Yield and Volatility of Cryptocurrency under Long-term Uncertain Situation: Evidence from Covid-19 Pandemic

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Abstract. The birth of Bitcoin, the development of cryptocurrency, the establishment of digital platforms, and the investment of international capital. As the meta-cosmic era approaches, how does the blockchain platform occupy a place in the financial market, and how does it affect the world economy? What changes have taken place in the international financial sector? How has the economic downturn caused by the epidemic positively affected Bitcoin? As a market participant, how to reach a consensus on bitcoin, and how to invest, is a rational decision. This article is intended to use the Augmented Dickey-Fuller (ADF) Unit Root Test, Vector Autoregression (VAR) Model, ARMA-GARCH Model, Impulse Response, and the application of models such as ARMA-GARCH Estimation Results and Variance Equation analyzes the causes of bitcoin price fluctuations in the epidemic and how the epidemic has positively affected cryptocurrencies. Based on data, assisted by ICONS, the text analyzes the connection between the epidemic and cryptocurrencies.

Keywords: Bitcoin, Covid-19, Time Series.

1. Introduction

The era of the metaverse has arrived, and the block-chain economy arises at a historic moment, and cryptocurrency, as a derivative of the block-chain platform, has unknowingly occupied a pivotal position in the financial market.

Cryptocurrencies protect transactions through cryptographic technology, which is a virtual currency or digital currency. It can also be any form of currency [1]. Cryptocurrencies are usually traded by decentralized systems and have no regulators. The advantage of this system is that it can avoid unnecessary property loss caused by artificial manipulation in the transaction process, and save the transaction time. Of the tens of thousands of cryptocurrencies, bitcoin is the first cryptocurrency, founded in 2009, and by far the largest trading volume and holder of investors. Since its inception, Bitcoin has risen in value from a few cents to $60,000 last year and has dropped to $20,000 so far due to the outbreak. It is also precisely because of the great flexibility of digital currency, it should be cautious in its investment, and this is also one of the main reasons why the cryptocurrency is very attractive.

Satoshi Nakamoto did not initially invent bitcoin to issue digital currencies but wanted to provide a decentralized trading system for solving the massive future Internet trade. Bitcoin was born because of the needs of the trading system, and the price of bitcoin is the value of its underlying network.

The most powerful bitcoin trading system is its simplicity and security. Traditional fiat coins are issued by the central bank, and commercial banks are responsible for underwriting the distribution. Bitcoin, in theory, can be a node with just one computer, and it provides computing power that maintains network security and completes currency issuance and distribution. As long as there are other recipients, it will naturally circulate. It uses technology to solve the double payment problem and establish a trust mechanism by using cryptography. By comparison, bitcoin is indeed very concise.

This simplicity of the Bitcoin payment system provides strong security (the longest chain) over time that cannot be replaced by other currencies and payment systems. In theory, even with 51%

computing power, only individual transactions can be changed, not transactions by others, because if others' transactions are changed, their own accounts need to be constantly changed along the longest chain.

When it comes to bitcoin transactions, there must be a platform as a carrier. Ethereum, founded in 2015, Ethereum is the most popular and acclaimed blockchain platform to date [2]. Recently, on September 15, 2022, the TP Wallet and Ethereum completed the merger, which represents a combination of Ethereum's existing executive layer and its new proof of equity consensus layer beacon chain, using the pledged ETH to protect the network. Cryptocurrencies and blockchain platforms are becoming more scalable, secure, and sustainable [3].

Bitcoin has flourished based on several big investors: Sequoia Capital and Grayscale Capital [4]. Sequoia Capital, a leading venture capital firm, has changed its official Twitter profile to " We help courageous people build a legendary DAO, from ideas to token airdrops."In the outside world, this is an important sign of Sequoia Capital's investment focus on the crypto industry represented by DAO organizations, and also caused a wide discussion in the crypto industry and the venture capital industry. In fact, Sequoia Capital has been investing in the crypto industry for a long time [5]. Grayscale Investment is a subsidiary of the Digital Currency Group, established in 2013. Grayscale Asset Management provides a channel for investors to legally buy and sell cryptocurrencies, mainly by setting up a cryptocurrency trust fund that allows investors to participate in buying [6]. The Grayscale Trust's investment goal is to "track the market price of bitcoin. “This investment goal means that the trust products do not create excess returns, and as long as the trust returns can be basically consistent with the price changes of bitcoin, its mission will be effectively fulfilled [7]. The arrival of these two capitals makes bitcoin more solid.

The value of the increasingly popular bitcoin has reached its peak in 2020. In addition to the increase in large international investment, the production of bitcoin has also halved, and the reduced supply leads to the relative scarcity of bitcoin and a sharp increase in its price. However, the world, the sudden outbreak at the end of 2020 was like a bolt from the blue, leaving bitcoin in a state of downturn and ups and downs over the past three years. Bitcoin has not avoided the collapse of global financial markets and the pandemic. The Fed has poured massive dollar liquidity into the market, It has caused volatility in global financial markets, including digital currency markets.

The Bitcoin payment network is essentially designed to solve the Internet trade. If the number of trades shrinks, it will reduce the value of the network. Similarly, as the carrier of payment network value, the price of Bitcoin will also fall. Under the influence of the epidemic, global economic activity has been greatly restricted, the global economy has declined, and the economic activity on the bitcoin payment network has naturally decreased, so bitcoin cannot escape the fate of following the stock market and other declines. The difference is that the panic is more radical than other financial assets, with restrictions. And because bitcoin speculation is still serious, it will be down.

Although the epidemic has seriously hindered the normal economic behavior of countries, online economic activity is overall better than offline, and many businesses are begun to turn online. Bitcoin's payment network is designed to address Internet trade, and the increase in online economic activity is actually conducive to the fundamentals of bitcoin. In addition, the global central bank reform will undoubtedly push up asset prices in the long term, and the price of bitcoin has a lot of room for appreciation in the long term [8].

So, the impact of the epidemic on bitcoin is overall positive. As a digital gold, bitcoin has the ability to fight inflation [9]. When the epidemic puts the global economy in a pessimistic state, the circulation and trading of bitcoin will rise accordingly, which is also due to the risk aversion driven by the epidemic. Digital platforms are an extremely unstable area, especially with the impact of COVID-19 in recent years, leaving the whole platform in a state of ups and downs. Let's next find a balance in this field through a series of analyses [10].

The remaining parts of this paper will be organized as follows: Section 2 is a methodology, including data source, Augmented Dickey-Fuller test, and model specification; Section 3 is Empirical Results and Analysis. Section 4 is discussion and section 5 is conclusion.

2. Methodology

2.1. Data Source

Among the all frequently used cryptocurrency, bitcoin carries the most valuable data to be used as an accurate reference on to the overall cryptocurrency market. It contains the largest trading volume and holder of investors. The study of Logarithmic Price (Ln price) and Closing Yield (Ln Yield) of bitcoin [11]. Affected by the newly confirmed case on covid-19, separate as two different behavior markets: China and Overseas [12, 13]. The data starts in 2020, the year the first confirmed case of covid-19 appears and makes an impact on society, to present. The essence goal of observing previous data is to figure out the impact of worldwide newly increased covid-19 cases on bitcoin price. To elaborate, the data of worldwide total confirmed cases of covid-19 from "Day 0" (assumed as the present), will be subtracted by the worldwide total confirmed cases of covid-19 from "Day -1", the conclusion will be equal to the newly confirmed cases of covid-19(worldwide) for "Day-0". The yield and volatility of Cryptocurrency data will be observed and different from the daily Logarithmic Price and daily Closing Yield. During the calculation, there will be inevitable error causing the data to be inaccurate, to prevent such an unfortunate status will be used to analyze the data and construct models for further exploration.

2.2. Augmented Dickey–Fuller (ADF) Unit Root Test

ADF test will be used on testing whether the data are stable or unsteady, to secure and prove the strictness of data. According to Table 1, the P value of Bitcoin Ln yield was equal to 0, which means the data appear to be steady. But both China and Overseas newly confirmed cases p-value appears to be close to 0, so the answer can be drawn: The data model is appropriate and the data are likely to be stationary.

Table 1. ADF test

Variables	t-statistic	p-value
Bitcoin		
Ln price	-0.340	0.9886
Ln yield	-21.458	0.0000***
Proxy variable of normalized Covid-19: newly confirmed cases		
China	-3.845	0.0144**
Overseas	-4.865	0.0004 ***

2.3. Vector Autoregression (VAR) Model

A VAR model can represent the change of an endogenous variable (represented as "k"), over time. In this paper each period of time is numbered, and all variables are collected in a vector such as ($x_{t,1}$).

VAR models are used in this paper because some information shows that under the period of covid pandemic, online economic activity is overall better than offline economic activity, it should have an impact on bitcoin's volatility. The VAR model wasn't in need of any typical strict economic theory, and it is a form that is frequently used to estimate the jointly determined endogenous variable and its dynamic relationship.

As Table 1 shown above, this model carries three different variables:Logarithmic rate of return of Bitcoin, newly confirmed case in China and newly confirmed case Overseas. Out of that, there will be three separate time series variables, denoted by ($x_{t,1}$), ($x_{t,2}$)and ($x_{t,3}$), resulting in a triradiate VAR(p) mode.

$$x_{t,1} = \alpha_1 + \emptyset_{11}x_{t-1,1} + \ldots + \emptyset_{1p}x_{t-p,1} + \beta_{11}x_{t-1,2} + \ldots + \beta_{1p}x_{t-p,2} + \delta_{11}x_{t-1,3} + \ldots + \delta_{1p}x_{t-p,3} + e_{1t} \quad (1)$$

$$x_{t,2} = \alpha_2 + \emptyset_{21}x_{t-1,1} + \ldots + \emptyset_{2p}x_{t-1,1} + \beta_{21}x_{t-1,2} + \ldots + \beta_{2p}x_{t-p,2} + \delta_{21}x_{t-1,3} + \ldots + \delta_{2p}x_{t-p,3} + e_{2t} \quad (2)$$

$$x_{t,3} = \alpha_3 + \emptyset_{31}x_{t-1,1} + \ldots + \emptyset_{3p}x_{t-1,1} + \beta_{31}x_{t-1,2} + \ldots + \beta_{3p}x_{t-p,2} + \delta_{31}x_{t-1,3} + \ldots + \delta_{3p}x_{t-p,3} + \quad (3)$$

The equation (1), (2), and (3) , are for Ln price of bitcoin, Ln yield of Bitcoin, newly confirmed case in China and newly confirmed case Overseas. To clarify, in equation

The Ln price of bitcoin, Ln yield of bitcoin, newly confirmed case in China and Newly confirmed case Overseas is modeled using historical values for the variable.

2.4. ARMA-GARCH Model

Both the yied and volatility of bitcoin can be evaluated in the ARMA-GARCH Model.

And this model will be breaking down into two parts as ARMA and GARCH, here is the further explanation.

2.4.1 ARMA

$$y_t = \emptyset_0 + \sum_{i=1}^{p} \emptyset_i y_{t-i} + \alpha_i - \sum_{i=1}^{q} \emptyset_i \alpha_{t-i} \quad (4)$$

The essence formula of the ARMA model appears above as equation (1).

$\emptyset_0 + \sum_{i=1}^{p} \emptyset_i y_{t-i}$ inside the general expression represent the AR(p), $\alpha_i - \sum_{i=1}^{1} \emptyset_i \alpha_{t-i}$ is the representation of MA(q). AR(p) which uses the past data of Bitcoin (Ln price, Ln yield), to calculate and give predictions to the possible future outcome. The MA (1) model uses an error term to do the similar prediction.

2.4.2 GARCH

The generalized autoregressive conditional heteroskedasticity model basically is a derivative of ARCH. Appears to be one of the most frequently used processes for estimating the volatility of the financial market. In this paper, for Table 3, the GARCH and ARCH model will be used to estimate the volatility of Bitcoin as a representative of the Cryptocurrency market.

The GARCH model follows the equation (5):

$$\sigma_t^2 = \alpha_{0,1} + \alpha_1 \varepsilon_{t-1}^2 + \beta_t m_t + \gamma_1 \sigma_{t-1}^2 \quad (5)$$

From the equation above, ARCH appear as formula $\alpha_1 \varepsilon_{t-1}^2$, and GARCH appear as formula $\gamma_1 \sigma_{t-1}^2$, formula $\beta_t m_t$ represents a newly confirmed case of covid-19 that acted as an extra explanatory variable in the model.

3. Empirical Results and Analysis

3.1. Order of VAR Model

To find out the optimal lag order for a VAR model, the LR statistic and other information criterion of each lag should be assessed. An asterisk sign (*) appears after the data to signify the desired lag order.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1414.08				.020288	4.61589	4.62429	4.63748
1	34.1103	2896.4	9	0.000	.000187	-.072021	-.038428	.014364
2	174.701	281.18	9	0.000	.000122	-.500655	-.441868	-.349483
3	207.319	65.235	9	0.000	.000113	-.577585	-.493603	-.361624
4	228.211	41.785	9	0.000	.000108	-.616323	-.507146	-.335574
5	268.653	80.883	9	0.000	.000098	-.718738	-.584367	-.373201
6	294.123	50.94	9	0.000	.000093	-.772386	-.61282	-.362061
7	346.579	104.91	9	0.000	.00008	-.913937	-.729177*	-.438824*
8	354.624	16.091	9	0.065	.000081	-.910828	-.700872	-.370926
9	358.701	8.1532	9	0.519	.000082	-.894791	-.659641	-.290101
10	373.463	29.525	9	0.001	.000081	-.913561	-.653216	-.244083
11	382.558	18.189	9	0.033	.000081	-.913869	-.628329	-.179602
12	393.625	22.134*	9	0.008	.00008*	-.920602*	-.609868	-.121548

Table 2 reveals that lags 7 and 12 have that sign. Because lag7 has the lowest SBIC, so the present optimal lag order for VAR model should be 7.

Following the specification of the VAR model's order, it is crucial to examine whether the VAR model is stationary. If the VAR model is non-stationary, the impulse-response function will not converge to zero, indicating that COVID-19 pandemic has long lasting effects on the Yield and Volatility of Cryptocurrency. After that, the model's applicability was determined by carrying out the unit root test and sketching a unit circle with the roots. All of the roots are clearly within the circle in Figure 1, implying that there is no need to reevaluate the lag order and that triradiate VAR (7) is a stable model.

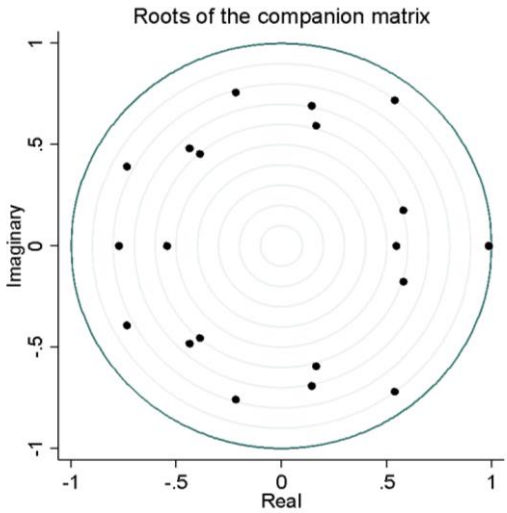


Figure 1. Unit circle test

Photo credit: Original

3.2. Impulse Response

"The swift and massive shock of the coronavirus pandemic and shutdown measures to contain it have plunged the global economy into a severe contraction. According to World Bank forecasts, the global economy will shrink by 5.2% this year.1 That would represent the deepest recession since the Second World War, with the largest fraction of economies experiencing declines in per capita output since 1870, the World Bank says in its June 2020 Global Economic Prospects." [13] From a fundamental point of view, the COVID-19 pandemic in early 2020 led to a global economic recession. Whether in China, the U.S. or Europe, investors panicked in the short term after the rapid spread of

the virus, and the risk aversion of capital led to a massive "escape" from the financial markets, which led to a precipitous decline in the financial market indices. Aviation, maritime, consumer services, media and retail fell heavily, while a few sectors like healthcare, precious metals and cryptocurrencies were the biggest winners. There has been a tremendous amount of positive sector sentiment in the short term and the market has reacted to this information. This industry divergence is largely consistent across all regions of the globe. For a short time, cryptocurrencies saw a surge, with Bitcoin, for example, multiplying in value several times in the year following the outbreak. However, after 2021, there was a successive crash which can be explained by "overreaction" (overreaction theory is one of the key theories of Western investment psychology, which explains that markets always overreact. People exhibit enhanced investment psychology in the investment process due to a range of emotional and cognitive factors, leading to market overreaction.) Whether this effect persists in the long term, as people's perceptions of the COVID-19 deepen and behavior returns to rationality, needs to be tested empirically.

As can be seen from the impulse response estimates, a 1% increase in the number of new confirmed cases of covid in China in period t=0 has a positive impact on bitcoin returns in periods t=0 to t=4, with the maximum value occurring in period t=1 at slightly more than 0.1%. The impact of a 1-unit pandemic shock in the current period becomes negative on bitcoin returns after period 5, with a magnitude of about 0.1%.

In terms of time effects, shocks in period t=0 decay to zero after period 10.

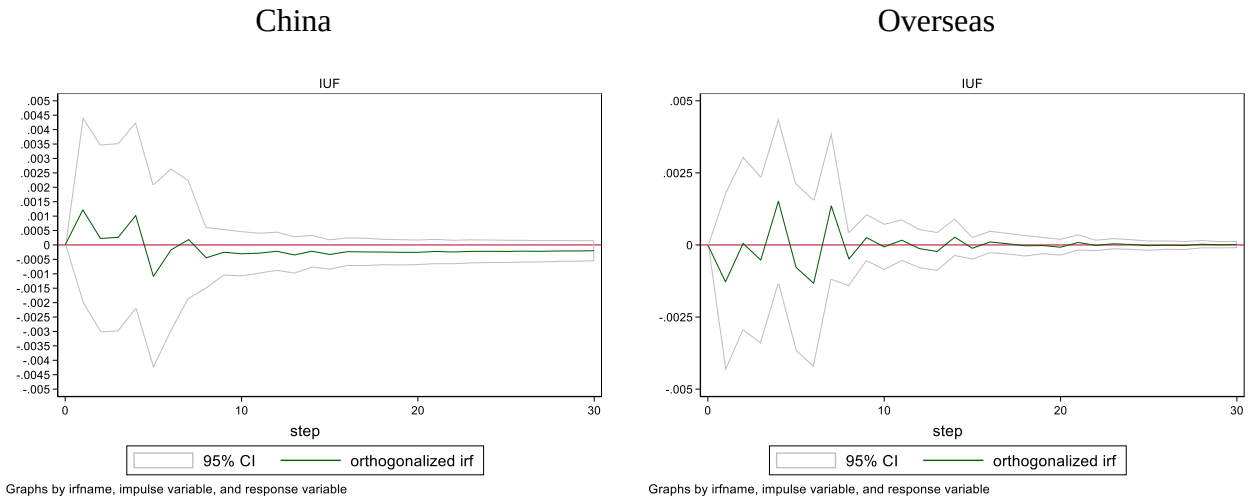


Figure 2. Impulse and response

Photo credit: Original

As the results shown in Figure 2, Chinese investors seems never learn from their experience, and bitcoin yields have pretty much repeated the history, only with a shorter time horizon.

It is important to note that if the number of new confirmed cases continues to increase in the short run, it could further push bitcoin prices higher. One difference is that in a normalized epidemic environment, the panic among Chinese investors is no longer as severe and the impact on bitcoin yields is no longer as great as it was at the beginning of the outbreak. In the case of overseas epidemics, there is no similar effect in the long run. Due to China's different pandemic prevention policies than other countries, the mortality rate for COVID-19 is roughly 0.53% in China and 1.10% in the US. The worldwide infection rate is 7.74%, and the infection rate in China is only 0.07%. People abroad only see coronavirus as a common cold, but the Chinese feel it is a serious infectious disease.

3.3. ARMA Specification

Regarding the order of the stock return in logarithm, PACF and ACF can be helpful to derive the lag orders for AR(p) and MA(q). In Figure 3, the first part beyond the critical values is 1 for both

PACF and ACF plots, demonstrating that AR(p) and MA(q) both have order 1 and value of p and q are equal to 1.

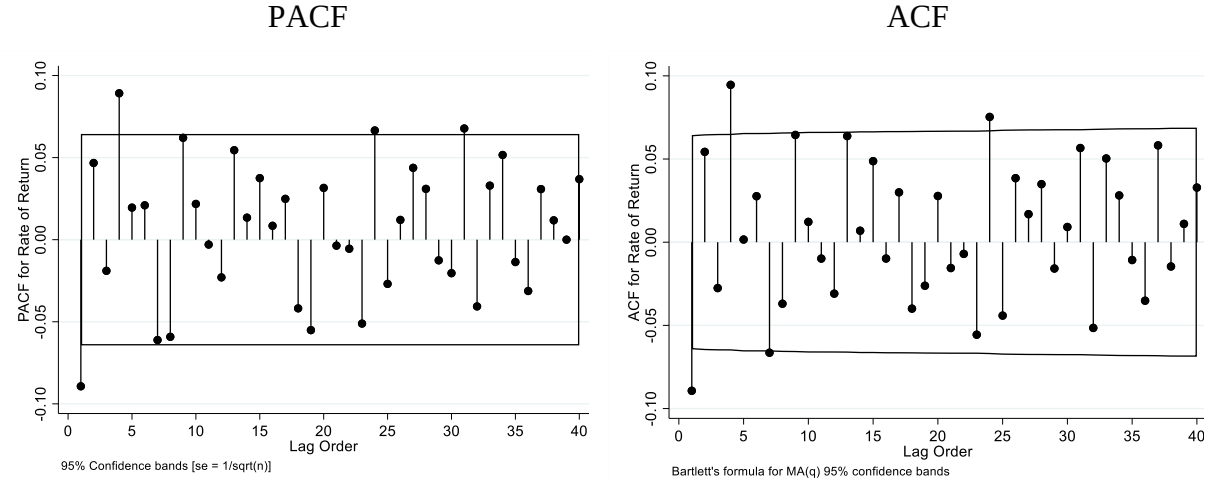


Figure 3. PACF and ACF

Photo credit: Original

3.4. ARMA-GARCH Estimation Results and Variance Equation

From the estimation results of the ARMA-GARCH model (Table 3), the GARCH term is significant in model (1) and both the ARCH and GARCH terms are significant in model (2) (as long as one of these two is significant), indicating that after controlling for autocorrelation in the mean equation, bitcoin returns still have statistically significant conditional heteroskedasticity and can be modeled GARCH.

The results from the estimation of the external explanatory variables show that the increase in the number of new confirmed cases no longer increases the volatility of the cryptocurrency market in the setting of a regular epidemic.

Table 3. ARMA-GARCH estimation results

Variables	(1)			(2)		
	Coefficient	Std. err	P>|z|	Coefficient	Std. err	P>|z|
Mean equation						
Constant	0.0003	0.0014	0.786	.0013	0.0015	0.361
AR						
L1	-0.4456	0.2305	0.053	-0.1888	0.4632	0.684
L4	-0.2092	0.2140	0.328	-.0214	0.4009	0.593
MA						
L1	0.3688	0.2344	0.116	0.1372	0.4585	0.765
L4	0.2989	0.2111	0.157	0.2886	0.3941	0.464
Variance equation						
Newly confirmed cases						
China	-0.1234	0.0190	0.000			
Overseas				-0.1663	0.0219	0.000
GARCH (1, 1)						
ARCH (-1)	0.0067	0.0041	0.108	0.0365	0.0155	0.019
GARCH (-1)	-0.8157	0.0669	0.000	0.8832	0.0463	0.000
Constant	-5.3468	0.0412	0.000	-6.7989	0.2753	0.000

4. Conclusion

The essential point of this paper is on how newly confirmed covid-19 cases in China and global wide take affection on the volatility and yield of bitcoin, to discuss the possible outcome when cryptocurrency market faces a long-term uncertain situation, for this paper, covid-19 pandemic. To provide an accurate and stable database for this paper, VAR model, ARMA model, ARCH model and GARCH model have all been used properly.

Nowadays, cryptocurrency as the anti-block-chain platform, carries the ability to prevent unnecessary property loss caused by artificial manipulation in the transaction process, and save the transaction time. Already become one of the most valuable topics as investment. This paper reports a significant point for all cryptocurrency investors, there will be no need to focus on the latest pandemic confirmed cases.

The purpose of this study is to predict the correlation in terms of returns and volatility of cryptocurrencies under long-term uncertainty from covid-19 pandemic evidence. For this purpose, VAR and ARMA-GARCH models were introduced, where the VAR model explores the impulse response and the ARMA-GARCH model evaluates bitcoin returns and conditional variances. The study draws conclusions after conducting an empirical investigation. In conclusion this paper shows that increased public enthusiasm for investing in cryptocurrencies during the spread of the disease is not indicative of a sustained growth or decline of an industry. Rather, it is a short-term shock, a sudden increase in confirmed cases over a short period of time that leads to a sudden increase in cryptocurrency quotes. Although the epidemic shows no signs of receding, fear of COVID-19 has tapered off as people learn more about the virus. The long-term future impact on cryptocurrency yields and volatility will eventually wane and return to normal, following the general trend of the cryptocurrency market.

References

[1] What is a cryptocurrency, and how does it work. [EB/OL]. (2022) [2022-09--25]. https://www.kaspersky.com.cn/resource-center/definitions/what-is-cryptocurrency.

[2] Ethereum. Ethereum Whitepaper. [EB/OL]. (7/10/2022) [25/9/2022] https://ethereum.org/en/whitepaper/2022 / 09 / 15 Announcement on completion of Ethereum merger. [EB/OL]. (2022) [2022-09-26]. https://help.tokenpocket.pro/cn/announcement/announcement/merge-over

[3] Sequoia. Investor Relations. [EB/OL]. (27/9/2022) [27/9/2022). https://www2.asx.com.au/markets/company/seq

[4] Sequoia homepage. [EB/OL]. (1972) [2022-09-27]. https://www.sequoia.com.au/

[5] Huidu Technology. Shenzhen Huidu Technology Co., Ltd. [EB/OL]. (2009) [2022-09-27]. https://www.huidu.cn/about/157.html

[6] Bitcoin's biggest institutional investor: Grayscale Capital. [EB/OL]. (2013) [2022-09-27]. https://grayscale.com/

[7] Zhang, Y., Zhu, P., Xu, Y. Has COVID-19 Changed the Hedge Effectiveness of Bitcoin? [EB/OL]. (2021) [2022-09-28]. https://www.frontiersin.org/articles/10.3389/fpubh.2021.704900/full.

[8] Rahul De', Neena Pandey, and Abhipsa Palc. Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. [EB/OL]. (2020-09-06) [2022-09-10]. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7280123/

[9] CRYPTO AM: TALKING LEGAL. The impact of Covid-19 on the development of central bank digital currencies. [EB/OL]. (2022-07-07) [2022-10-09]. https://www.cityam.com/the-impact-of-covid-19-on-the-development-of-central-bank-digital-currencies/

[10] Investing.com: Bitcoin historical data. Logarithmic rate of return of Bitcoin. [EB/OL]. [2022-10-11]. Bitcoin Price (BTC) | Bitcoin Value - Investing.com

[11] National Health Commission of People's Republic of China: Newly confirmed cases of covid-19 in China. [EB/OL]. [2022-10-11]. https://nhc.gov.cn

[12] World Health Organization (WHO): Newly confirmed cases of covid-19 overseas. [EB/OL]. [2022-10-11]. https://www.who.int/

[13] World Bank Group. COVID-19 to Plunge Global Economy into Worst Recession since World War II [EB/OL]. (2020-06-08) [2022-10-11]. https://www.worldbank.org/en/news/press-release/2020/06/08/covid-19-to-plunge-global-economy-into-worst-recession-since-world-war-ii.