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Cryptocurrency Volatility and Its Impact on Emerging Markets: Quantitative Analysis

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Cryptocurrency, a booming decentralised asset designed based on the blockchain architecture, is particularly important to the market at the present time by studying the volatility risk of cryptocurrencies. In this paper, we empirically analyse the volatility risk of cryptocurrencies through quantitative analysis models, comprehensively using the Markov state transition GARCH model with skewed distribution (Skew-MSGARCH) and the autoregressive conditional volatility density ARJI model introducing the Poisson jump factor, and selecting the earliest developed and the most mature currency price volatility daily return series, to deeply explore the volatility risk of digital cryptocurrencies. risk. Finally, it can be seen through in-depth analyses that the expectation factor and information inducement are the main reasons leading to the exacerbation of the volatility risk of digital cryptocurrencies. It is recommended that this situation be optimised and improved in terms of the value function of digital cryptocurrencies themselves and the implementation of systematic risk management and regulatory innovation. As an important component of the digital economy, blockchain technology can effectively regulate and improve the volatility of digital cryptocurrencies under macroeconomic policies, thereby maintaining the security and stability of emerging financial markets.

Keywords: cryptocurrency, volatility, emerging markets, quantitative analysis

Introduction

With the development of blockchain technology and artificial intelligence, digital encrypted currency has gradually entered people's vision. The types of digital encrypted currencies are becoming more and more diversified, and there are various kinds of digital encrypted currencies in the world. And it is greatly improved on the original basis. For example, the design of mining procedures has changed from complexity to simplicity, the flexibility of transactions and the increasing standardization of bankers. On the one hand, its existence is a reflection of the development of blockchain technology and artificial intelligence. On the other hand, it threatens national financial security and emerging finance because of its decentralization, anonymity, speculative attributes and volatility. Compared to other currencies, cryptocurrency has greater price fluctuations. Unsecured encrypted assets have no fundamental value, so their valuation mainly depends on highly volatile speculative demand. A stable currency will also be affected by price fluctuations. Because their prices in the secondary market are not always linked to the reference currency, and there is a risk of a run on the market. May cause them to deviate

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significantly from the pegged exchange rate. The concentration of token ownership may also affect price fluctuations in the secondary market. Therefore, the study of cryptocurrency volatility is currently the primary issue in cryptocurrency research. In recent years, due to changes in macroeconomic conditions such as policy changes, major domestic and international events, and related information disclosures, market volatility behavior has changed, leading to increased volatility risks and causing huge losses for investors, further increasing financial market risks. The risk of cryptocurrency price fluctuations is related to the cryptocurrency technology itself. Cryptocurrency technology is becoming increasingly mature, and new application scenarios are constantly emerging, all of which will have an impact on the sentiment of the cryptocurrency market. In addition, policy changes can also pose significant risks to the price of cryptocurrencies (Jia, Shen, & Zhang, 2023). Many countries have different attitudes towards cryptocurrencies, and policy changes often trigger severe market fluctuations. Finally, some political events in the market, such as wars, earthquakes, etc., can also pose risks to cryptocurrencies. At this point, investors usually change their investment direction, causing fluctuations in their prices. Due to risk spillover effects, it may even threaten national financial security and stability, which will have serious impacts at both the micro and macro levels. Therefore, research on the volatility of digital cryptocurrencies has become an urgent task for the development of emerging financial markets. It determines the stability of the overall monetary and financial markets and has significant significance for creating favorable international monetary order conditions.

Empirical Analysis of the Volatility Risk of Cryptocurrencies

Sample Data Selection and Inspection

Selection of sample data. In order to better analyze the volatility behavior characteristics and volatility risks of digital cryptocurrencies, this paper takes Bitcoin as the research object and compares the volatility risks of Bitcoin. For Bitcoin, its sample data is longer than that of other cryptocurrencies, so this study is based on Bitcoin. The currency market data, as the research object, is persuasive for studying the risk of jumping fluctuations in the digital cryptocurrency market.

Currency market data, as the research object, is convincing to study the jump volatility risk of the digital encrypted currency market. Table 1 shows the top five cryptocurrencies by market capitalization.

Table 1

Top 5 Cryptocurrencies by Market Capitalization (USD)

Currency	Name	Price	Circulating market value (hundred million)	Proportion of market value (%)
BTC	Bitcoin	51442.13	9622.79	59.71
ETH	Ethereum	1609.70	1850.37	11.48
ADA	Ida coin	1.25	398.49	2.47
BNB	Coin An Coin	247.49	382.46	2.37
DOT	Poca chain	37.45	363.16	2.25

As can be seen from Table 1, the market value of Bitcoin accounts for the highest proportion, as of March 3, 2023, the market value of Bitcoin accounts for 59.71%. The weight of the market value of the digital encrypted currency can show the position of the currency in the digital encrypted currency market. The larger the market value, the more dominant it is, that is, the currency can determine the trend and development of the digital encrypted currency market.

Descriptive statistics of sample data. Table 2 shows the descriptive statistical characteristics of the time series of the daily yield of Bitcoin. From the table, we can see that the average yield is positive. It shows that the overall return of Bitcoin is good during the sample period. From the analysis of the maximum and minimum value of its yield, the results are quite different, which shows that its income can double, but its risk can also double, and its volatility risk can not be small. From the value of its standard deviation, we can also see that the volatility of its earnings is more intense (Zeng, 2021). Observing the skewness and kurtosis data, from the skewness data, the skewness of the sample yield of Bitcoin is not zero, and it is left-biased, while the kurtosis coefficient is 15.01. It is much larger than kurtosis value 3 under the standard normal, which shows that the daily return series of Bitcoin has the characteristics of sharp peak and fat tail. And from the test value of the statistic, the value is a 22069, the probability of following the standard normal distribution is 0, this also confirms the original assumption that the return series of Bitcoin does not obey the normal distribution.

Table 2

Descriptive Statistical Characteristics of Daily Return Series of Bitcoin

Sequence	Mean value	Maximum value	Minimum value	Standard deviation	Skewness	Kurtosis	J-B value	obs
Rb	0.0033	0.4246	-0.4915	0.0536	-0.267	15.627	22063	3655

Sample data inspection. In the data test, this study uses stationary test to analyze, which mainly includes ADF test, PP test, DF-GLS test and KPSS test. In this paper, the commonly used ADF test is mainly used. Let the original hypothesis H. There is no unit root in the time series of the yield of the digital encrypted currency, and after the ADF stationarity test. If the statistical value of ADF obtained by the test is greater than critical value, the null hypothesis is accepted, indicating the existence of a unit root. That is to say, the time series of Bitcoin yield is unstable. If the statistical value of ADF obtained by the test is less than critical value, the null hypothesis is rejected. It shows that there is no unit root, that is, the time series of Bitcoin yield is stationary (Chen, 2021). Since the perturbation term in the ADF test may be autocorrelated, a higher order ADF test is considered. First of all, the maximum lag order should be determined. According to the formula, the maximum lag order = 12 is obtained. The last order lag term is L4D, which means that when the lag order is 4, it is significantly different from zero at the 5% level. The results of the stationarity test of the daily return series of Bitcoin are summarized in Table 3 below.

$$P\left[12 * (T/100)^{1/365}\right]_{max} \mathrm{P}_{\max}$$

Table 3

Stationarity Test Results of Bitcoin Daily Return Series

Sequence	ADF statistics	Prob	Significant level%	Corresponding ADF critical value
			1	-3.42
Bitcoin	-26.527	0.000	5	-2.86
			10	-2.54

In Table 3, it can be seen from the table that the ADF test statistic is significant at the 1%, 5%, and 10% significance levels. And the ADF statistics are less than critical values corresponding to the three significance levels, that is, the null hypothesis is rejected. It shows that there is no unit root in the return series of Bitcoin, and its time series is stable. GARCH modeling and parameter estimation can be carried out.

Analysis of Volatility Model

Model selection and parameter estimation. Volatility model here refers to the compound model formed by introducing volatility factors on the basis of GARCH model. This section also shows the constant volatility density assuming a fixed volatility intensity.

Model Jump-GARCH and an autoregressive conditional volatility density model ARJI assuming time-varying volatility intensity. In this model, the value of the jump density parameter, which measures the strength of the volatility of Bitcoin, is a fixed value λ; the volatility density parameter of ARJI family model changes with time, which reflects the time-varying behavior of volatility. Because of the difference of their fluctuation density parameter equation, the influence factors of the fluctuation density parameter value are also different.

As can be seen from Table 4, in terms of model fitting, according to the report results of the maximum likelihood value LL of each volatility model,

As a result, it is found that the LL value of the constant fluctuation density model is the smallest, while the LL value of the ARJI-ht model is the largest, and the estimated results of the parameters are more significant. According to the rule that the larger the maximum likelihood value is, the better the model fitting is. It is found that the constant volatility density model with a fixed value of the volatility density parameter fits the Bitcoin yield with volatility behavior (Qiu, & Xie, 2024). The goodness-of-fit is not good for volatility, while the goodness-of-fit of the ARJI family model assuming that the volatility intensity is time-varying is better. Because the ARJI family model belongs to the conditional volatility density, the parameterized ARJI model allows the conditional volatility density parameter value λ to change over time, unlike the constant volatility model, the volatility density is a fixed value, so it can improve the likelihood value.

Table 4

Parameter Estimation Results for Various Types of Volatility Jump Models

Parameter	Constant jump density model	ARJI model	ARJI-R_{t-1}^2 Model	ARJI-h_t Model
μ	0.0014 (0.00)	0.0013 (0.00)	0.0015 (0.00)	0.0015 (0.00)
Φ_1	0.0080 (0.65)	-0.0081 (0.63)	-0.1172 (0.00)	-0.1481 (0.00)
Φ_2	-0.0281 (0.11)	-0.0350 (0.04)	-0.0395 (0.01)	-0.0484 (0.00)
ϖ	0.0000 (0.17)	0.0000 (0.00)	0.0000 (0.04)	0.0000 (0.02)
α	0.1413 (0.00)	0.1037 (0.00)	0.0493 (0.00)	0.0382 (0.00)
β	0.7387 (0.00)	0.6010 (0.00)	0.7758 (0.00)	0.7492 (0.00)
ζ_1	0.0552 (0.00)	0.0436 (0.00)	0.0352 (0.00)	0.0220 (0.00)

Next, analyze the meaning represented by the estimated result value of each model parameter in Table 4. In Table 4, observe and analyze the parameter estimate results of each fluctuation model, and select several important parameters estimates here to explain to distinguish the effect of different models on the fluctuation fitting of cryptocurrencies. The main explanation only exists in the ARJI family model. Parameter estimates, and analyze the fluctuation characteristics of cryptocurrencies in combination with the parameter estimates. We discuss and further understand the fluctuation behavior of cryptocurrencies based on the following points:

(1) For the parameter estimate μ, this parameter can be used to judge whether the jump direction is asymmetrical. It can be seen from the table that the constant jump model and the standard ARI model cannot recognize the asymmetry of the jump behavior, and ARJI-R_{t-1}^2 and ARJI-h_t Model's μ, the parameters can well portray the asymmetry of jump fluctuations, that is, the impact of negative jumps and positive jumps on future fluctuations is inconsistent. However, it can be seen from the data in the table that ARJI-R_{t-1}^2 and ARJI-h_t, model's

μ, the parameter value is significantly positive, indicating that during the sample survey, there is no asymmetrical feature of the jump fluctuation of Bitcoin after the collapse of the value.

(2) And the parameter estimate ϖ. It can be used to describe the probability of jumping behavior jumping from one period to another. For example, for the standard ARII model, its ϖ the estimated value of the parameter is 0.9787, which corresponds to ϖ. The value is 0.00, indicating that the high jump behavior during this period often follows the probability of a high jump in the future. And for ARJI-$R^2_{t\text{-}1}$ Model and ARJI-h_t, Model's ϖ the parameter estimates are 0.9878 and 0.9870 respectively, and the corresponding ϖ. The value is very significant, which further shows that the jumping behavior is agglomeration.

(3) Parameter estimate α, it indicates that the jump intensity parameter is relative to the past impact. ζ_t, the sensitivity of -1, for the ARJI family model, its sensitivity is also different due to the different factors affected by its jump intensity coefficient. For example, for the standard ARI model, when ζ_t-1, each additional unit will lead to the inhibitory effect of the jump density in the next period of 0.2099: for ARJI-$R^2_{t\text{-}1}$ in the model, the inhibitory effect of its past impact on the next period is 0.1051; while for the ARII model, the inhibitory effect of its past impact on the next period is only 0.0591. From the empirical results, we can find that the better the model fitting, the weaker the inhibitory effect of the past impact on the future, that is, the better the model fit, the more it can portray the impact of the past impact on the future fluctuations of cryptocurrencies.

Drawing instructions for the volatility intensity of cryptocurrency. In order to have a more intuitive visualization of the price fluctuation jump intensity characteristics of digital cryptocurrencies, such as time change and aggregation understand, we draw the time series diagram of the jump intensity parameter of Bitcoin during the sample survey as shown in Figure 1. In order to have a deeper understanding of the risk of jumping fluctuations of digital cryptocurrencies.

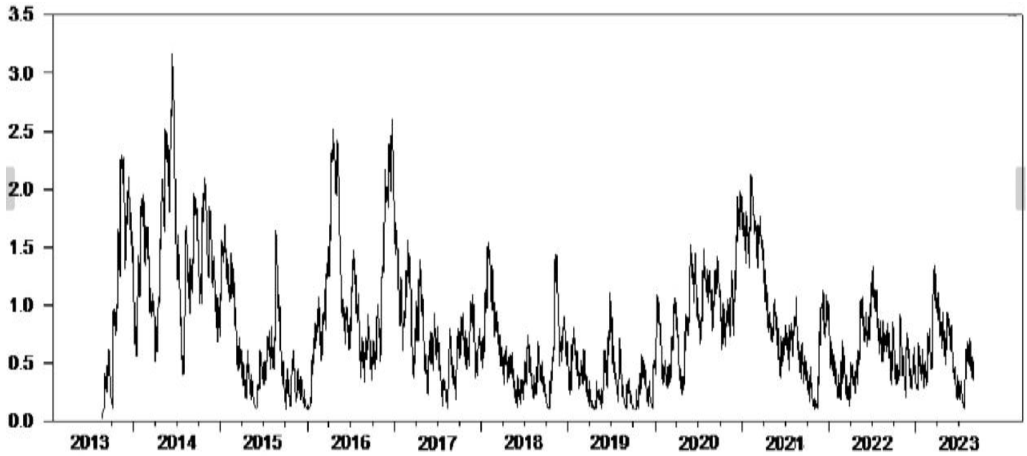

Figure 1. Fluctuation Intensity Chart.

It can be seen from Figure 1 that the density parameters of cryptocurrency fluctuations can change over time, indicating that the fluctuation intensity value is time-variable, and it is inappropriate to assume that the constant fluctuation density model is a fixed value. It is not difficult to see from the figure that the characteristics of fluctuation behavior are continuous and aggregate, that is, at some times, the number of fluctuations will increase, and the magnitude of fluctuations will sometimes increase. Specifically, during the selected sample inspection period, the cryptocurrency price fluctuated sharply for the first time around 2011 and the price reached $1 for the first time, and the cryptocurrency price reached its peak at the end of 2017 and 2019, especially at the end of

2017, from It can also be seen from the figure that the volatility intensity of cryptocurrencies during these periods has also increased.

Of course, we can also see from the figure that the size and value of the fluctuation intensity in different periods of time are also different, sometimes higher and sometimes lower. Is this speculation whether this result is related to the fluctuation of yield? It is speculated that the relationship between the fluctuation of yield and the corresponding fluctuation intensity value is: the greater the fluctuation of the yield, the higher the corresponding conditional fluctuation density value may be (Lu, 2020). On the contrary, the lower the fluctuation of the yield, the lower the corresponding conditional fluctuation density value. In order to prove this conjecture, this paper selects the data of the end of 2021 and the first 15 days of the end of the second quarter of 2023, and draws its yield fluctuation and its corresponding fluctuation intensity parameter values as shown in Figure 2.

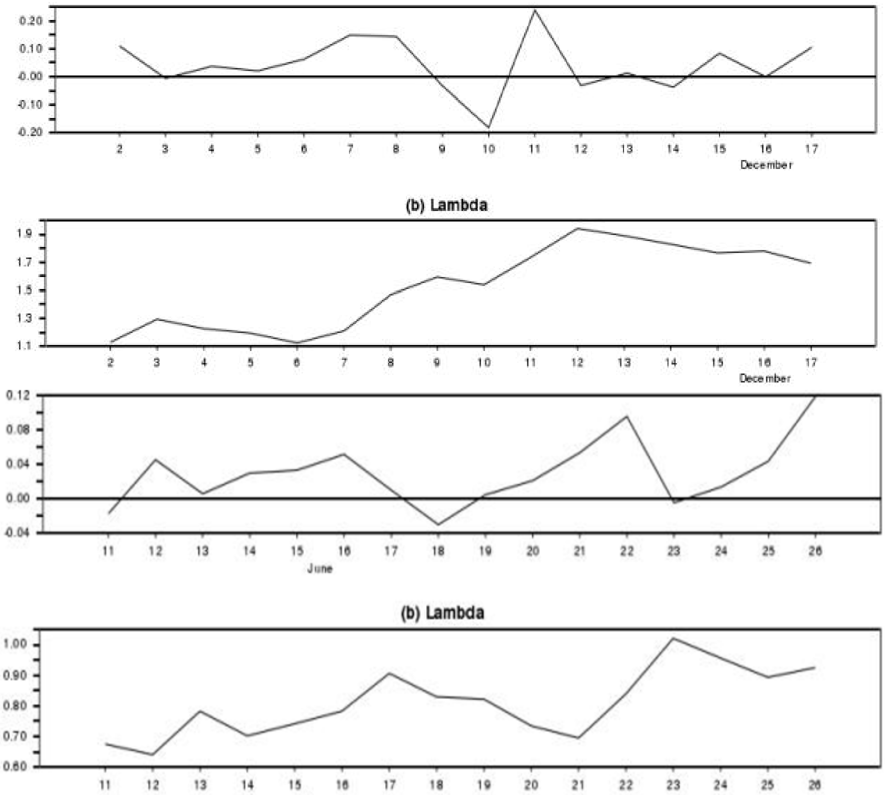

Figure 2. The first 15-day yield R (above) and the corresponding fluctuation intensity λ (Part 2) trend chart.

It is best to observe the changes in the conditional volatility intensity coefficient before the peak of cryptocurrency by observing the volatility of the yield and its corresponding volatility intensity values in Figure 2. No one can say for sure that there is still room for the value of cryptocurrency to rise before reaching its peak. In addition to mining capabilities and investor sentiment, it may also be related to external environmental factors such as macro policy regulation. To be precise, the price of cryptocurrency reached its first historical peak on December 17, 2017, with a price equivalent to approximately 120000 US dollars, which is an unprecedented historical high. On June 26, 2019, it reached its second historical peak with a price equivalent to approximately 87000 US dollars. When the value of a currency reaches its peak, its value cannot continue to rise. Because we know the numbers from the above theory. There are a lot of speculative foam in the price of cryptocurrency. Once the foam bursts, the price will fall. Collapse is inevitable.

In addition, observing Figure 2, it was found that the fluctuation of λ before the peak of the two cycles showed an overall upward trend.

This indicates that the results show that the intensity of volatility increases with the increase of returns, and after reaching a certain level, there will be a decline, ultimately leading to a price drop in the cryptocurrency market. Just like the mortgage crisis in 2008, it is only a matter of time before the foam will burst.

Discussion and analysis of results. In this section, constant fluctuation density models and autoregressive conditional fluctuation density ARJI family models were used. In this study, for ARJI family models with jump distribution, it is assumed that the jump intensity values are time-varying. It can better explain the jumping phenomenon of price fluctuations in digital cryptocurrencies represented by Bitcoin. In addition, to examine the relationship between the volatility of cryptocurrencies and emerging markets, we chose two significant fluctuations in the development of Bitcoin over the past 10 years as the analysis objects. Comparing the returns of the first 15 days before the peak of the two sub sample intervals with the corresponding jump intensity values, it was found that volatility increases with the development of the market. Therefore, we need to explore the nature of the development of emerging markets, whether it is the foam or the cryptocurrency market, which is the key to its research and also its rationality

Conclusion

The inherent financial properties of cryptocurrencies and the potential of decentralized technology behind them have attracted widespread attention. It has gradually become a popular research field in financial technology. However, in the process of development and promotion, the fluctuation trend of cryptocurrencies. This will have a serious impact on the prices and markets of emerging financial currencies. Therefore, in the empirical part of the research, this article further explores, including analyzing the reasons for the jumping volatility of cryptocurrencies and the impact of jumping volatility on investment and financial markets. Based on this, relevant policy recommendations and inspirations are given for the future development of digital cryptocurrencies from the perspectives of their value function and risk regulatory measures. In the future, with the development of the digital cryptocurrency market, the correlation between the spot and futures markets of digital cryptocurrencies and the financial market relationship will increase. Here, new models can be established to analyze their dynamic relationship, or to examine the impact of important news on the market, analyze the correlation between markets and their risk spillover effects, and gain a deeper understanding of the volatility of digital cryptocurrencies.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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