

The Time-varying Impact of Covid-19 Pandemic on Bitcoin and Ethereum: Evidence from Time Series Model

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Abstract. At the beginning of 2020, the panic of Covid-19 had an excessive impact on global economics and the financial market. Based on the unit root test, this paper exposes the newly global Covid-19 confirmed cases and the rate of return of Ethereum and Bitcoin are stationary time series. This paper further completes the VAR model and ARMA-GARCH model. The VAR model examines the effect of newly confirmed cases on to rate of return of Bitcoin and Ethereum, and the ARMA-GARCH model scrutinizes the newly confirmed cases to the fluctuation of Bitcoin and Ethereum. This study found that the impact of the COVID-19 on cryptocurrency earnings was short-term, and did not improve the market volatility.

Keywords: Covid-19 pandemic; Bitcoin; Ethereum; Time-varying impact.

1. Introduction

During the panic of covid-19, there is an excessive change in global economics. Researchers point out that unemployment has an incredible during the panic [1]. The panic of Covid-19 not only affects people's health but also leads to people losing their jobs. Most people have to work remotely during the panic; however, some jobs cannot allow people to work remotely such as industrial workers. During the economic recession, people expect to keep their assets away from inflation or earn more profits by investment. Cryptocurrency is more and more popular. Many people adopt it as a safe-haven asset because they thought the value of money is decreasing due to inflation. In the current economy, people would not like to hold lots of cash because inflation would make their cashless valuable. Researchers find out that 16% of Americans say they have ever invested or traded crypto. Cryptocurrency is not only popular in the US, but also around the world [2]. Josh Howarth shows that over 81 million people are users of Bitcoin [3]. Own crypto as an asset become trendy during the panic of COVID-19. Many technology companies are interested in crypto. For example, Steve Kovach during the pandemic of COVID-19, the famous technology company, TESLA bought 1.5 billion Bitcoin and planned to accept cryptocurrency as a method of payment [4]. Cryptocurrency is considered a safe-haven asset like gold. Indeed, Cryptocurrency is similar to gold. James Spillane claims Cryptocurrency has had excellent performance for the past ten years and could be a safe-haven asset during the pandemic of covid-19 [5]. Spillane also claims JP Morgan proves that the market of Cryptocurrency become more mature and attracted more and more investors. Because digital currency is not related to the national currency, it could be a good way to invest. Both are limited in the world. As we know, the amount of gold on the Earth is limited. People could create more cash, but they cannot create more gold. Cryptocurrency is the same as gold in this aspect. The amount of Bitcoin is also limited in the world. Although both Bitcoins and gold are limited in the world, it does not mean Bitcoin is a haven. Cryptocurrency prices have accelerated in recent years. For example, the price of Bitcoin was about five thousand in March 2020. However, it is about thirty-eight thousand in Feb. 2022. The price of gold is about thirteen thousand dollars per ounce in March 2020, and it is about fourteen thousand dollars per ounce in February 2022. It is an outstanding fact that Bitcoin's volatility surpasses gold. Observing the daily price of crypto during the panic, we would demonstrate that although the price of crypto in 2022 is higher than in 2020, crypto's fluctuation is much higher than most currencies.

With the outbreak of Covid-19, the global economy and financial market were under the pressure. [6] In June 2020, the World Bank claims the global economy will contract by 5.2% this year; It is the most severe recession since World War II. Researchers estimate economic activities in advanced economies will contract by 7 percent; the average income would decrease by 3.6% [6]. People were under the pressure from the economic recession during the panic of Covid-19; such as unemployment and loss of revenue. Especially banks, Banks are under the pressure that some borrowers cannot afford their debt in the short term because of the economic recession. Guoliang Cai shows that banks were taking the pressure during this epidemic, and the interest rate of banks was decreasing [7]. According to the idea from Cai, keeping money in the bank seems not an ideal option during the panic of Covid-19. Researchers point out that the economic recession brought by the panic of Covid-19 would lead to the decline in financial market returns and a market panic; the market panic would trigger volatility of financial market prices [8] [9]. This paper would discuss how the panic of Covid-19 affects the rate of return of cryptocurrency and the volatility of crypto. With more and more people considering cryptocurrency as an excellent way to keep assets safe because of the limited number of cryptocurrencies, Bo Lan and Lei Zhuang claim that cryptocurrency cannot be safe assets during the panic of Covid-19 by using the model of VAR and VCC-M-GARCH models [10]. Lan proves that cryptocurrency could not be considered a safe asset for the long term because of its high volatility.

The rest of this paper is organized as follows: the second part is the research design which includes the source of data, the result of the unit root test, and the identification of the VAR model and ARMA-GARCH model. The third part of this paper consists of VAR model selection, the explanation of the impulse and response graph, and clarification of the ARMA-GARCH model. The last part of this paper is about the discussion of empirical results and the conclusion.

2. Research Design

2.1 Data sources

This article analyzes the effect of Covid-19 on cryptocurrency. The rate of new confirmed number of Covid-19 and the price of cryptocurrency are the key data for this study. The data on the price of Bitcoin and Ethereum is from cn.investing.com which could provide quotes, portfolios, and data on stocks and cryptocurrency. The number of new confirmed Covid-19 cases is from John Hopkins University's website. As we know, John Hopkins University has powerful data for medical issues. This study discusses the daily data from January 4th, 2020, to March 25th, 2022. To avoid the effect of the Russian-Ukrainian conflict on cryptocurrency. The period of the data is before the Russian-Ukrainian conflict in 2022.

2.2 Unit root test

Selva Prabhakaran shows that the Augmented Dickey-Fuller test (ADF test) is a common statistical method to test if a given time series is stationary or not [11].

$$x_t = c_t + Bx_{t-1} + \sum_{i=1}^{p1} \phi_i \Delta x_{t-i} + e_t \quad (1)$$

x_t is the value of time series at time t ; x_{t-1} is lag 1 of time series. Δx_{t-i} is the difference of the series at the time $t-i$. The null hypothesis accepts the presence of the unit root test which is $\alpha = 1$, the p-value is supposed to be less than the significance level which is 0.05 to reject the null hypothesis. This study uses the Unit Root Test to check if the data is stationary in this time series. The null hypothesis is defined as the presence of a unit; the alternative hypothesis is stationary. This thesis checked the daily data of the price of Bitcoin, the price of Ethereum, the rate of return of Bitcoin, the rate of return of Ethereum, and the number of new global confirmed cases. In Table 1 ADF-test, the p-value of the Price of Bitcoin and Ethereum is greater than 0.1, showing that the price of Bitcoin and Ethereum is not stationary. However, the p-value of the rate of return and newly confirmed cases of

the global is less than 1%. This p-value rejects the null hypothesis and shows that the trend of rate of return of Bitcoin and Ethereum and Newly Confirmed cases the global is stationary.

Table 1. ADF-test

Variables	t-statistic	p-value
Price		
Bitcoin	-2.233	0.4712
Ethereum	-2.240	0.4676
Rate of return		
Bitcoin	-25.678	0.0000***
Ethereum	-24.565	0.0000***
Newly Confirmed cases		
The global	-6.485	0.0000***

2.3 The model identification for VAR

The professor from Penn State University describes the vector autoregressive (VAR) model that could help people to find out the relationship between multiple time series as they change over time [12]. The VAR model is an excellent tool to predict multiple variables; VAR could make those variables mutually consistent.

For example, for two-time series variables, the system of VAR (p) is like this formula, denoted by γ_{1t} and γ_{2t} . In this formula γ_{1t} is the rate of return of cryptocurrency, ε_{1t} is the new global confirmed cases; β is the coefficient. The model VAR is for finding the relationship between the rate of return (γ_{1t}) and new confirmed cases (ε_{1t}).

$$\gamma_{1t} = \beta_{10} + \beta_{11}\gamma_{1,t-1} + \dots + \gamma_{1p}\gamma_{2,t-p} + \varepsilon_{1t} \quad (2)$$

$$\gamma_{2t} = \beta_{20} + \beta_{21}\gamma_{1,t-1} + \dots + \gamma_{2p}\gamma_{2,t-p} + \varepsilon_{2t} \quad (3)$$

2.4 ARMA-GARCH model

$$y_t = c + \phi_1 y_{t-1} + \Theta_1 \varepsilon_{t-1} + \varepsilon_t \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \dots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2 \quad (5)$$

$$\sigma_t^2 = \alpha_0 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_p \sigma_{t-p}^2 \quad (6)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \dots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_p \sigma_{t-p}^2 \quad (7)$$

The autoregressive Moving Average model comes from two models. One is the Autoregressive. (AR). Another one is the Moving Average (MA). Viktor Mechandzhiyski claims that the ARMA constructs future estimation while it utilizes the past values and errors [13]. Formula 4 and 5 is a simple ARMA model. In this formula γ_t is the rate of return; σ_t^2 is the volatility of the cryptocurrency. For a model of ARCH (1), if we need to keep the forecast variance σ_t^2 is not negative. ε is the actual standard deviation which belongs to the Normal distribution of $N(\mu, \sigma_t^2)$. GARCH model could show the volatility in financial markets. Formula (6) is the GARCH model. People place the GARCH term and ARCH term together and generalize the ARMA-GARCH model which is formula 7. We demand to retain α_0, α_1 , and β as positive so that the forecast standard deviation

would be non-negative. Due to GARCH (1,1) being the same as the infinite ARCH model, we could use GARCH (1,1) for generalizing ε . By using the ARMA-GARCH model, people could predict the rate of return and volatility better. And we could use the GARCH model to deal with the problem of p being large. In this study, we could use the ARMA-GARCH model to generalize the volatility of Bitcoin and Ethereum.

3. Empirical Results and Analysis

3.1 VAR model identification

This study utilizes the rate of return of Ethereum, Bitcoin, and newly confirmed cases globally into the Vector Autoregression system. The result of Table 2 is from the VAR with 11 orders. Different orders would generate different results. The method to identify the model of VAR model is by finding the minimum value of FPE, AIC, HOIC, and SBIC. After generating the VAR model identification, this article uses Stata to test the stability of the vector autoregression. According to figure 1, all dots locate inside the circle that figure out the VAR model is stationary; and we could use the model for our further study.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE
1	761.285	1847.5	9	0.0000	0.000031
2	779.163	35.761	9	0.0000	0.00003
3	783.953	9.5751	9	0.386	0.00003
4	786.537	5.1692	9	0.819	0.000031
5	787.718	2.3624	9	0.984	0.000032
6	794.739	14.041	9	0.121	0.000032
7	823.498	57.518	9	0.000	0.00003
8	826.768	6.5397	9	0.685	0.000031
9	835.235	16.934	9	0.050	0.000031
10	863.017	55.565	9	0.000	0.000029
11	883.436	40.838	9	0.000	0.000028
12	889.81	12.747	9	0.174	0.000029

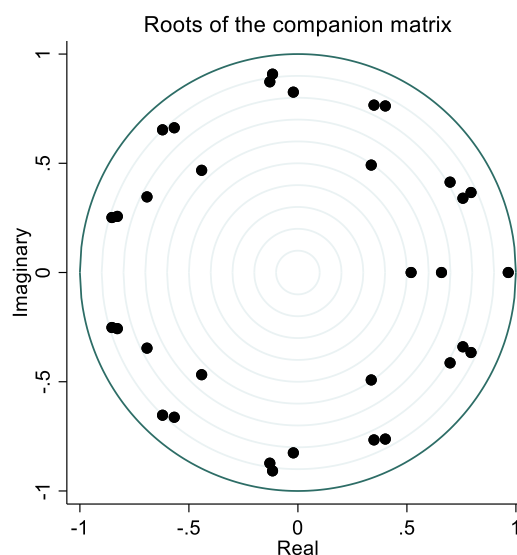


Figure 1. VAR stability test

3.2 Impulse and response

The graph of IUF is concerning the response of cryptocurrency, once the newly global confirmed cases are increasing. According to Figure 3, the price of Ethereum increases at first and then declines. It is never stable after the outbreak of COVID-19. The condition of Bitcoin is similar to Ethereum. The price of Bitcoin increases at the beginning of the outbreak of COVID-19, but it does not keep increasing all the time. The price is fluctuant.

By observing the figure of impulse and response, this paper deduces that the magnitude of growth is close to the degree of reduction. For the short term, Bitcoin or Ethereum might increase massive profits or losses, however, for the long term, the profit would almost offset the loss. For the fluctuation, Bitcoin is more volatile than Ethereum, because the range of Bitcoin is larger than the range of Ethereum in the graph.

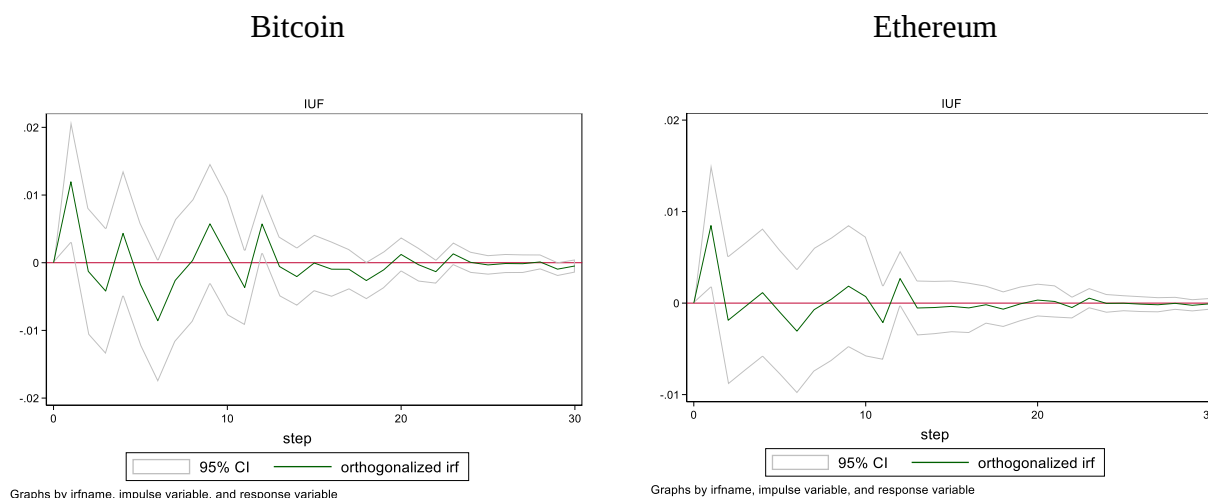


Figure 2. Impulse and response

3.3 ARMA order identification

By observing the PACF of Bitcoin in figure 3, we could find that lag 1, lag 2, lag 10, lag 11, lag 22, and lag 30 are over the boundary; For convenience, this research chooses lag 1 as the order identification. For the ACF of Bitcoin, PACF of Ethereum, and ACF of Ethereum, the method of lag identification is the same as the PACF of Bitcoin.

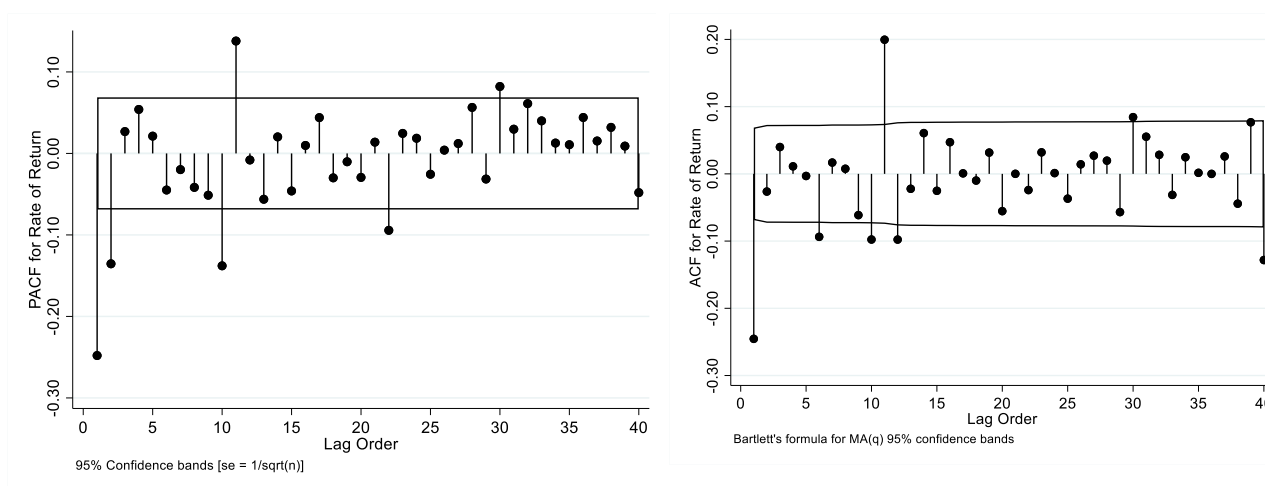


Figure 3. PACF and ACF for ARMA identification, Bitcoin

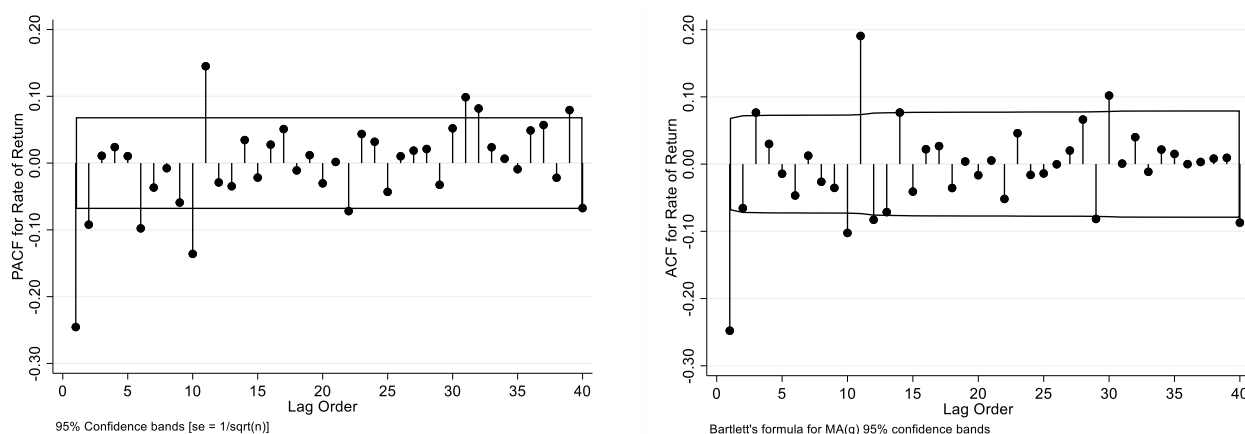


Figure 4. PACF and ACF for ARMA identification, Ethereum

3.4 ARMA-GARCH model estimation results

According to column (1), we could see a tight connection between newly confirmed cases globally with the price of Bitcoin, because the level of significance is at 1%. The coefficient of -0.0662 which is the standard deviation of the GARCH model shows that the volatility of Bitcoin would decline by 0.06662 once the newly confirmed cases increase by 1 percent. For column 2, when T is equal to 0, the coefficient shows that the volatility of Bitcoin would decline by 0.5038 once the confirmed cases increase by 1 percent.; the significance of this result is also 1 percent. When T is 1 for column 2, the volatility for Bitcoin would increase by 0.5204 if the new confirmed cases of COVID-19 would increase by 1 percent. For column 3, the volatility of Bitcoin would decline by 0.5294 while the new confirmed cases increase one percent; this result is based on a significance of 1%.

Based on information in column 4, Ethereum's volatility would decline by 0.237 once the new confirmed cases increase by one percent. For column 5, while the new confirmed cases increase a percent, the volatility of Ethereum would decrease by 0.9463 at $T=0$ and increase by 0.9565 at $T=1$. For column 6 the volatility of Ethereum would drop 0.9514 once the new confirmed cases increase by one percent. Those results are all based on the 1 percent of the level of significance. The great level of significance would make the data more persuasive.

For Bitcoin variable 2, the value at $T = 0$ is 0.5038 which is could almost offset by the value at $T = 1$ which is 0.5204. This result further proves the observation from IUF; the growth of volatility would compensate by the reduction of the volatility for the long term. This situation also occurs in column 5 which is the volatility for Ethereum. In the long term, the increased number of newly confirmed cases does not accelerate the volatility of cryptocurrency.

Table 3. ARMA-GARCH model estimation results, variance equation

Variables	Bitcoin			Ethereum		
	(1)	(2)	(3)	(4)	(5)	(6)
Newly confirmed cases, the global						
T=0	-0.0662*** (0.0091)	-0.5038*** (0.0365)	-0.5294*** (0.0532)	-0.2370*** (0.0096)	-0.9463*** (0.0316)	-0.9514*** (0.0357)
T=-1		0.5204*** (0.0468)	0.2079 (0.2934)		0.9565*** (0.0319)	0.5250 (0.3684)
T=-2			0.3477 (0.2574)			0.4276 (0.3488)
ARCH						
ARCH (-1)	0.1932*** (0.0525)	0.0781*** (0.0139)	0.0812*** (0.0193)	0.2856*** (0.0559)	0.0756*** (0.0138)	0.0770*** (0.0139)
GARCH (-1)	0.0831 (0.0637)	0.6058*** (0.0435)	0.6070*** (0.0698)	0.1330*** (0.0210)	0.5190*** (0.0208)	0.5182*** (0.0372)
Constant	-4.1035*** (0.1129)	-6.0419*** (0.3332)	-6.1762*** (0.3751)	-1.5143*** (0.1296)	-5.3034*** (0.2062)	-5.1812*** (0.3273)

4. Discussion

This study finds the rate of return of Ethereum, and Bitcoin is significantly impacted by the increasing number of newly confirmed COVID-19 cases globally. During the covid-19 panic, people wanted to find a safe way to protect their assets. Digital currency became a nice method for them. The author claims “Such results are supported by the continued Chinese guidance and support of cryptocurrencies as a viable and stable asset class. Such government reassurance could act as both a catalyst and supporting structure to perceived investment safety during a market panic” in the article “Any port in a storm: Cryptocurrency safe-havens during the COVID-19 pandemic” Yang Hu states that people would more like to utilize Cryptocurrency as a safe way during the panic because the government would support this digital currency [14].

Unlike Yang Hu’s claims about people would use Crypto as a safe way to save money, this paper disagrees to buy Crypto as a safe asset, because of its high fluctuation. According to the impulse of response, the performance of crypto did have a good performance for the short term, however, the performance is not stable for a long time; the rate of return usually declines a lot in a certain term. While people cannot predict when the crypto would decline a lot, crypto cannot be a safe asset. As a safe asset, it cannot lose a lot of value like crypto. Is crypto a good stock for investment? The answer might be not. According to the result of the ARMA-GARCH test, most situations show that the return rate of crypto is negative. The negative return rate is not competitive with other good stocks. Subhan Ullah claims that “As a financial asset, bitcoin prices are vulnerable to a wider range of micro-and macro-level factors, including celebrity endorsements, government announcements relating to the adoption, governance, and regulations of bitcoin” in the article “Assessing the influence of celebrity and government endorsements on bitcoin’s price volatility” [15]. The author claims people would be attracted to buy more digital currency if they see the propaganda from some celebrity. The short-term increasing price of Bitcoin might be the result of the celebrity’s effect. While celebrities attract more people to buy Bitcoin, the price of Bitcoin would increase for the short term; however, the price would decrease after this short term. Further study could find out other effects of COVID-19. For example, the covid-19 might result in unemployment. The rate of Unemployment might also affect the price of crypto. And comparing the trend of crypto before or after the outbreak of panic might be an excellent way to further understand crypto.

5. Conclusion

This paper utilizes the VAR model and ARMA-GARCH model to analyze the effects of newly confirmed cases on the rate of return and volatility of cryptocurrency. The VAR model's results show that the rate of return is stationary so we could use the result for the next study. By observing the IUF, we could find although the graph is volatile, the highest point could almost offset the lowest point. The ARMA-GARCH model also proves that; the volatility of day 2 could compensate for the volatility of day 1. The standard error for standard deviation is less than 0.05 which demonstrates a high significance level for volatility. Both IUF and ARAMA-GARCH models show that although the cryptocurrency is volatile for the short term, the growth would compensate for the reduction in the long term. This study demonstrates that the panic of Covid-19 would not affect the volatility of cryptocurrency in the long term.

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