The tail risk measurement of bitcoin price fluctuations under strict supervision - based on GPD distribution

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Abstract. The research interval is divided into three intervals according to the date of occurrence, “China announced to shut down bitcoin exchanges” and “American Securities and Exchange Commission published the announcement of non-standardization of digital currency exchanges”. And the Generalized Pareto Distribution is used to measure the tail risk of bitcoin price fluctuation in the three intervals. It is found that the Generalized Pareto distribution can better fit the thick tail of the bitcoin yield, and the risk of price fluctuation in the three intervals presents a change of “low-high-low”.

1. Introduction

On September 14, 2017, China announced to shut down bitcoin exchanges. At the same time, bitcoin prices fell in a short period of time and then rose rapidly. By mid-December 2017, bitcoin price rose to nearly $20,000. On March 7, 2018, the American Securities and Exchange Commission (SEC) issued an announcement, which pointed out that there were irregular problems in digital currency trading platforms. The announcement means that the American regulatory policy on Bitcoin has tightened and bitcoin price has fallen. HP filtering method is adopted to analyze the overall trend of bitcoin price changes. As shown in figure 1, the price of bitcoin was on an upward trend in 2017. After March 2018, the price of bitcoin was on a downward trend.

Figure 1 shows the overall trend of bitcoin price fluctuations

Bitcoin transactions are P2P online transactions, so there is a serious information asymmetry in bitcoin transactions. This information asymmetry leads to the blind herd mentality of the public,
resulting in the herding effect in the bitcoin market. The herding effect makes the public make irrational investment behaviors when they get the market news, which leads to the violent fluctuation of bitcoin price. The violent fluctuation of bitcoin price makes investors suffer heavy losses and has serious adverse effects on individuals, society and families. Therefore, it is of great significance to study the risk of bitcoin price fluctuation.

2. Literature review

Domestic and foreign scholars have conducted a lot of research on bitcoin price and bitcoin market risk. In terms of the price of bitcoin, the research mainly revolves around the determinants of the price of bitcoin. In the aspect of bitcoin market risk, a few scholars try to measure the risk of bitcoin market with financial risk measurement model.

2.1. Research on bitcoin prices

Kristoufek (2014) [1] pointed out that conventional economic factors such as trade demand, supply and price levels have an important impact on the long-term development of Bitcoin, and the attitude of governments to Bitcoin plays a decisive role in their fate. Eli Bouri (2018) [3] believes that there is a right-tail correlation between the global financial stress index and the bitcoin return rate, and Bitcoin can be used as a safe haven against global financial pressure. Bob Stark (2013) [2] holds the same view that fiscal policy or monetary policy has limited impact on bitcoin prices, and the most important determinant is the attitude of governments. Ju Hyun Yu (2019) [4] believes that the growth rate of Google Trends has a statistically significant effect on the fluctuations in Bitcoin earnings. Donglian Ma (2019) [5] considered that the daily-week effect in the yield equation varies with the sample period, while the volatility on Monday and Thursday is significantly higher. Giray Gozgor (2019) [6] argues that during the period of institutional change, the uncertainty of trade policy has a significant negative impact on Bitcoin earnings.

2.2. Research on the risk and regulation of the Bitcoin market

Kelly (2018) [22] believes that the “regulatory sandbox” mechanism should be used for reference, and the “regulatory sandbox” based on observation should be implemented for Bitcoin. Wang Xin (2016) [23] believes that virtual currency has four potential risks: money laundering and terrorist financing risks, consumption risks, financial stability risks and currency stability risks. It should learn from the supervision experience of foreign virtual currency and implement legislation on Bitcoin. Xu Junjun (2019) [24] believes that the future of virtual currency has the following regulatory trends.

In general, scholars at home and abroad have done a lot of research on bitcoin. However, the research on the risk of the bitcoin market is still in its early stage, and there are few studies on the measurement of the risk of the bitcoin market. This paper analyzes the influence mechanism of strict regulatory policies on bitcoin price volatility, and measures the extreme risk of bitcoin price volatility through Generalized Pareto distribution fitting.

3. Empirical analysis

3.1 Selection of variables

According to the purpose of this paper, we need to compare the risk changes of the bitcoin price fluctuations before and after the event "China closes the Bitcoin exchange" and "American Securities and Exchange Commission published the announcement of non-standardization of digital currency exchanges", so the large interval is selected [2017-3-14, 2018-9-14], according to the date of occurrence of the two events, the large interval is divided into three cells, which are the first sub-interval [2017-3-14, 2017-9-14], and the second Sub-interval [2017-9-14, 2018-3-7], third interval [2018-3-7, 2018-9-14].

In order to make the variables smoother, logarithmic processing is performed on each subinterval variable. A first-order difference is made to the bitcoin price of each sub-interval to obtain a sequence
of yields for each sub-interval. Explore the risk of bitcoin price volatility by analyzing the bitcoin yield series.

3.2 Normality test
This paper examines the normality of bitcoin yield for each interval by observing the skewness and kurtosis and the JB statistic.

3.3 Generalized Pareto distribution fitted bitcoin yield
When fitting Generalized Pareto distribution, the selection of threshold value is very important. In principle, the selection of threshold should not be too small, the number of overthreshold generally do not exceed 10% of the sample length. In this paper, the graph of average transcendence function and the principle of threshold selection are combined to select the threshold.

3.3.1 Generalized Pareto distribution fitting the first interval of bitcoin yield
Figure 5 is the average transcendence function graph of bitcoin yield rate in the first interval. We can see that above the threshold of 0.0609, the figure shows a straight upward trend, and it can be considered that there is a fat tail phenomenon. On the basis of the selected threshold value of 0.0609, the GPD distribution fitting graph of yield rate was made. It can be seen intuitively that the bitcoin yield GPD overthreshold fitting graph has a good fitting effect, indicating that the use of extreme value theory in the fitting of GPD distribution in the tail of bitcoin yield has reliability. When the threshold value is 0.0609, there are 10 sample points beyond the threshold, and at the significance level of 99%, the VAR value is about -0.0674. Which means the VAR value is -0.0674 under the GPD distribution.
3.3.2 GPD distribution fitted the second interval bitcoin yield

Figure 7 is the average transcendence function graph of bitcoin yield rate in the second interval. We can see that above the threshold of 0.0998, the figure shows a straight upward trend, and it can be considered that there is a fat tail phenomenon. On the basis of the selected threshold value of 0.0998, the GPD distribution fitting graph of yield rate was made. It can be seen intuitively that the bitcoin yield GPD overthreshold fitting graph has a good fitting effect, indicating that the use of extreme value theory in the fitting of GPD distribution in the tail of bitcoin yield has reliability. When the threshold value is 0.0998, there are 8 sample points beyond the threshold value. At the significance level of 99%, the VAR value is about -0.1039. Which means the VAR value is -0.1039 under the GPD distribution.

3.3.3 GPD distribution fitting third interval bitcoin yield

Figure 10 is the average transcendence function graph of bitcoin yield rate in the third interval. We can see that above the threshold of 0.0820, the figure shows a straight upward trend, and it can be considered that there is a fat tail phenomenon. On the basis of the selected threshold value of 0.0820, the GPD distribution fitting graph of yield rate was made. It can be seen intuitively that the bitcoin yield GPD overthreshold fitting graph has a good fitting effect, indicating that the use of extreme value theory in the fitting of GPD distribution in the tail of bitcoin yield has reliability. When the threshold value is 0.0820, there are 3 sample points beyond the threshold value. At the significance level of 99%, the VAR value is about -0.0680. Which means under the VAR value is -0.0680 under the GPD distribution.
4. Conclusion

4.1 GPD distribution can better fit the thick tail of bitcoin yield
The return rate sequence of bitcoin does not obey the normal distribution, and presents the distribution feature of "thick tail". The GPD distribution in the extreme-value theory is used to fit the thick-tail feature of bitcoin yield rate, which has reference value to measure the extreme volatility risk of bitcoin price. It is of reference value for investors and regulators to discuss the risk of bitcoin price fluctuation from a static perspective, especially for the public who blindly invest in bitcoin.

4.2 Tail risk changes of bitcoin price fluctuations under regulatory policies
The value at risk of the bitcoin yield under the GPD shows “low-high-low” changes in three sub-intervals. Facts have proved that when the state implements strict regulatory policies, that is, when bad news strikes, it will have a downward impact on bitcoin prices. Whether it will rebound or not will be affected by other factors.

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