BITCOIN: The Emergence Of Global Investment Asset

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Abstract:

This article attempts to answer the following questions: How closely are bitcoin, the US stock market, gold, and the US dollar interconnected in times of global crisis? Moreover, what do the magnitudes and directions of their interaction tell about their relationship? This research paper examines flight to safe behavior triggered by covid in early 2020. The methodology used weekly return covariance between bitcoin, the stock market, gold, and the USD. Did investors' confidence affect these assets' relationship as investment assets? This paper aims to identify potential patterns and trends between investment assets and discuss these findings' implications for investment strategies. The study controlled for bitcoin volatility (GARCH (1,1) model), global bitcoin popularity, and short-term US Treasuries. The result suggests that, at a 99% confidence interval, market volatility has a statistically significant impact on the relationships between bitcoin and other assets. Faced with extreme market uncertainty, most investors considered bitcoin a risky investment rather than a safe hideout during market turmoil. Furthermore, to hedge against bitcoin during a negative market shock, gold is a better safe haven for bitcoin than the US dollar. Overall, the analysis provides insight into the benefits and risks of investing in bitcoin and may inform future research on this topic.

1. Introduction:

The debate around bitcoin mainly discusses bitcoin as digital money and investment asset. Theoretically, if Bitcoin primarily pays for goods and services, it will compete with fiat currencies. If, on the other hand, it is mainly used as an investment, it will compete with investment assets such as stocks, gold, or currency. The least discussed scenario is when investors no longer have interest in bitcoin, and bitcoin will go into oblivion as investors move to a new speculative asset. Since 2017, discussions revolved around what kind of investment asset is bitcoin, a risky speculative asset, or a risk management tool for investors. Market shock in early 2020 offered an opportunity to observe the relationship of bitcoin with gold, the stock market, and the US dollar during a market panic. The findings suggest bitcoin is considered a risky asset rather than a safe haven during market turmoil. An asset's risk characteristic profoundly concerns investors, and bitcoin volatility hinders its viability. Bitcoin's volatility GARCH(1,1) model measures bitcoin's volatility, considering recent news impact on return. Bitcoin's popularity is measured by public interest collected on Google Trends.

This study makes three contributions to the existing financial literature on bitcoin. Firstly is the examination of flight to safe theory in bitcoin. This paper applied behavior finance in the cryptocurrency market and shed light on the behavior of bitcoin in times of financial distress to better understand bitcoin risks and prospects. The second contribution stems from my unique approach to assessing the relationship between bitcoin and gold, stock, and the dollar using weekly return covariance to represent co-movement between assets. Despite not being included in the traditional financial market, bitcoin showed well-defined relationships with conventional financial assets during market shock. Thirdly, short-term market uncertainty is captured through the CBOE VIX index and the US 3-month Treasury bill.

2. Literature review

2.1, Bitcoin fundamentals

In 2008, Nakamoto Satoshi - the pseudo name for individuals/organizations that created bitcoin - introduced a new payment network to the world, and despite the odds, bitcoin's ecosystem is still thriving. Bitcoin originated as a peer-to-peer payment network that allows individuals to securely exchange products and services without relying on a single third-party intermediary (central banks, governments) to validate transactions. Each successive bitcoin transaction contains a timestamp, which is added to a public ledger (blockchain) that stores every transaction in the network (Nakamoto, 2008). The unique characteristic of bitcoin is Nakamoto's answer to the double spending problem in banks, which occurs when institutions lend out consumer million to finance waves of credit bubbles while retaining little in reserve. Bitcoin's supply limit is set at 21 million, and the supply rate is cut in half every four years to simulate gold scarcity. There will be no more inflation after discovering the last bitcoin (Weber, 2014). Bitcoin enthusiasts believe bitcoin will be the solution to the centralized control of money transactions by financial organizations. Low transaction costs, peer-to-peer design, global coverage, anti-inflation feature, and transaction secrecy are among the advantages of payment systems.

2.2 Criticism of bitcoin as a Currency

Shortcomings of bitcoin as a medium of exchange, store of value, and unit of account have led to doubt about its viability. Previous researchers are pessimistic about bitcoin's feasibility due to obstacles such as extreme volatility, lack of regulation, trust between transaction parties, and liquidity. Before central exchanges, there was a technological barrier to entry because of the hardship of acquiring a bitcoin (Baur & Dimpfl, 2021; Yermack, 2013; Bonelli, 2020; Cheah & Fry, 2015; Weber, 2014). Bitcoin's weakness as a means of exchange stems from its isolation from the banking and payment systems, its incompatibility with credit markets, and the technological barrier to acquiring bitcoin (Yermark, 2013). Bitcoin's absence of payment-related services and significant

exchange rate risk in the short term have limited its usage as a medium of exchange (Weber, 2014; Bonelli, 2020; Baur & Dimpfl, 2021). Only through trust do individuals and organizations accord bitcoin value as a currency unit and accept it as payment for products or services. Because of Bitcoin's extraordinary volatility, determining the true value of a specific good measured in Bitcoin is difficult or impossible (Baur & Dimpfl, 2021). Cheah and Fry (2015) established that bitcoin's fundamental value is zero without a commodity or an organization backing it. The critical distinction between fiat currencies and Bitcoin is that the government controls fiat currencies, whereas Bitcoin is not controlled by any single entity (Goodhart, 1998). Bitcoin's supply is capped at 21 million units, which raises the problem of expanding an economy using bitcoin as a currency. However, through network voting, a change in the system will be made if the majority agrees (Nakamoto, 2008). The case of El Salvador will be intriguing to see the outcomes.

2.3, Bitcoin emerges as an investment asset

Assets do not have the same characteristics as currencies. Instead, assets are typically held for investment purposes or to store wealth. Examples of assets include stocks, bonds, real estate, and precious metals. Bitcoin's correlation with investment assets supports bitcoin's value (Bonelli, 2020). Bitcoin is considered a speculative asset because there is no guarantee of repayment at any point. Bitcoin's failure to perform as a currency or "digital gold", along with excessive volatility and excess return compare to the S&P 500, makes bitcoin better resemble an investment asset (Yermack, 2013; Kristoufek, 2013; Bouoiyour et al., 2015; Weber, 2014; Fry & Cheah, 2016; Li et al., 2018; Baur, Dimpfl, et al., 2018; Baur, Hong, et al., 2018). Investors evaluate the risks and rewards of any investment. Figure 1 depicts the risk and return of investing in bitcoin from 2016 and 2022. During the peak of the 2017 bull run, bitcoin's one-year return on investment (ROI) reached 2204%, a 22-fold gain. If an investor put $1000 into bitcoin, they would have received $22,000 a year later. However, bitcoin saw excessive volatility throughout this period. The gray band in the graph below reflects a 1.1 standard deviation from the mean, indicating that bitcoin

frequently fluctuates beyond the normal range. Bitcoin is less volatile throughout the bull run from 2019 to 2022, but the maximum one-year ROI is only half as good as in 2017. As bitcoin matures as an asset, it becomes less volatile and less rewarding.

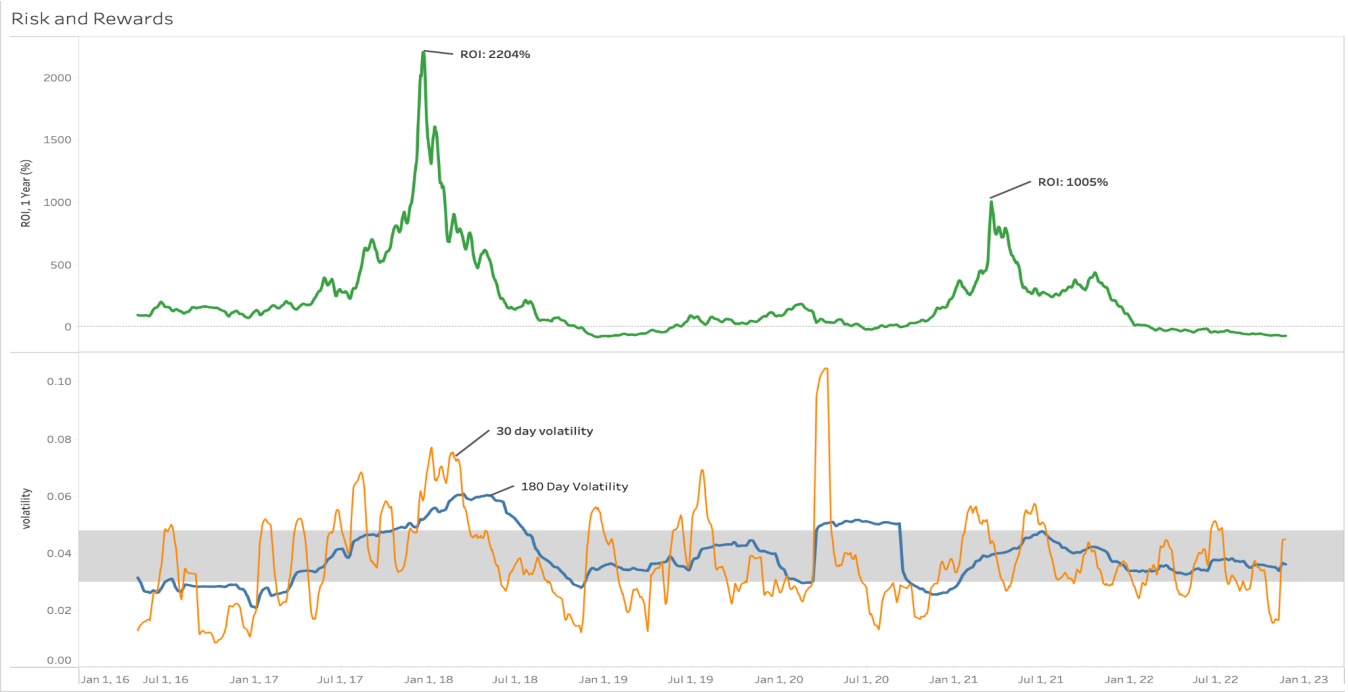

Figure 1. Bitcoin's 1-year ROI (%) and volatility, 2016 - 2022. Data source: Coinmetrics.io

Researchers regarded bitcoin as a speculative asset or a risk-management tool by arguing that the law of demand and supply may justify the worth of bitcoin (Baur & Dimpfl et al., 2018; Baur, Hong et al., 2018; Baur & Dimpfl, 2021; Bonelli, 2020). The notion that bitcoin is "digital gold" derives from its design to mirror gold's limited quantity, decreasing supply rate, and lack of government support (Li et al., 2018). If the current official money is solely based on trust and force, the loss of trust by a sufficient number of community members could result in the adoption a new currency (Weber, 2014). Investors have a negative expectation of government-backed currencies during times of crisis, high inflation, or political uncertainty, prompting a transition of money to bitcoin as a hedge against inflation (Li et al., 2018). In this instance, Bitcoin acts as new gold in the digital era, a safe haven for global investors who do not trust governments, central banks, or fiat currencies (Bonelli, 2020).

According to Smales (2019), such a comparison is only possible if we can examine the interaction between bitcoin and other assets during global crises. When shifting funds between Bitcoin and a financial instrument, Stensås et al. (2019) urge investors to be aware of Bitcoin's lack of liquidity. Nguyen (2021) found a significant positive correlation between bitcoin and the S&P 500 in times of high market uncertainty.

According to Thomas (2015) and Sawar (2016), a surge in the CBOE VIX results in "flights to safety." Thomas (2015) suggests that the incentive for flight-to-safety asset reallocations stems from the market's shock, measured by VIX, as opposed to changes in non-stock volatility. Bitcoin volatility is crucial when considering bitcoin as an investment or currency (Bouri et al., 2017; Katsiampa, 2017; Ardia et al., 2019). According to Byström and Krygier (2018) and Kristoufeck (2013), search pressure on search engines such as Google significantly affects bitcoin's return.

3. Prediscussion

Flight to safety theory suggests that investors will move their capital from risky assets (stocks) to safe assets (gold, the US dollar, US Treasuries) in extreme market uncertainty. Investors employ cross-market hedging to hedge their portfolios against strong market fluctuations. This paper examines the interaction of bitcoin with gold, the S&P 500, and the US dollar under the market shock in 2020.

In Figure 2, there was a shock in the US stock market and the 3 month US Treasury bill around the time President Donald Trump announced Covid-19 as a national emergency. Investors sold off their stocks and simultaneously bought into the US Treasuries. Risk-averse investors want safer assets during times of strong market fluctuations and are willing to receive lower return payments, resulting in the price of short-term US Treasuries. Bitcoin's popularity and volatility are moving in lockstep. However, in early 2020, there was a spike in bitcoin volatility, but the public had little attention to bitcoin. I suspect bitcoin volatility primarily stems from the effect of flight to

safety behavior. Is bitcoin being sold off like a risky asset or acted like a safe haven in times of market panic?

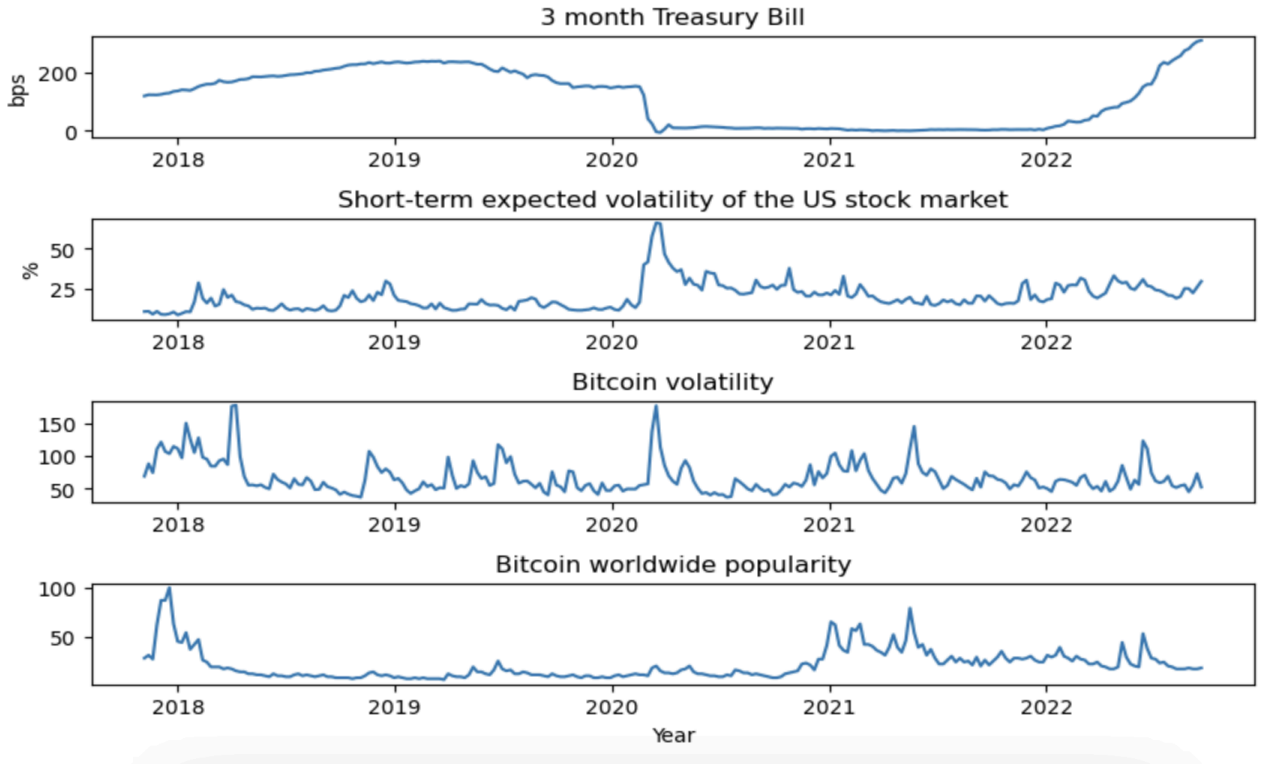

Figure 2: 3-month US Treasury Bill yield (bps), VIX index, bitcoin volatility, and bitcoin keyword on Google Trends.

This paper examines the effect of investor confidence (represented by VIX and Treasuries bills) on the relationship between bitcoin and the stock market in case of a negative market shock. Bitcoin's possibility of acting as hedging for a market downturn will be put to the test in Covid-19. First case scenario, bitcoin remains independent of the stock market or they move in the opposite direction. This result suggests bitcoin is an appropriate risk management tool for global investors. Second case scenario, bitcoin and the stock market move in the same direction. This result suggests bitcoin has a positive correlation with the stock market during market shock, and bitcoin fails to hedge against market downturn. For bitcoin to be an attractive speculative investment, risk-averse investors will expect bitcoin to have a higher return than the S&P 500 to compensate for its higher volatility. During a crisis, investors prefer safe holdings to speculative investments to minimize loss and switch to holding either cash or gold. Bitcoin can be owned globally. To match its global coverage, only gold and the current reserve currency, the USD, are appropriate hedging tools.

4, Data and methodology

This paper uses data from the last five years, from October 2017 to the end of September 2022. Assets' weekly closing price, CBOE VIX, and 3-month US Treasury bill are collected on Yahoo Finance and Alphavintage; bitcoin volatility is measured using Garch(1,1) model collected on V-lab by NYU Stern; bitcoin popularity is collected by using the keyword “bitcoin” on Google Trends.

Assets’ return = ((current week closing price - last week closing price) / last week closing price) * 100 (%). Return (%) allows me to examine asset behavior on a better scale than using a dollar base. I compute rolling covariance for a 12-week window using weekly return.

Covariance = (X - E(X))*(Y - E(Y))

- Cov_bspy: covariance of bitcoin and SPDR S&P 500 ETF Trust
- Cov_bgld: covariance of bitcoin and SPDR gold share
- Cov_busd: covariance of bitcoin and U.S Dollar Index (DXY)
- VIX: CBOE VIX measures market attitude toward the market in the next 30 days, representing investors’ short-term confidence.
- gg_trend_wrld: keyword “bitcoin” on Google trends
- btc_garch: bitcoin volatility measured by Garch(1,1) model
- Covid: time dummy variable, from January 01, 2020, to August 31, 2020.

	tbill	vix	cov_bspy	cov_bgld	cov_busd	gg_trend_wrld	btc_garch	covid
count	255.000000	255.000000	255.000000	255.000000	255.000000	255.000000	255.000000	255.000000
mean	111.321569	20.410118	2.498511	-2.704242	0.993996	21.043137	67.604661	0.137255
std	95.755569	8.345464	9.915798	6.367252	3.164353	15.373119	24.612861	0.344793
min	-5.800000	9.220000	-21.524296	-26.782293	-5.461005	6.000000	36.744210	0.000000
25%	8.300000	14.850000	-2.394157	-4.675520	-1.212192	10.000000	51.652433	0.000000
50%	135.500002	18.559999	1.150417	-1.868501	0.637997	16.000000	60.068708	0.000000
75%	195.500004	24.490000	5.396253	1.121521	2.294879	27.000000	75.839375	0.000000
max	310.800004	66.040001	47.373208	10.143276	13.008234	100.000000	179.208595	1.000000

Table 1. Summary statistics

Investor confidence indicators, US Treasuries, and VIX index had extreme reactions during this period. 3-month US Treasuries at its lowest gave a negative return, investors lost 0,058% of their money with this investment. Even though investors were losing money buying short-term US Treasuries, it was a relatively better holding than stocks. Typically, the VIX index falls between 10 and 30, where 10 is a very calm market, and 30 represents high market fear. During this time, VIX's highest value was 66, far above the usual upper bound of the market fear indicator.

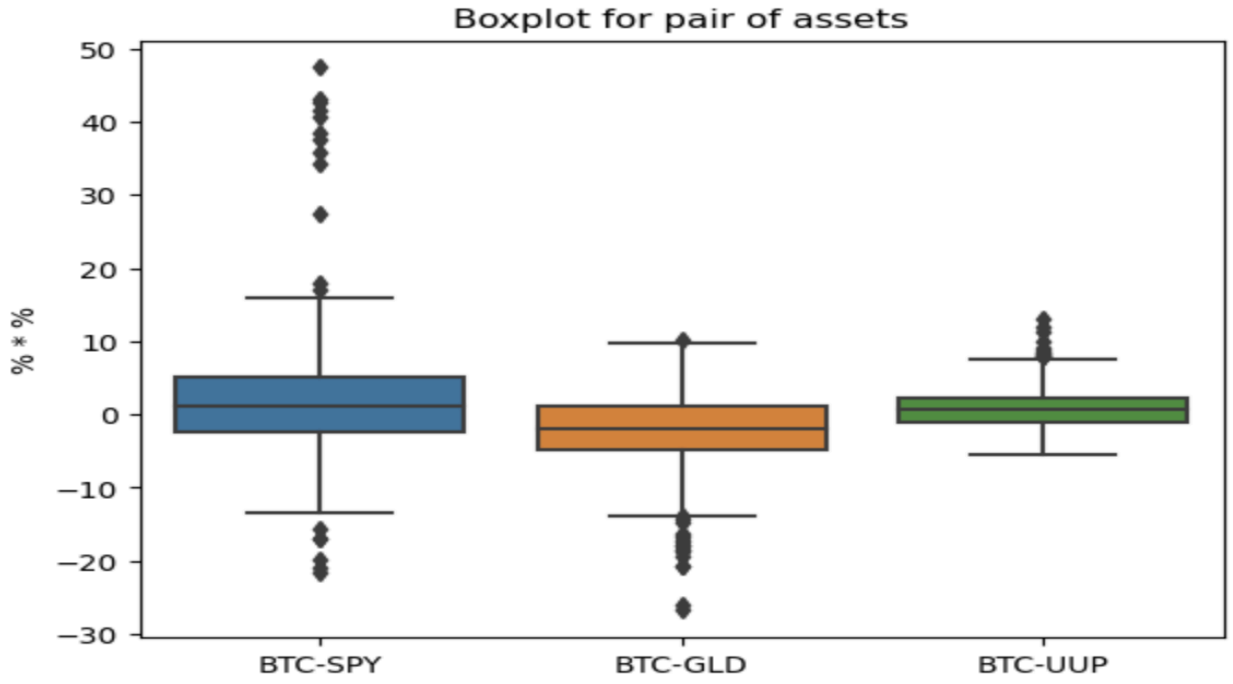

Figure 3. Boxplot for the covariance of asset pairs.

OLS Regressions:

$$cov\_bspy_t = \beta0 + \beta1(VIX) + \beta2(VIX*covid) + \beta3(tbill) + \beta4(tbill*covid) + \beta5(gg\_trend\_wrld) + \beta6(btc\_garch) + u$$

$$cov\_bgld_t = \beta0 + \beta1(VIX) + \beta2(VIX*covid) + \beta3(tbill) + \beta4(tbill*covid) + \beta5(gg\_trend\_wrld) + \beta6(btc\_garch) + u$$

$$cov\_busd_t = \beta0 + \beta1(VIX) + \beta2(VIX*covid) + \beta3(tbill) + \beta4(tbill*covid) + \beta5(gg\_trend\_wrld) + \beta6(btc\_garch) + u$$

Hypothesis:

Null hypothesis: Investor confidence did not affect the assets' correlation during covid

$$VIX*covid = 0$$

$$tbill * covid = 0$$

Alternative hypothesis: Investor confidence affected the assets' correlation during covid

$$VIX*covid \neq 0$$

$$tbill * covid \neq 0$$

5, Results and Discussion

Regressions Result

	cov_bspy	cov_bgld	cov_busd
VIX	0.021	0.089	-0.021
	(0.093)	(0.063)	(0.031)
3-month Tbill	0.012*	-0.006	-0.006**
	(0.007)	(0.005)	(0.002)
bitcoin volatility	-0.093***	-0.078***	0.064***
	(0.027)	(0.018)	(0.009)
bitcoin popularity	0.132***	-0.006	-0.053***
	(0.049)	(0.033)	(0.016)
VIX during covid	0.579***	-0.266***	0.070***
	(0.071)	(0.048)	(0.024)
3-month Tbill during covid	-0.086***	0.062***	-0.006
	(0.022)	(0.015)	(0.007)
Constant	2.304	2.287	-1.400*
	(2.485)	(1.687)	(0.834)
Observations	255	255	255
R^2	0.347	0.270	0.278
Adjusted R^2	0.331	0.253	0.260
Residual Std. Error (df = 248)	8.108	5.504	2.722
F Statistic (df = 6; 248)	21.985***	15.325***	15.894***

Note: *p<0.1; **p<0.05; ***p<0.01

Sorce: Yahoo Finance, NYU V-lab, Aplhavantage, Google Trends

Table 2. Results table

On average, US short-term Treasuries and bitcoin popularity have a statistically significant positive impact on bitcoin's correlation with the stock market. In contrast, higher bitcoin volatility is a barrier for bitcoin to mimic the stock market movement.

During covid, both investor confidence indicators statistically affect the co-movement between bitcoin and the stock market. The result suggests that conventional market indicators affected the bitcoin market during covid. The flight to safety theory raises whether risk-averse

investors perceive bitcoin as a risky speculative asset or a risk management tool. At a 99% confidence interval, the result suggests that when VIX increases by 1 percentage point, the covariance between bitcoin and the stock market rises by 0,593 (%*%). When the 3-month US Treasury interest rate decreases by 1 basis point (Treasuries getting more expensive), the covariance between bitcoin and the stock market increases by 0,086 (%*%). These findings consistently suggest that during times of high market uncertainty, bitcoin moves in the same direction as the stock market, indicating that investors are selling off bitcoin. As a result, bitcoin fails to act as a hedge during stock market downturns, weakening the argument that bitcoin can serve as a safe haven for global investors. Thus, the research findings support the notion that bitcoin is more of a risky speculative asset than a risk management tool.

According to Baur and Lucey (2010), a diversifier is an asset that is weakly correlated to another asset or portfolio on average. Baur and McDermott (2010) defined a hedge as an asset that negatively correlates with another asset or portfolio on average. A safe haven is an asset that negatively correlates with another asset or portfolio only during certain periods. At a 99% confidence interval, the result suggests that when VIX increases by 1 percentage point, the covariance between bitcoin and gold decreases by 0,266 (%*%). When the 3-month US Treasury interest rate decreases by 1 basis point (Treasuries getting more expensive), the covariance between bitcoin and gold decreases by 0,062 (%*%). The relationship between bitcoin and the USD during covid was only significantly affected by the VIX index. At a 99% confidence interval, when VIX increases by 1 percentage point during a market shock, the correlation between bitcoin and the US dollar rises by 0,07 (%*%). In a period of low market confidence, market fear triggered a stronger reaction between bitcoin and gold compared to the response between bitcoin and the US dollar. In particular, gold and bitcoin moved more significantly in the opposite direction (-0,266 %*%), while the co-movement between bitcoin and the USD was relatively weak (0,07 %*%). Based on arguments by Baur and Lucey (2010), and Baur and McDermott (2010), the finding suggests gold can be a safe haven for bitcoin, and the US dollar works well as a diversifier.

The results indicate that bitcoin's volatility further emphasizes gold's ability to hedge against bitcoin. Additionally, the volatility and popularity of bitcoin have a conflicting effect on the correlation between bitcoin and the US dollar; their relationship is still ambiguous and calls for further research.

6, Conclusion

Originally designed as a peer-to-peer electronic payment system, Bitcoin has experienced a shift in its perception and is now widely regarded as an investment asset. The ongoing debate revolves around whether Bitcoin should be considered a speculative or safe asset during periods of market turbulence. The findings of this paper underscore Bitcoin's failure to shield investors from stock market downturns during the COVID-19 pandemic, providing further support for the notion that Bitcoin is more aligned with being a speculative asset rather than a reliable risk management tool. With higher volatility and less diversity, bitcoin would underperform the stock market in a downturn. However, for the same reason, when the market enters the recovery and expansion phase, bitcoin is expected to have an excess return compared to the stock market to compensate for its volatility.

Additionally, this research examines the relationship between Bitcoin, gold, and the US dollar to determine which assets are better hedges for Bitcoin. The analysis reveals that during periods of low investor confidence, gold exhibits an inverse correlation with Bitcoin, while the US dollar displays a relatively weak correlation. Gold emerges as a safe haven for Bitcoin, while the US dollar proves to be more effective as a diversifier. Consequently, a portfolio incorporating Bitcoin can utilize dollar-denominated assets as diversifiers to mitigate overall portfolio risk. This strategic approach enables a balanced portfolio that is more resilient to market fluctuations and other risks that may impact the value of Bitcoin.

Future research may examine the influence of rate hikes in late 2022 on the interactions between Bitcoin and other financial assets. Alternatively, one could conduct a comprehensive

long-term analysis of bitcoin’s risk-return profile. Another critical area of research is the regulation, especially in light of the negative consequences caused by FTX's failure, which has tarnished the reputation of cryptocurrencies. By investigating these topics, researchers can gain significant insights into the evolving dynamics of bitcoin, its interaction with established financial institutions, and the regulatory framework required to assure investor protection and market integrity.

REFERENCES

Ardia, D., Bluteau, K., & Rüede, M. (2019). Regime changes in Bitcoin GARCH volatility dynamics. *Finance Research Letters*, *29*, 266–271. https://doi.org/10.1016/j.frl.2018.08.009

Arratia, A., & López-Barrantes, A. X. (2021). Do Google Trends forecast bitcoins? Stylized facts and statistical evidence. *Journal of Banking and Financial Technology*. https://doi.org/10.1007/s42786-021-00027-4

Baur, D. G., & Dimpfl, T. (2021). The volatility of Bitcoin and its role as a medium of exchange and a store of value. *Empirical Economics*, *61*(5). https://doi.org/10.1007/s00181-020-01990-5

Baur, D. G., Dimpfl, T., & Kuck, K. (2018). Bitcoin, gold and the US dollar – A replication and extension. *Finance Research Letters*, *25*, 103–110. https://doi.org/10.1016/j.frl.2017.10.012

Baur, D. G., Hong, K., & Lee, A. D. (2018). Bitcoin: Medium of exchange or speculative assets? *Journal of International Financial Markets, Institutions and Money*, *54*, 177–189. https://doi.org/10.1016/j.intfin.2017.12.004

Baur, D. G., & Lucey, B. M. (2010). Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold. *Financial Review*, *45*(2), 217–229. https://doi.org/10.1111/j.1540-6288.2010.00244.x

Baur, D. G., & McDermott, T. K. (2010). Is gold a safe haven? International evidence. *Journal of Banking & Finance*, *34*(8), 1886–1898. https://doi.org/10.1016/j.jbankfin.2009.12.008

Bonelli, M. I. (2020). What Type of Asset is Bitcoin? An Answer from the Stock Market. *2020 2nd International Conference on Economic Management and Model Engineering (ICEMME)*. https://doi.org/10.1109/icemme51517.2020.00211

Bouoiyour, J., Selmi, R., & Tiwari, A. K. (2015). Is bitcoin business income or speculative foolery? new ideas through an improved frequency domain analysis. *Annals of Financial Economics*, *10*(01), 1550002. https://doi.org/10.1142/s2010495215500025

Bouri, E., Azzi, G., & Haubo Dyhrberg, A. (2017). On the return-volatility relationship in the Bitcoin market around the price crash of 2013. *Economics: The Open-Access, Open-Assessment E-Journal*. https://doi.org/10.5018/economics-ejournal.ja.2017-2

Bouri, E., Gupta, R., Tiwari, A. K., Roubaud, D. (2017). Does Bitcoin hedge global uncertainty? Evidence from wavelet-based quantile-in-quantile regressions. *Finance Research Letters*, *23*, 87–89. https://doi.org/10.1016/j.frl.2017.02.009

Cheah, E.-T., & Fry, J. (2015). Speculative bubbles in Bitcoin markets? An empirical investigation into the fundamental value of Bitcoin. *Economics Letters*, *130*, 32–36. https://doi.org/10.1016/j.econlet.2015.02.029

Fry, J., & Cheah, E.-T. (2016). Negative bubbles and shocks in cryptocurrency markets. *International Review of Financial Analysis*, *47*, 343–352. https://doi.org/10.1016/j.irfa.2016.02.008

Katsiampa, P. (2017). Volatility estimation for Bitcoin: A comparison of GARCH models. *Economics Letters*, *158*, 3–6. https://doi.org/10.1016/j.econlet.2017.06.023

Kristoufek, L. (2013). BitCoin meets Google Trends and Wikipedia: Quantifying the relationship between phenomena of the Internet era. *Scientific Reports*, *3*(1). https://doi.org/10.1038/srep03415

Li, Z.-Z., Tao, R., Su, C.-W., & Lobonţ, O.-R. (2018). Does Bitcoin bubble burst? *Quality & Quantity*, *53*(1), 91–105. https://doi.org/10.1007/s11135-018-0728-3

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3440802

Nguyen, K. (2021). The correlation between the stock market and Bitcoin during COVID-19 and other uncertainty periods. *Finance Research Letters*, 102284. https://doi.org/10.1016/j.frl.2021.102284

Sandoval, L., & Franca, I. D. P. (2012). Correlation of financial markets in times of crisis. *Physica A: Statistical Mechanics and Its Applications*, *391*(1-2), 187–208. https://doi.org/10.1016/j.physa.2011.07.023

Sarwar, G. (2017). Examining the flight-to-safety with the implied volatilities. *Finance Research Letters*, *20*, 118–124. https://doi.org/10.1016/j.frl.2016.09.015

Smales, L. A. (2019). Bitcoin as a safe haven: Is it even worth considering? *Finance Research Letters*, *30*, 385–393. https://doi.org/10.1016/j.frl.2018.11.002

Stensås, A., Nygaard, M. F., Kyaw, K., & Treepongkaruna, S. (2019). Can Bitcoin be a diversifier, hedge or safe haven tool? *Cogent Economics & Finance*, *7*(1). https://doi.org/10.1080/23322039.2019.1593072

Thomas, J. M. (2015). Structural Relationships and Portfolio Efficiency. *The Journal of Portfolio Management*, *42*(1), 135–142. https://doi.org/10.3905/jpm.2015.42.1.135

Vo, N. N. Y., & Xu, G. (2017). The volatility of Bitcoin returns and its correlation to financial markets. *2017 International Conference on Behavioral, Economic, Socio-Cultural Computing (BESC)*. https://doi.org/10.1109/besc.2017.8256365

Weber, B. (2014). Bitcoin and the legitimacy crisis of money. *Cambridge Journal of Economics*, *40*(1), 17–41. https://doi.org/10.1093/cje/beu067

Yermack, D. (2013). *Is Bitcoin a Real Currency? An economic appraisal*. https://doi.org/10.3386/w19747