

The Time-varying Impact of Covid-19 Pandemic on Niche Cryptocurrency Returns and Volatility

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Abstract. Since the outbreak of COVID-19 in 2020, all industries have been hit to a greater or lesser extent, and the financial sector is no exception. And in previous studies of mainstream cryptocurrencies, cryptocurrencies appear to have been relatively unaffected by the epidemic. This paper, however, explores the impact of the epidemic on niche cryptocurrencies such as BNB, ADA, and dogecoin based on VAR and ARMA-GARCH models. The results show that the impact on returns is relatively small, while the impact on volatility is almost non-existent. These results may provide references for government departments and individual investors to avoid the systemic risk caused by the epidemic.

Keywords: Niche Cryptocurrency; COVID-19; VAR; ARMA-GARCH.

1. Introduction

COVID-19 has influenced a wide number of businesses in one form or another since its breakout in early 2020. The cryptocurrency market has always been sensitive to external influencing factors. Judging from the current global trend of the epidemic, various mutant strains keep appearing, making it difficult to the epidemic for a while. John W. Goodell's study first analyzed the economic impact of the epidemic, concluding that the epidemic would affect the economy by increasing additional expenses [1]. It next studied COVID-19's influence on the banking and insurance sectors, which raised the risk of non-performing loans and, in extreme situations, bank runs; it also examined the impact on financial and capital markets, which were also harmed by COVID-19's economic slump. Adrian Fernandez-Perez's paper went into further detail about the influence of COVID-19 on stock markets in various ethnocultural countries [2]. Silvio Contessi et al. examined the influence of the Chinese stock market on the global stock market in the early stages of the pandemic using a statistical method. [3]. Susan Sunila Sharma's study, on the other hand, looked at differences in stock price volatility in Hong Kong, Japan, Russia, Singapore, and South Korea, concluding that the Singapore stock exchange had the highest volatility [4]. The study by Maretno Agus Harjoto et al., on the other hand, analyzed the effects of COVID-19 on the stocks of different companies, and the effects of government subsidies on different firms [5].

Based on past research, we may conclude that COVID-19's influence on the financial sector is the most significant for the real economy. The weakened willingness and purchasing power of the public, the increase in social and medical costs, and the impact on the operation and functioning of enterprises will lead to a weakening of investor confidence in the market, which will naturally lead to a decline in the stocks of individual companies and the general market. Moreover, since the global economy and financial markets are closely linked, the impact of an epidemic in one country may spread to many neighboring countries. This has a big influence on the world's markets. While COVID-19 appears to have had a significant influence on the stock market as a whole, it appears to have had a far smaller impact on cryptocurrencies.

The influence of COVID-19 on cryptocurrencies has already been studied using popular currencies like Bitcoin and Ethereum. M Ozturk et al. examined the effects of COVID-19 on the volatility of international crude oil prices, gold, exchange rates, and bitcoin, concluding that the interactions between price fluctuations are relatively tight [6]; When comparing Bitcoin to the stock/fund market, Huang Y et al. found that Bitcoin was more stable than other investment choices in the face of the pandemic [7]; Caferra R et al. compared the response of various cryptocurrencies and stocks to the

new pneumonia epidemic and concluded that cryptocurrencies were affected for a relatively short period and suffered relatively little impact [8]; The association between cryptocurrency and COVID-19 cases/deaths was investigated by Demir E et al. They observed that bitcoin prices declined as the number of reported illnesses and fatalities grew, but that they were afterward positively related. [9]. After the emergence of COVID-19, Corbet S et al. focused on the interrelationships between cryptocurrency liquidity and volatility, presenting more evidence that many individuals were transferring cash into cryptocurrency, a "haven" that was generally untouched by the epidemic [10].

Since COVID-19 is likely to continue for some time, it is important to study the impact and influence of the new crown pneumonia on cryptocurrencies for both investors and policymakers. For mainstream cryptocurrencies such as Bitcoin and Ether, previous research has been more than adequate. For niche currencies such as BNB, ADA, and dogecoin, the impact of COVID-19 on them is not quite clear yet. Therefore, it is necessary to carry out research in this area. From previous studies, we can find that mainstream cryptocurrencies have relatively limited volatility changes in response to shocks from COVID-19 because of the relatively small correlation between cryptocurrency volatility and developments in the real economy. Whether the more niche cryptocurrencies have the same results will be answered in the following study.

The main study in this article is divided into two sections: the influence of COVID-19 on daily returns and volatility. Chapter 2 will primarily focus on the paper's research material, including the data source, smoothness test, and VAR and ARMA-GARCH models created to study the influence of earnings and volatility; The results of our studies will be shown in Chapter 3; The outcomes of the paper will be discussed in Chapter 4, and the entire article will be summarized in Chapter 5.

2. Research Design

2.1 Data source

In order to be able to obtain accurate cryptocurrency ticker data, the python API interface of the coin gecko website was chosen to obtain daily ticker information of electronic cryptocurrencies. Here, the daily closing prices of three types of cryptocurrencies, BNB, ADA, and dogecoin, from January 24, 2020, after the outbreak of the COVID-19 to February 24, 2022, before the Russian-Ukrainian conflict were selected. In addition, global epidemic information from Johns Hopkins University were used to calculate the daily amount of new COVID-19 infections throughout the world.

2.2 The determination of the number of network layers

We must first ensure that each time series is smooth before we can model the time series analysis. As a result, we must run a smoothness test on each time series data set before we begin modeling. The unit root test, often known as the ADF test, is one of the most popular smoothness tests. The ADF test stands for Augmented Dickey-Fuller Exam, and it's an expanded version of the Dickey-Fuller test. The DF test may only be used in first-order situations, while the ADF test may be used when there is any higher-order lagged correlation in time series, making the ADF an extension of the DF test.

$$y_t = by_{t-1} + a_0 + \sum_{i=1}^{p-1} \phi_i \Delta x_{t-i} + \epsilon_t \quad (1)$$

To perform an ADF test, which is a unit root test, one must first grasp a concept: the item to be tested - the unit root. During the process of autoregressive: $y_t = by_{t-1} + a + \epsilon_t$. when the lag term coefficient b is 1, it is referred to as the unit root. When a unit root occurs, the relationship between the independent and dependent variables is deceptive since any error in the residual sequence does not disappear as the study sample (i.e., the number of periods) grows, signaling that the residuals' effect in the model is constant.

2.3 VAR Model Setting

In the case of univariate regression, the basic model that is usually built is the n th-order AR model as shown in equation (2)

$$y_t = \alpha_0 + \sum_{i=1}^n \alpha_i y_{t-i} + \epsilon_t \quad (2)$$

In the multivariate instance, the VAR model is typically used to describe a set of realization series, which allows for the consideration of variable interactions. Equation (3) shows the expression for the two-variable VAR model:

$$Y_t = \Phi_0 + \sum_{i=1}^n \Phi_i Y_{t-i} + BX_t + \epsilon_t \quad (3)$$

$$\text{Where } Y_t = \begin{pmatrix} y_{1t} \\ y_{2t} \\ \vdots \\ y_{kt} \end{pmatrix}, \Phi_0 = \begin{pmatrix} \Phi_{10} \\ \Phi_{20} \\ \dots \\ \Phi_{k0} \end{pmatrix}, \Phi_i = \begin{pmatrix} \phi_{11}(i) & \phi_{12}(i) & \dots & \phi_{1k}(i) \\ \phi_{21}(i) & \phi_{22}(i) & \dots & \phi_{2k}(i) \\ \vdots & \vdots & \ddots & \vdots \\ \phi_{k1}(i) & \phi_{k2}(i) & \dots & \phi_{kk}(i) \end{pmatrix},$$

$$i = 1, 2, \dots, n, \epsilon_t = \begin{pmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \vdots \\ \epsilon_{kt} \end{pmatrix}.$$

B in $k \times d$ dimensional matrix, X_t is a d -dimensional exogenous variable that might be a constant, a linear trend term, or any other non-random variable.

The following are the properties of the VAR model: (1) It is not based on economic theory. (2) The parameters are not subjected to a zero restriction. (The economic value of the regression parameters is not investigated, and insignificant factor predictions are not deleted from the equation.) (3) There are no present-period factors in the independent variable, and the VAR model does not solve any of the issues presented by the joint cubic equation model. (4) A large number of parameters must be calculated. When the sample size is small, the errors in the estimations of most parameters are greater. (5) Near-term projections made outside of the sample are quite accurate. It can only anticipate the trend of change when undertaking out-of-sample long-term forecasting, but not the short-term volatility.

The VAR model, as can be observed, is an analytical approach that can more easily study the effect of variables on one another, and may employ impulse response analysis and variance decomposition to determine the degree of influence between variables.

2.4 ARMA-GARCH Model Setting

In order to be able to model the returns and volatility of each currency under the influence of COVID-19, an ARMA-GARCH model for each currency is considered here for modeling purposes.

The ARMA model may be expressed as follows:

$$y_t = \phi_0 + \sum_{i=1}^p \phi_i y_{t-i} + \epsilon_t - \sum_{j=1}^q \theta_j \epsilon_{t-j} \quad (4)$$

Where the $\{\epsilon_t\}$ is the white noise sequence, ϵ_t can be expressed as $\epsilon_t = \sigma_t \mu_t$, where $\{\mu_t\}$ is a collection of random variables having a mean of 0 and a variation of 1 that are all independent and have the same distribution. For the variance σ_t a GARCH model can be built as shown in equation (5):

$$\sigma_t^2 = a_0 + \sum_{i=1}^p a_i \epsilon_{t-i}^2 + \sum_{j=1}^q b_j \sigma_{t-j}^2 \quad (5)$$

Where $a_0 > 0$, $a_i, b_j \geq 0$, $\sum_{i=1}^p a_i + \sum_{j=1}^q b_j < 1$, and assume that a_i, b_j satisfy certain conditions such that the conditional variance of ϵ_t is finite over time.

From (3) and (4), we can establish the ARMA-GARCH and then derive the impact of COVID-19 on various cryptocurrencies

3. Results

3.1 ADF Test

Before modeling the data in question, the first step is to conduct a smoothness test for each time series, the results of which are shown in table 1

Table 1. ADF test

Variables	t-statistic	p-value
Price		
BNB	-1.093	0.9302
ADA	-0.718	0.9720
DOGE	-1.991	0.6062
Yield		
BNB	-18.172	0.0000***
ADA	-18.734	0.0000***
DOGE	-21.156	0.0000***
Covid-19 Pandemic		
Global new confirmed cases	-5.166	0.0001***

The results show that the daily prices of the three types of cryptocurrencies themselves are non-stationary, but their yields are a stationary series and are three-star stationery. Also, the daily number of new cases of the new crown pneumonia outbreak is a three-star smooth series. Therefore, it is possible to model the associated coin prices as well as the number of new cases per day.

3.2 VAR model order Identification

The order of the VAR model is determined using the information criteria, and the results are displayed in the table below.

Table 2. VAR model identification

Lag	LL	LR	df	p
0	1577.75			
1	2484.08	1812.7	16	0
2	2521.98	75.812	16	0
3	2550.96	57.947	16	0
4	2566.33	30.735	16	0.015
5	2579.7	26.744	16	0.044
6	2589.14	18.888	16	0.275
7	2606.71	35.138*	16	0.004
8	2617.82	22.221	16	0.136
9	2624.59	13.538	16	0.633
10	2633.41	17.645	16	0.345
11	2643.76	20.692	16	0.191
12	2655.06	22.604	16	0.125

From the results calculated according to the information criterion, it is most reasonable to set the model as 7 orders. Finally, all the characteristic roots were examined and the results are shown in Figure 1. It can be found that all the characteristic roots are in the unit circle, so it can be considered that the constructed VAR system belongs to the smooth process, although the autocorrelation in the residuals.

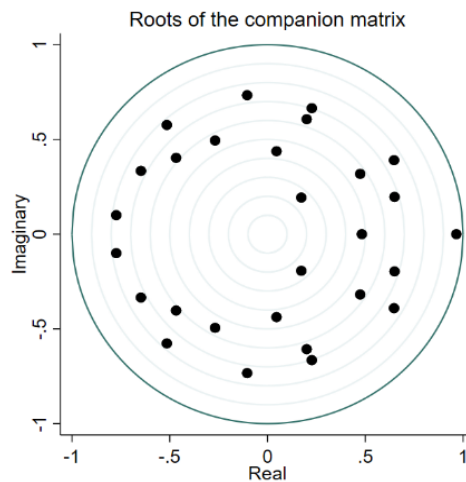
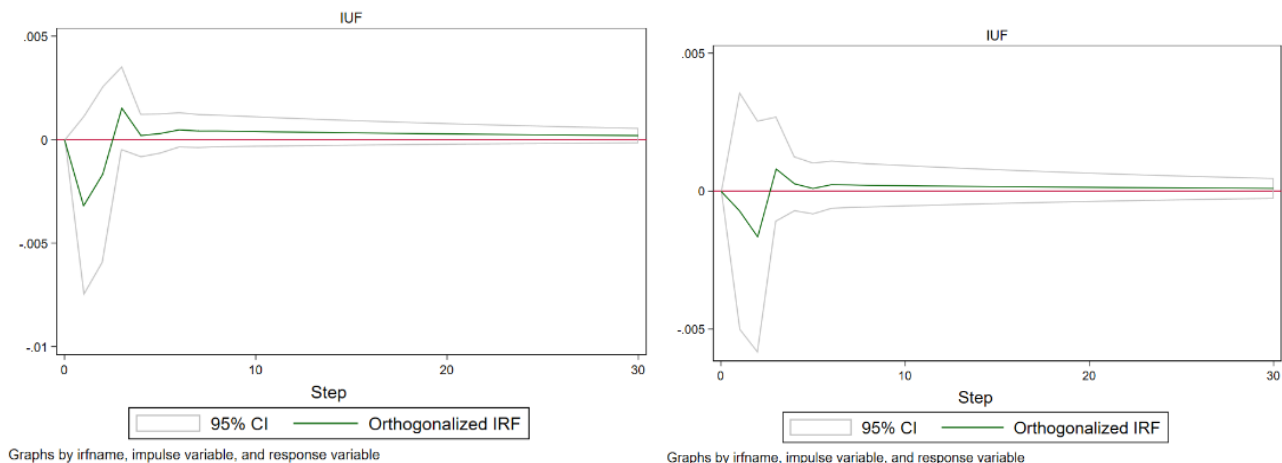


Figure 1. VAR stability

3.3 Impulse Response

To understand the impact of the related pneumonia epidemic on each cryptocurrency, the impulse response function of daily additions for each cryptocurrency coin price was plotted separately. The results are shown in Figure 2.



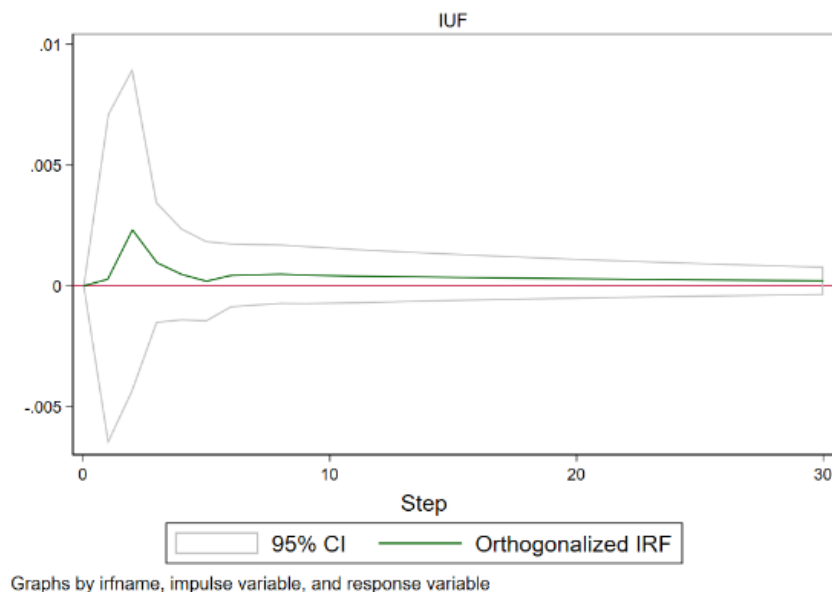


Figure 2. Impulse and response

The impact of COVID-19 on niche electronic cryptocurrencies is relatively limited, as seen in the estimation results of the pulse images. Specifically, the global daily number of new confirmed diagnoses increases by 1% in period $t=0$. The return of BNB decreases by 0.25% in period $t=1$, increases in period 2, and returns to positive after period 3. The effect of this shock tends to zero rapidly over time, and a similar effect exists for ADA. For dogecoin, the epidemic shock has a positive effect on dogecoin's return, but the effect also tends to disappear quickly over time.

3.4 ARMA model order Determination

The Partial Auto-Correlation Function (PACF) is a very useful tool for ranking AR models. Using this function, we can order the AR component of each of the three cryptocurrency classes. The Auto-Correlation Function (ACF) is also a useful tool for ranking MA models. The figure below shows the values of PACF and ACF functions for each cryptocurrency. Among them, BNB is considered to build ARMA (1,1) model, ADA is considered to build ARMA (1,1) model, and dogecoin is considered to build ARMA (3,3) model, and after the residual white noise test, all the above modeling results meet the requirements.

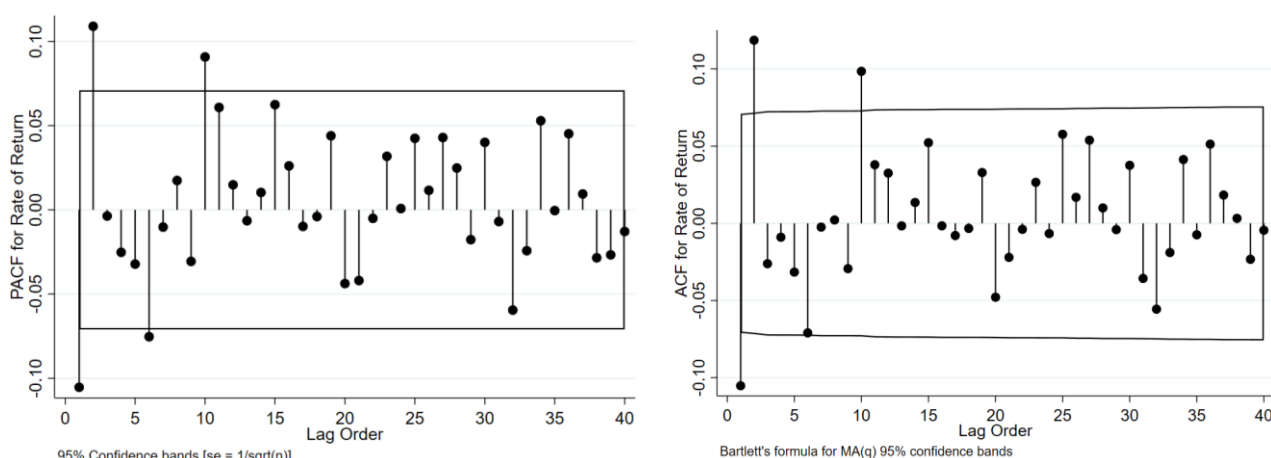


Figure 3 ARMA identification, BNB

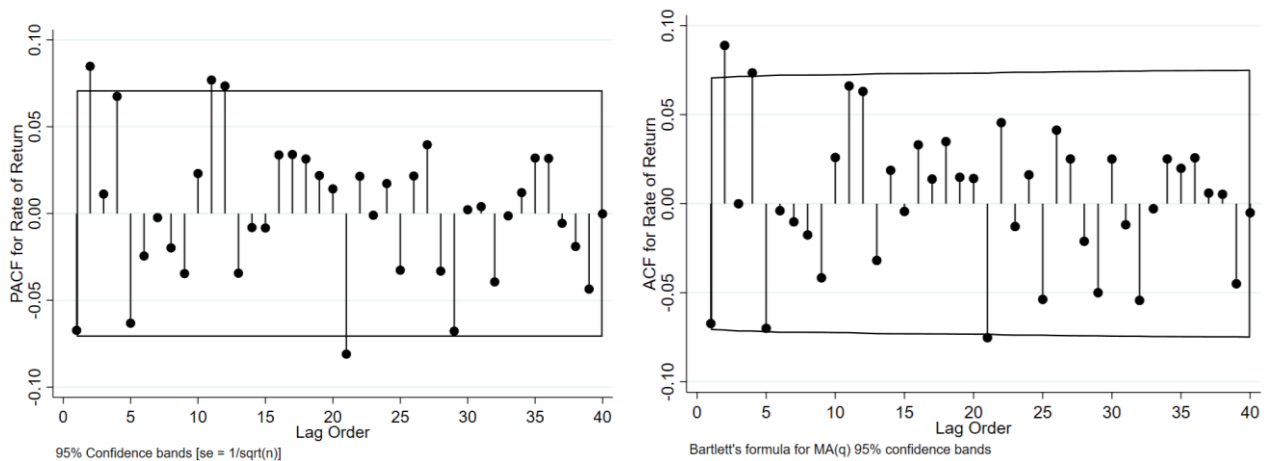


Figure 4. ARMA identification, ADA

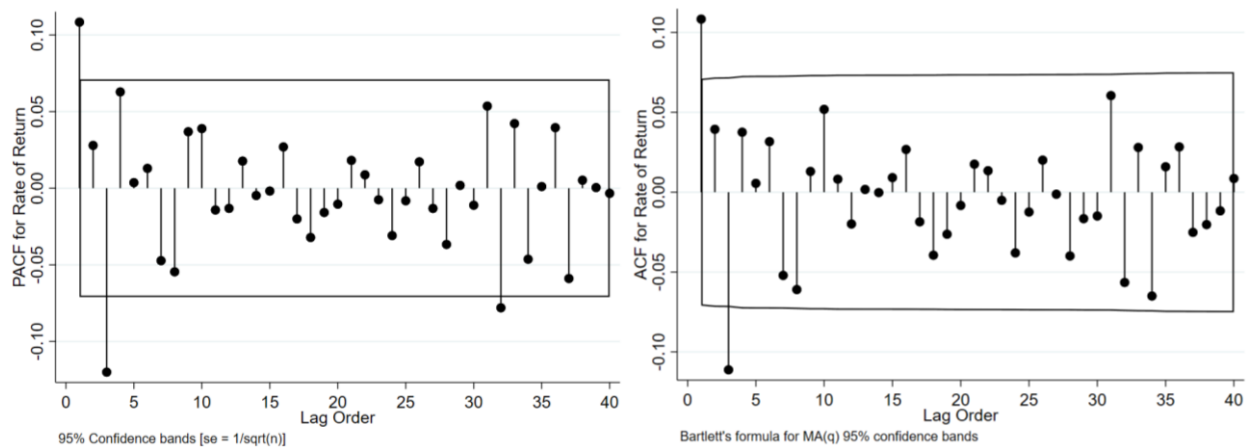
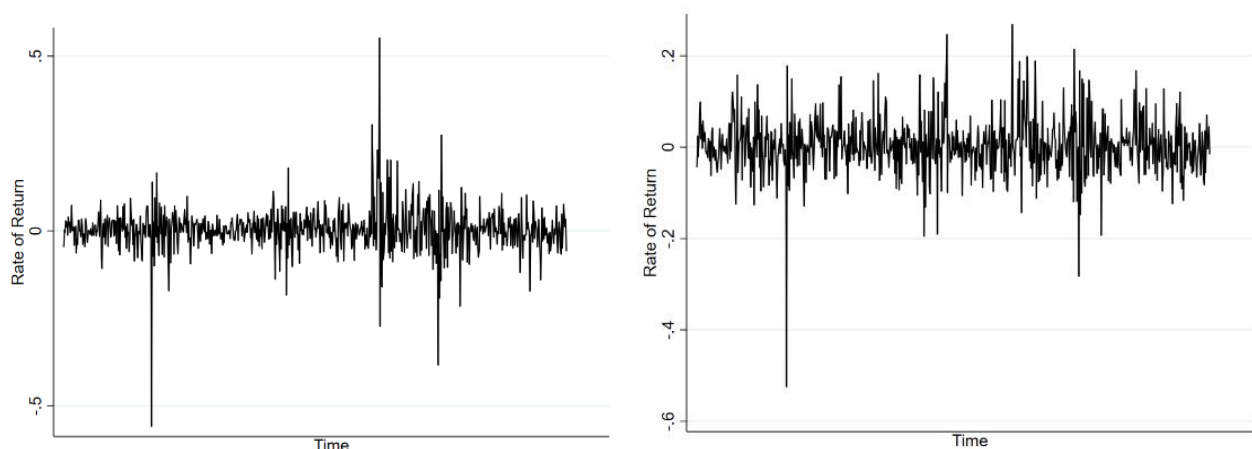


Figure 5. ARMA identification, DOGE

3.5 ARMA-GARCH Estimated Results

The variation of each cryptocurrency was printed out before commencing the study on the influence of COVID-19 on cryptocurrency variance, as shown in Figure 5.



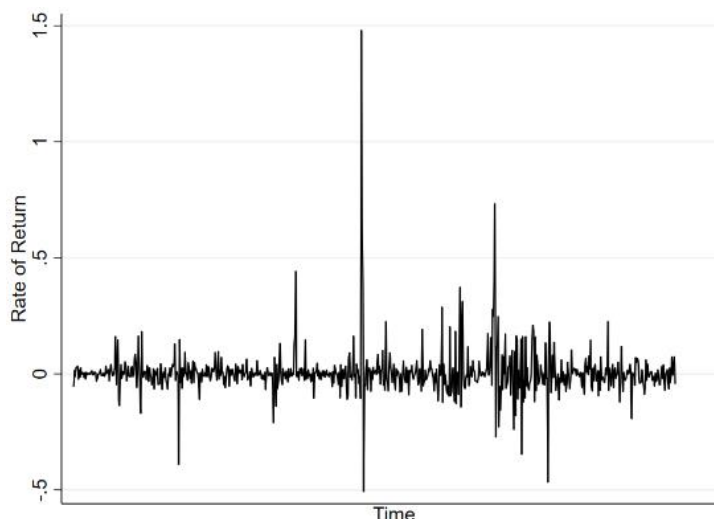


Figure 6. Yield trend

After the ARMA model was built, further ARMA-GARCH models were considered, and the variance was added to the modeling while the mean was modeled. Also, the daily added data of the epidemic were used as explanatory variables in the process of GARCH model building. And it was here that the GARCH (1,1) model was born. The table below shows the final modeling findings.

Table 3. ARMA-GARCH estimation results, variance equation

Variables	(1)	(2)	(3)
	BNB	ADA	DOGE
Global new confirmed cases	-0.4458*** (0.0441)	-0.2056*** (0.0278)	-0.0131 (0.0138)
ARCH (-1)	0.1174*** (0.0172)	0.0742*** (0.0173)	1.4157*** (0.0502)
GARCH (-1)	0.8771*** (0.0344)	0.8497*** (0.0344)	0.0014 (0.0095)
Constant	0.0033* (0.0017)	0.0025 (0.0021)	0.0047** (0.0019)

From the estimated results of the variance equation, it is clear that the increase in the global daily number of new confirmed diagnoses does not cause daily volatility in small-currency electronic cryptocurrencies. The global epidemic data has a very limited impact on small-currency cryptocurrencies.

4. Discussion

From the results of this paper, it is clear that the COVID-19 has a small impact on the returns of niche cryptocurrencies such as BNB, ADA, and dogecoin with a very limited impact on volatility. This is also consistent with previous studies on mainstream cryptocurrencies. In fact, since cryptocurrencies are not particularly sensitive to changes in the form of the real economy, external factors such as epidemics can hardly have a direct impact on them. Therefore, when an epidemic occurs, many investors will move their assets to cryptocurrencies, and niche currencies such as BNB, ADA, and dogecoin are among the more desirable options. For policymakers, they should take note of the properties of cryptocurrencies for being better able to combat the impact of an epidemic and could consider investor guidance towards investing in cryptocurrencies during a new crown pneumonia epidemic. Individual investors should not only be aware of the excellent role of cryptocurrencies for

epidemic risk avoidance but also consider the possible impact of the epidemic when investing in order to maximize their returns.

5. Conclusion

Using VAR and GAMA-GARCH to predict returns and volatility, this study investigates the impact of COVID-19 on niche cryptocurrencies such as BNB, ADA, and dogecoin. The influence of Covid-19 on niche cryptocurrency returns is then examined using the impulse response figure, and the impact on volatility is examined using the coefficient of global new confirmed instances of the GAMA-GARCH model. The outcomes of the study reveal that COVID-19 has a minor impact on returns and a negligible impact on volatility. When worldwide new confirmed cases increased, the prices of the first two cryptocurrencies increased slightly, and the price of dogecoin dropped slightly. However, as time passes, their effects dissipate. These findings suggest that niche cryptocurrencies are a great instrument for investors to reduce the risk presented by COVID-19 since they are not affected by the pandemic's progression. The government or other affiliated authorities might use this as a reference when creating policies, as well as investors when making investment decisions.

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