from 2012-2022 basically covering the entire time period since the beginning of Bitcoin market. Linear regression is run on individual variables and plotted on scatter charts along with the regression results.

III. Results

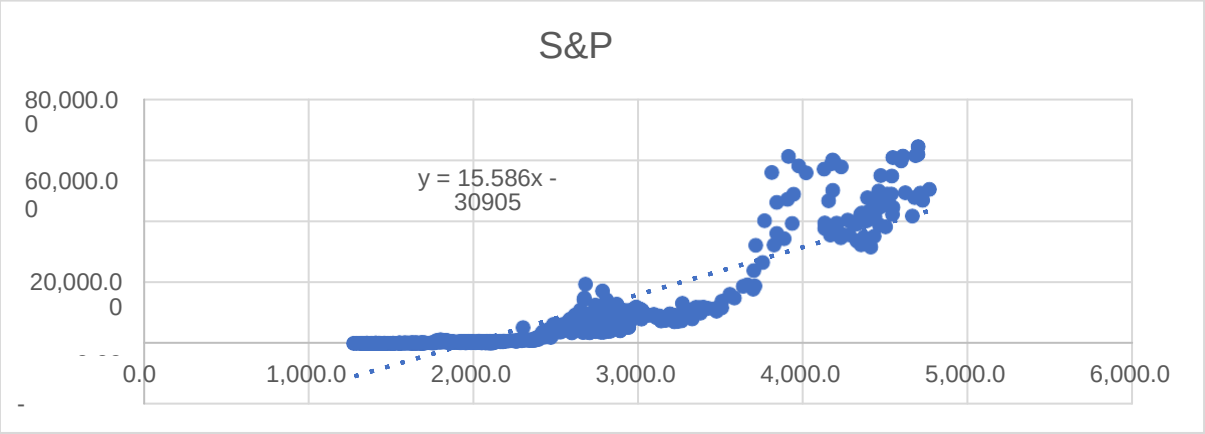


Fig 1.1

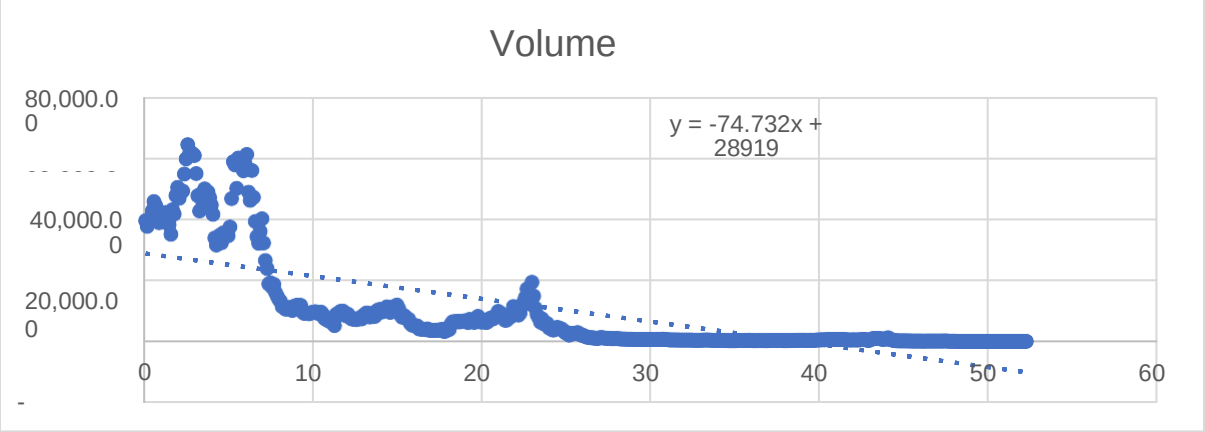


Fig 1.2

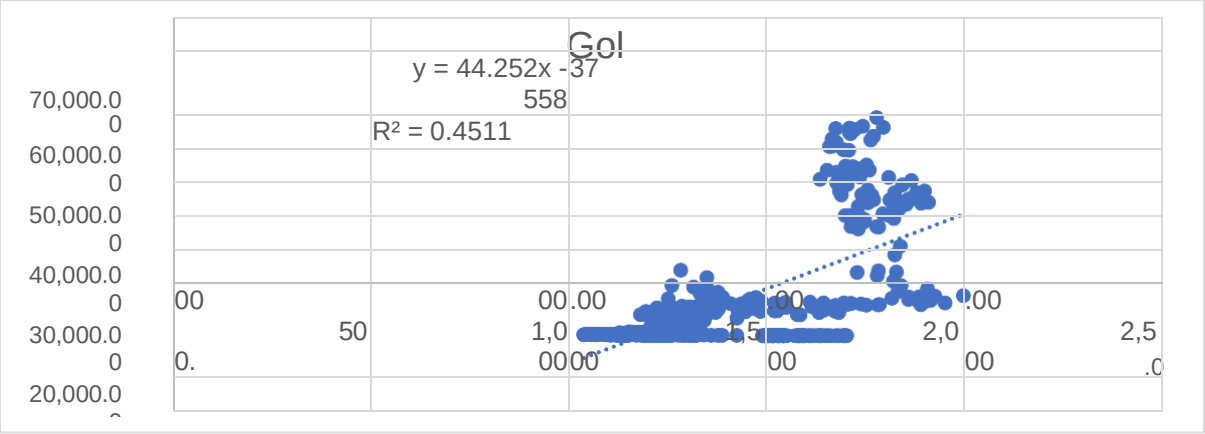


Fig 1.3

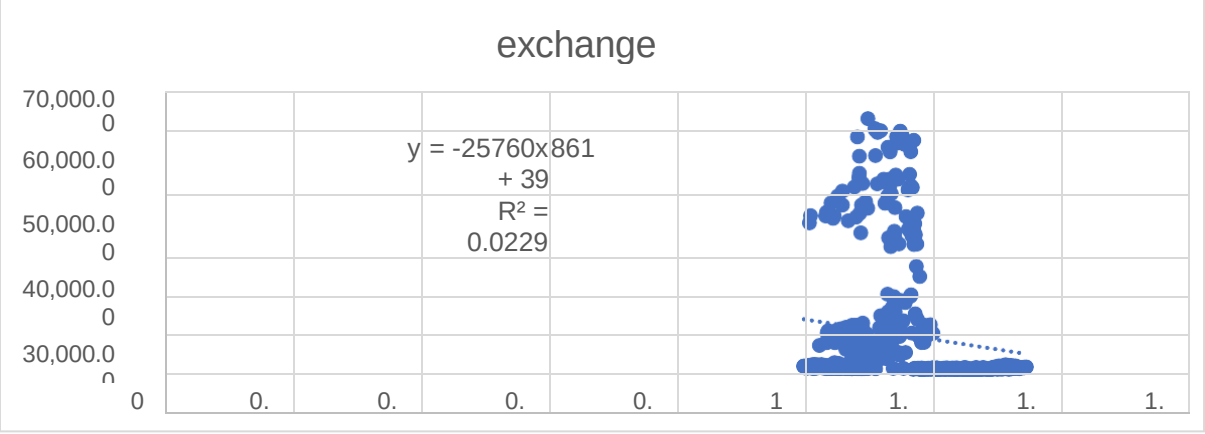


Fig 1.4

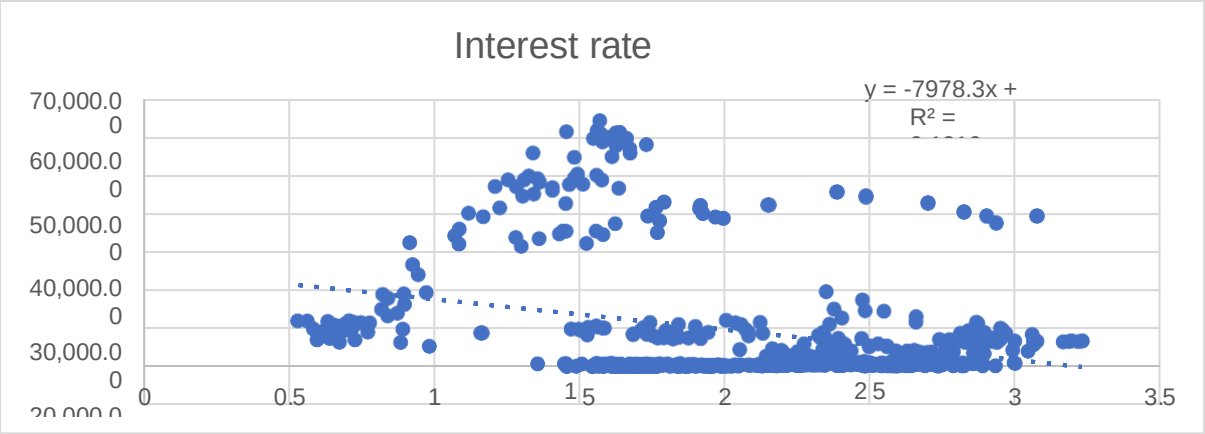


Fig 1.5

S&P 500 index and gold (Fig 1.1 & Fig 1.3) show positive correlation with a strong to moderate explanatory power with Bitcoin prices and thus can be concluded to be more of a volatile risky asset that does well when these assets do well, instead of being a safe haven. Thus gold and S&P 500 index gives a good idea regarding the price movement of Bitcoins Volume traded is a function of both supply and demand but since bitcoin market is mainly driven by demand forces (as discussed in the literature review), so the negative relationship a (Fig 1.2) represents a stronger case for bears since price is dragged down for a lower bid for instance if volume is high but price is low then traders expecting a rise in price are forced to sell for lower than they entered the market thus this acts as a worrying signal for investors.
The relationship with exchange rates (Fig 1.4) is at par with established results in prior literature. Bond yield rate shows a negative relationship (Fig 1.5) which states that bonds are a risk-free substitute of a risky financial asset like, Bitcoins.
From above, it can be seen that S&P 500 index, volume traded and gold are good enough indicators of Bitcoin's price movements.

Timeline study

For the timeline study, we have studied the changes in bitcoin pricing with respect to the three indicators- S&P 500 index, volume traded and gold triggered by specific macro- financial events. For this study, four timelines were chosen marked by major events that might have shaken the bitcoin market, as follows-
Timeline 1 (Feb'20-Aug'20)- When Covid-19 hit the economy and all financial markets crashed as a result, when it lost 50% of its value in a single day. This is when market analysts started calling it as a risky financial asset more than a safe haven.
Timeline 2 (Feb'21-May'21)- When there was a price surge of bitcoins after Tesla invested about 1.5 billion dollars in this cryptocurrency and also claimed this as a new mode of payment, to be adopted by the company.
Timeline 3 (June'21-Sep'21)- A price drop following news that Tesla has either sold or is planning to sell its bitcoin holdings, causing panic among investors especially after Elon Musk tweeted that tesla would not accept bitcoin as a mode of payment due to high energy consumption during Bitcoin mining process.
Timeline 4 (Jan'22-March'22)- When Bitcoin price experienced severe fluctuations during the Ukraine-Russia war, a price hike followed after an initial price slump as uncertainties continued to increase.

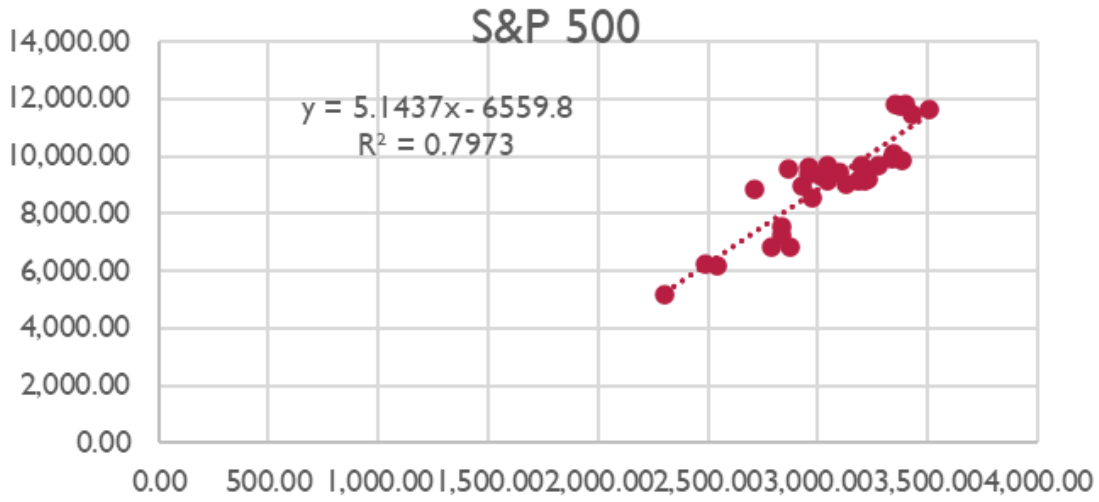
We will see whether the correlation between the three indicators with bitcoin price during these periods are at par with the previously discussed results or not or in other words if these three indicators are able to explain the price movement during these time periods as well like before.

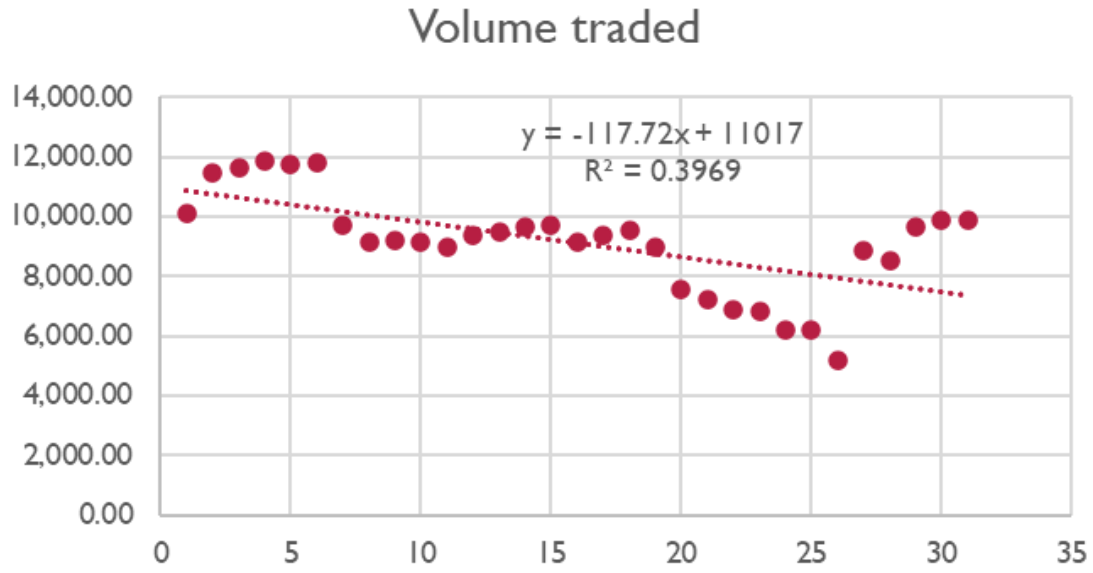
IV. Results

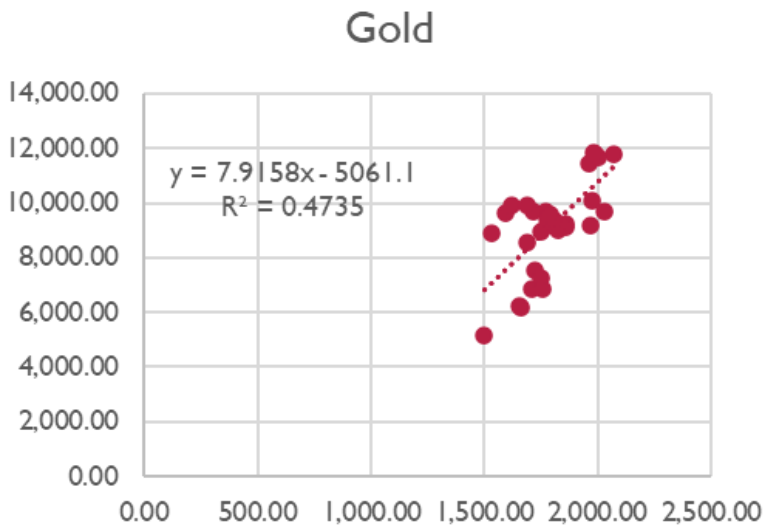
The results in timeline 1 are at par with the previously discussed results with a good to moderate explanatory power of the three indicators thus this event didn't have a major shocking impact on Bitcoin price movement. In timeline 2, S&P 500 index and Gold shows a negative relationship with bitcoins unlike before, showing that these assets act as substitutes of each other. Even volume traded shows a positive trend, which shows number of trades drives investors' expectations due to Elon Musk's increased confidence and gained acceptance as a mode of payment which eventually make this asset more attractive and price increases. The results from timeline 3 can be explained in a way that when investors lost confidence from bitcoins due to

Tesla's unprecedented move, they switched to acquiring safer assets like gold and thus the negative relationship between them, rest things remaining constant. During Timeline 4, the indicators have no significant impact on the price movement thus showing that prices in that period could not be explained by market fundamentals. There was an initial price drop when the war started but then people felt bitcoins and other crypto assets as a better investment option due to no institutional involvement, unlike stocks and other financial assets.

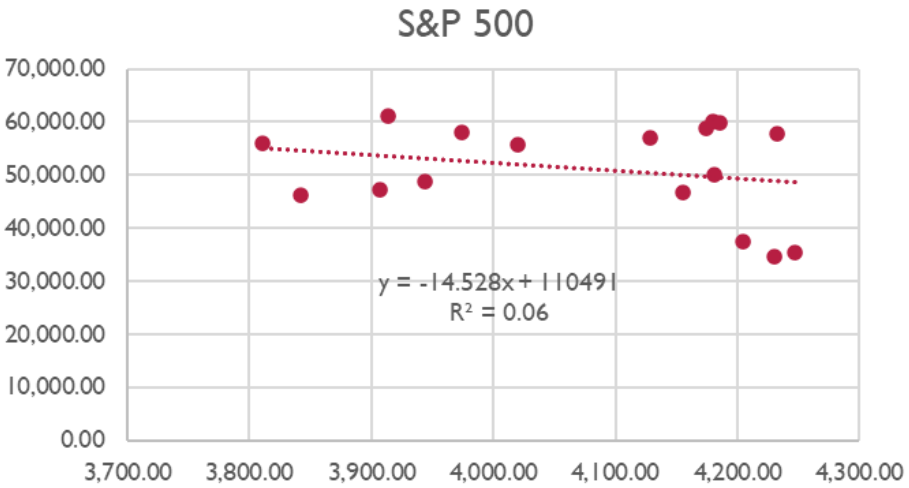
Timeline 1

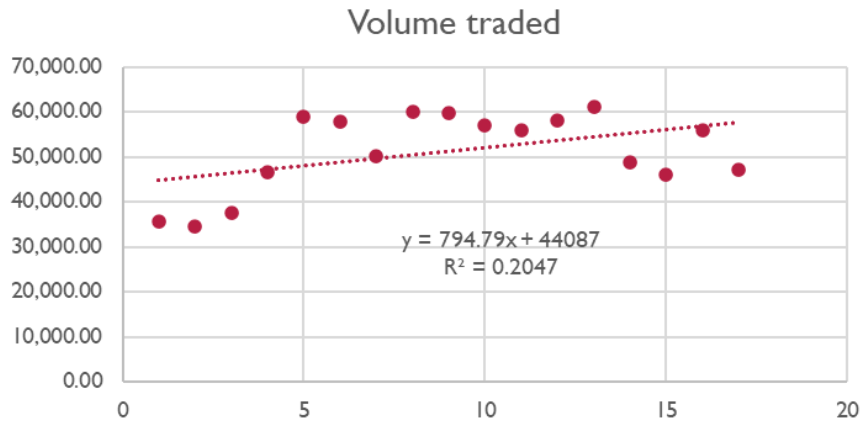


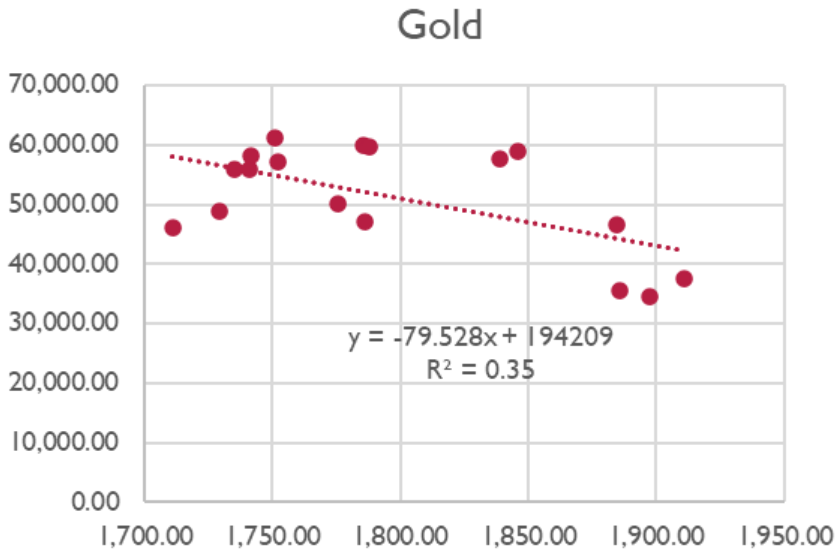



Gold
14,000.00
12,000.00
10,000.00
8,000.00
6,000.00
4,000.00
2,000.00
0.00
y = 7.9158x - 5061.1
R² = 0.4735
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00

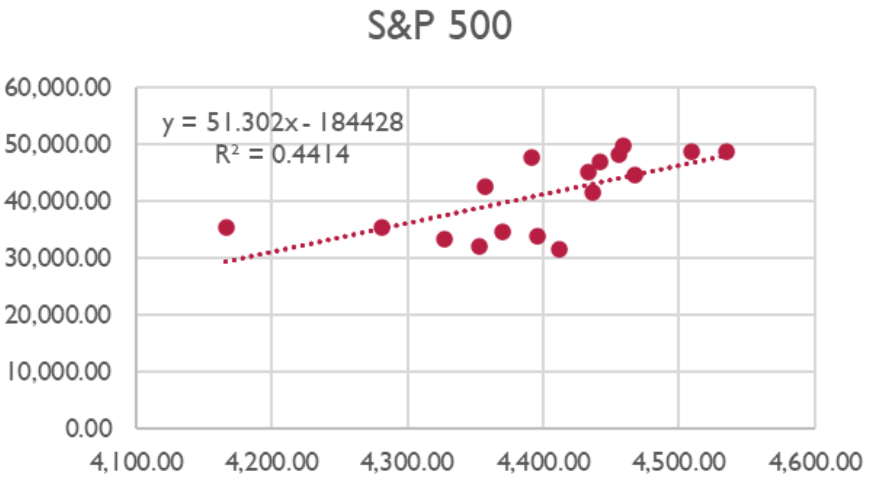
Timeline 2

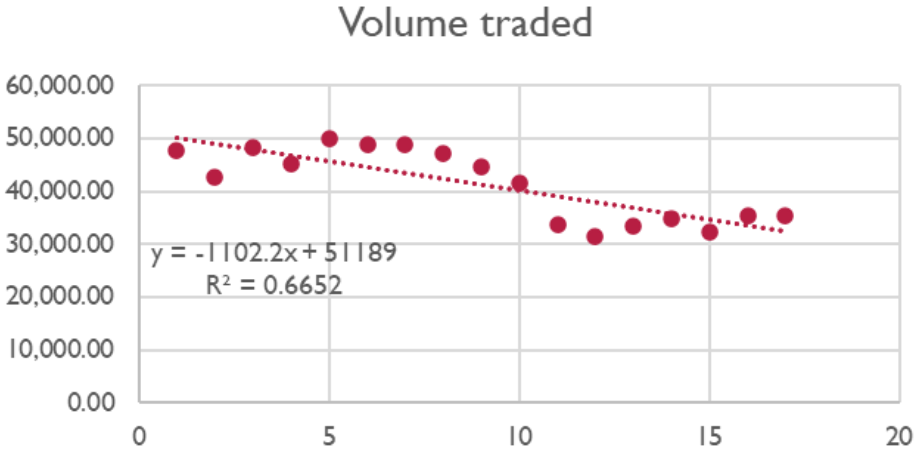

S&P 500
70,000.00
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
y = -14.528x + 110491
R² = 0.06
3,700.00
3,800.00
3,900.00
4,000.00
4,100.00
4,200.00
4,300.00

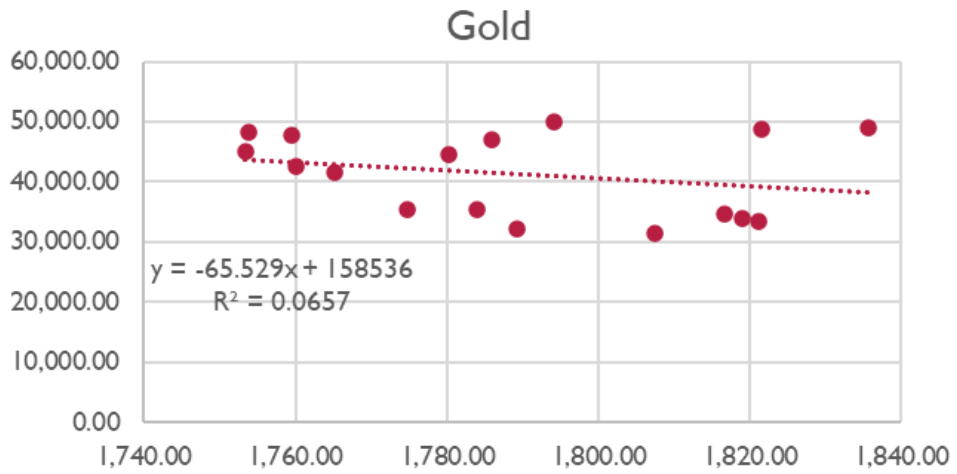

Volume traded
70,000.00
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
y = 794.79x + 44087
R² = 0.2047
0
5
10
15
20


Gold
70,000.00
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
1,700.00
1,750.00
1,800.00
1,850.00
1,900.00
1,950.00
y = -79.528x + 194209
R² = 0.35

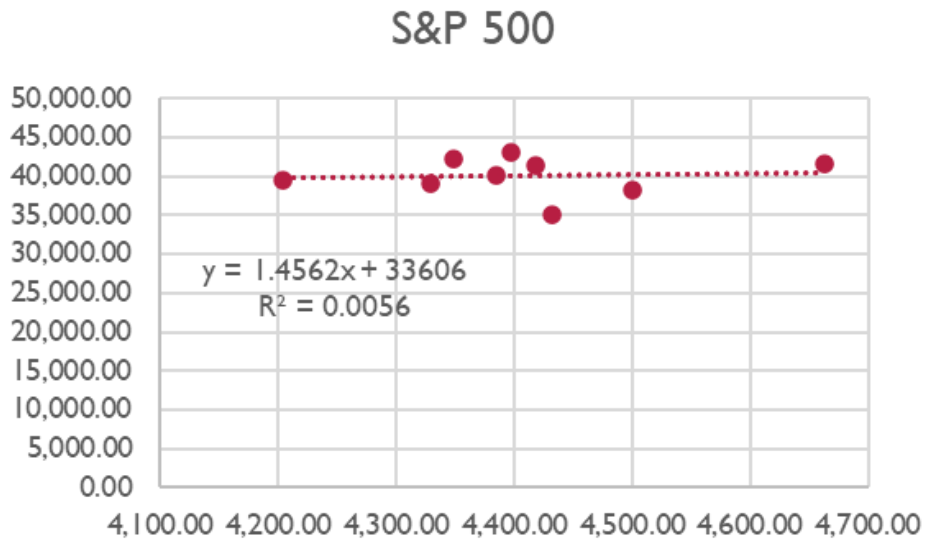
Timeline 3

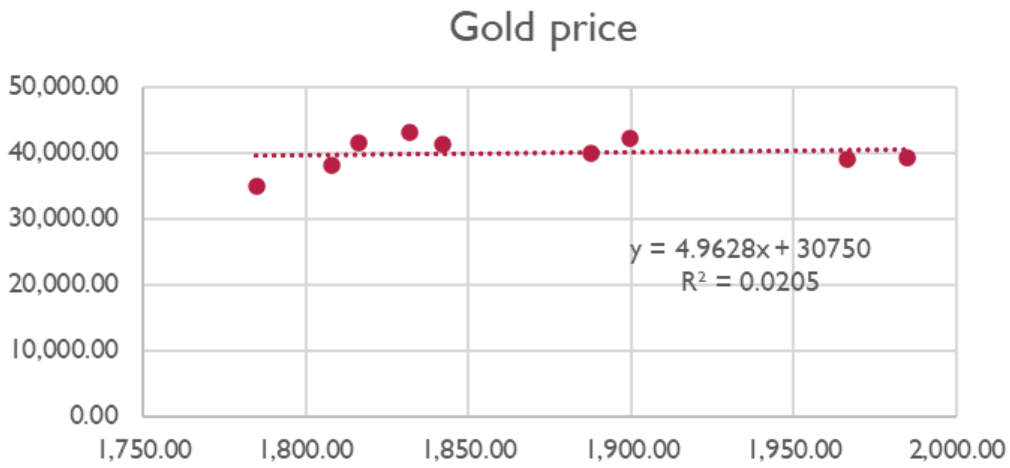

S&P 500
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
4,100.00
4,200.00
4,300.00
4,400.00
4,500.00
4,600.00
y = 51.302x - 184428
R² = 0.4414

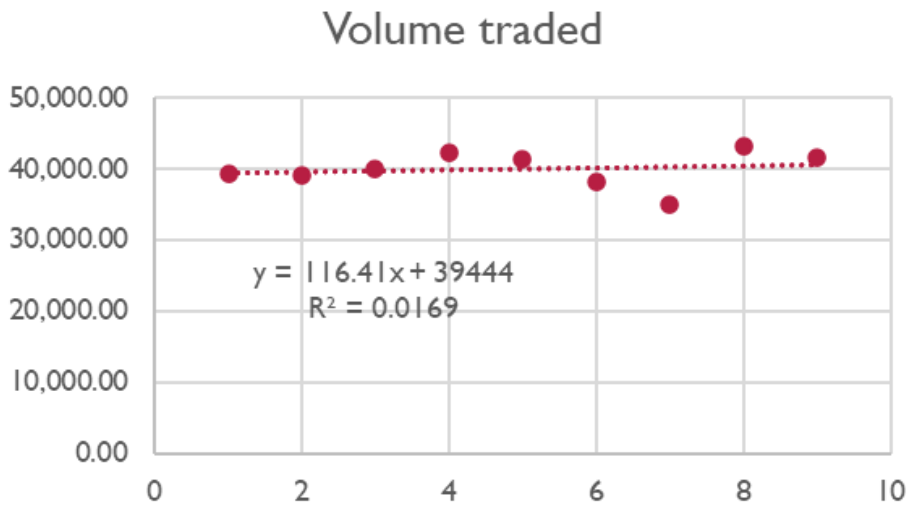

Volume traded
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
0
5
10
15
20
y = -1102.2x + 51189
R² = 0.6652


Gold
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
y = -65.529x + 158536
R² = 0.0657
1,740.00
1,760.00
1,780.00
1,800.00
1,820.00
1,840.00

Timeline 4


S&P 500
50,000.00
45,000.00
40,000.00
35,000.00
30,000.00
25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
y = 1.4562x + 33606
R² = 0.0056
4,100.00
4,200.00
4,300.00
4,400.00
4,500.00
4,600.00
4,700.00


Gold price
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
y = 4.9628x + 30750
R² = 0.0205
1,750.00
1,800.00
1,850.00
1,900.00
1,950.00
2,000.00



Liquidity Study

With increasing scope of Metaverse, the trading volume of cryptocurrencies, mainly Bitcoin have significantly increased implying more liquidity in the crypto market and increased investors' confidence, therefore. But since liquidity increases with more institutional involvement, there still remains an increased risk of liquidity transmission across cryptocurrencies. Massive price swings have brought about sudden and synchronized movements in cryptocurrency liquidity over the past few years, raising serious concerns among investors and policymakers (Al-Yahyaee et al. 2020). We are studying here how liquidity affects bitcoin returns.

There are various proxies to measure liquidity in use widely as given in the prior literature, which includes return reversal, price impact, different variations of spread, turnover, zero trading days and price impact. Domowitz and Wang (2005) point out the distance between the demand and supply represents the difference in traders' willingness to trade. The greater the supply-demand distance, the less the liquidity since it is more difficult to match orders and get a transaction done. When supply and demand meet perfectly, that is when liquidity is infinitely high although it is an ideal situation because in reality, supply and demand is always apart, and how far apart they are determines the liquidity.

This study used the 'price impact' proxy as measure of liquidity. Amihud (2002) suggested the illiquidity ratio as a proxy for price impact. The price impact is given by the average daily ratio of absolute return to daily volume.

$$Illiq_{i,t} = \frac{|R_{i,t}|}{V_{i,t}}$$

Where $R_{i,}$ is the return for asset i.

$V_{i,}$ is the dollar volume for asset i

Hypotheses

The persistence of liquidity implies its ability to forecast market returns. Intuitively, if liquidity is persistent, higher illiquidity today predicts higher illiquidity next period and results in a higher required rate of return. The liquidity persistence also implies a negative contemporaneous return-illiquidity relationship. This is because, if there is a positive illiquidity shock today, investors will anticipate higher illiquidity in the following period and depress current prices in order to earn higher expected returns. This suggests that return of an asset, traditionally includes a premium for liquidity. Amihud (2002) proposes expected return is an increasing function of expected market illiquidity for stock market. Since, Bitcoin and other crypto currencies are also an asset class traded on exchanges therefore the same results should hold for them also. Hence,
H 1: Ex ante return is an increasing function of expected illiquidity.

Higher realized illiquidity raises expected illiquidity that in turn raises expected returns and lower expected prices. Therefore, if unexpected illiquidity occurs, prices should fall.

H 2: Unexpected illiquidity has a negative effect on contemporaneous unexpected return.
Following the methodology suggested by Amihud (2002), the effect of risk on return is tested in this study. The ex-ante effect of illiquidity on return is given by:

$E(R_{Bt}) = f_0 + f_1 \ln Illiq^E$ (2)

Where RBt is the market return for period t

and $\ln Illid^E t$ is the expected illiquidity for period t based on information in t-1: The hypothesis 1 holds good if 'f1' is greater than zero.
Investors are assumed to predict illiquidity for period t based on information available in time period t-1 and then use this prediction to set prices that will generate the desired expected return in period t. Market illiquidity is assumed to follow the autoregressive model

$$\ln ILLIq_t = \beta_0 + \beta_1 \ln ILLIq_{t-1} + e_t \quad (3)$$

$$\log Illiq_t^U = \text{residual} = \log(illiq^E) - \log(illiq^E_{t-1}) \quad (4)$$

At the beginning of period 't' investors determine the expected illiquidity for the next period $\ln ILLIQ^E t$ based on information in period 't-1' that has just ended. Then, they set market prices at the beginning of period 't' that will generate the expected return for the period 't'. Therefore, expected market illiquidity leads to higher ex- ante return.

The effect of unexpected market illiquidity on contemporaneous unexpected return should be negative. This is because higher illiquidity in one period raises expected illiquidity for the following period. If higher expected illiquidity causes ex ante returns to rise, prices should fall when illiquidity unexpectedly rises. As a result, there should be a negative relationship between unexpected illiquidity and contemporaneous return. The above two hypothesis can be tested using the following:

$RR_{Bt} = c_0 + c_1 \ln Illiq^E_{t-1} + c_2 \ln ILLIq^U_t + \in_t$ (5)

Where $\ln Illiq^U t$ is the is the unexpected illiquidity in period t, which was calculated based on residual value in equation (3). That is, $\ln Illiq^U t$ = residual from equation (3). Hypothesis 1 holds good if c1 is greater than zero and hypothesis 2 holds good if c2 is less than zero.

V. Results

Autoregressive property of Illiquidity

Dependent Variable: ln Illiq	Coefficient	t- Statistic
INTERCEPT	-1.46821	-8.49907
Ln illiqt-1	0.466564	8.673669
R-square	0.21.6%	

The above results show that the liquidity predicts itself. The above table shows that illiquidity is auto regressive.

The effect of illiquidity on expected return- daily data

Dependent Variable: RB	Coefficient	t-stats
Intercept	0.046775	2.196883
Expected Illiq	0.011462	1.527738
Unexpected Illiq	-0.01761	-1.32701
R-square	0.009	

The results show that the sign of expected Illiquidity is positive and the sign of unexpected market illiquidity is negative. The results are consistent with Amihud's paper (2002) who show that return is positively related to expected liquidity and negatively related to unexpected illiquidity.

VI. Conclusion

In this study we tried to look at the study the relationship between various economic indicators and Bitcoin prices for a 10-year period (2012-2022) and found stock market index, Gold and volume traded as significant indicators among the rest. Exchange rate fluctuations impact negatively on the prices, in the long run as well as established in this study which is consistent with the short run effect of exchange rates on Bitcoin pricing (as mentioned in literature). We also studied the impact of bond yield rate which has a negative relationship with bitcoin price. All these trends showed that over the time the "safe haven" notion about Bitcoins has changed and it shows similar behavior as other financial assets like stocks. This analysis is also backed by the timeline study we did, where we had seen the price movement relative to S&P 500, Gold and volume traded during four major events, that affected the Bitcoin market, as a whole, where we saw that price movement during these periods could not be explained through the market fundamentals and mostly driven by investors' expectations. Due to its volatile nature, people also switched to buying safer assets like gold and thus we saw negative relationship between gold and bitcoin during these time periods. The risk factor considering there is no institutional involvement, also poses a threat on the liquidity of this cryptocurrency. We used price-impact proxy to measure the relationship between liquidity and Bitcoin returns and found that Bitcoin returns have a positive relationship with expected liquidity and negative relationship with unexpected liquidity, which is similar to the pattern shown by other asset classes. Thus it can be concluded that investors' will start treating this asset class just like stocks, and with more acceptance liquidity will improve as well.

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