

Dynamic Correlation Measurement Between Bitcoin, Crude Oil and Gold

Yadong Liu^{1, 2, a}, Nathee Naktnasukanjn^{1, *}

^a68675486@qq.com; ^{*}nathee@cmuic.net

¹International College of Digital Innovation, Chiang Mai University, Chiang Mai, 50200, Thailand

²Shandong Institute of Commerce and Technology, Jinan, Shandong Province, 250001, China

Abstract: As a financial asset, bitcoin has attracted the attention of many financial financial advisors and investors. This paper aims to analyze the dynamic correlation between bitcoin and two important financial assets, i.e., crude oil and gold. This paper selects weekly data from January 2014 to April 2022 and then uses the DCC-GARCH model to measure the dynamic correlation between bitcoin and crude oil, as well as bitcoin and gold assets. The empirical results show that: (1) Compared with gold and crude oil, bitcoin has the greatest risk, while gold has the least risk. However, crude oil proved a higher risk in the early period of the COVID-19 pandemic. (2) Bitcoin's rate of return is negatively correlated with risk, while the return and risk of gold and crude oil do not show significant correlation. (3) The correlation between bitcoin and crude oil and between bitcoin and gold shows obvious volatility. We can find that the positive correlation between bitcoin and crude oil increased significantly in the early period of the COVID-19 pandemic, while the negative correlation between bitcoin and gold became more pronounced during that time period. These findings contribute a valuable resource for choosing tools for risk prevention and control, emergency hedging, etc.

Keywords: Bitcoin, COVID-19, Crude oil, Gold, Dynamic correlation

1 Introduction

The concept of Bitcoin as a decentralized digital virtual currency was first proposed in 2008. Since the first transaction in January 2009, bitcoin has gradually entered into public awareness. With the rapid development of the bitcoin market, a large number of investors in the United States, Japan and other countries have turned their attention to bitcoin, increasing transaction and market activity, and became the focus of discussion in many sectors of society. With the in-depth development of bitcoin, and the resulting increase in trading volume, disadvantages such as high volatility, high risk, and high difficulty in supervision were exposed. In this regard, governments have adopted tax policies and market supervision policies to standardize and improve the bitcoin market and promote its healthy and sustainable development. In addition to the peer-to-peer payment function of bitcoin, many investors regard bitcoin as a financial investment product. Since the bitcoin market is independent of all other assets and does not

belong to any currency, and transactions on the blockchain do not need to involve any third party, bitcoin transactions are highly speculative and high-yield. Relevant data shows that in 2019, the proportion of bitcoin in the cryptocurrency market increased from 51.8% to 68.3%, and its market value doubled. More and more attention is being paid to the investment value of bitcoin, and it does occupy a certain position in an investment portfolio.

With the rapid development of the bitcoin market, more and more literature on bitcoin is being produced. Existing literature mainly focuses on the correlation between bitcoin and global economic activities, the financial asset capacity of bitcoin, its risk hedging ability, and its impact on other traditional markets. Conrad et al. (2018) applied the GARCH-MIDAS model to extract the long-term and short-term volatility components of bitcoin and pointed out that the volatility of bitcoin is closely related to global economic activities. [1] Corbet et al. (2018) and Symitsi and Chalvatzis (2019) studied the relationship between bitcoin and other traditional markets. [2] [3] Dyhrberg (2016) studied the hedging ability of bitcoin against the FTSE index and US dollar. [4] Henriques and Sadorsky (2018) applied DCC, ADCC and GO-GARCH models to study the substitution of bitcoin for gold in the portfolio. [5] The results showed that it was possible to replace gold with bitcoin in a portfolio and get a higher risk-adjusted return. Wang, Li, Shen, and Zhang (2020) found an insignificant impact of the EPU on the price volatility of bitcoin. [6] Colon, Kim, Kim, and Kim (2021) also observed that cryptocurrencies have a weak hedging capacity against economic policy uncertainty shocks, especially during optimistic economic expectations. [7] During periods with higher economic policy uncertainty, as observed during the COVID-19 pandemic, bitcoin can be an effective alternative to traditional assets and hedges risks against uncertainty shocks (Goodell, 2020).

The remainder of this paper is organized as follows. The data and sample statistics are described in Section 2. The methodologies and empirical results are presented in Section 3 and Section 4, respectively. Concluding remarks are made in Section 5.

2 The data

In order to investigate the dynamic correlation between bitcoin and two important financial assets, crude oil and gold, this paper uses the weekly return data of NYSE bitcoin stock index, and the gold futures price and crude oil WTI futures price as the research index. Among the indexes the return adopts the logarithmic return of the closing price, and the sample investigation period is from January 2014 to April 2022. The data is from Investing.com. The volatility of the returns of bitcoin, crude oil and gold from 2014 to 2022 is shown in Figure 1. Overall, the volatility of bitcoin and crude oil is very high, while the volatility of gold is very low, indicating that gold is an asset with a more stable yield. Specifically, bitcoin has high risk and volatility in the two years from 2017 to 2018. That may be related to the Fed's interest rate hike and the phased strengthening of the US dollar, which increased cross-border capital flows and pulled away from market liquidity. It is worth noting that in the early period of the COVID-19 pandemic, crude oil showed a higher risk, and its risk fluctuation even exceeded that of bitcoin.

Table 1 shows the basic descriptive statistical characteristics of bitcoin, crude oil and gold. The average weekly logarithmic rate of return of the three assets is greater than 0, and the maximum average rate of return of bitcoin is 0.008796, but its standard deviation is also the largest, indicating that the risk is also the highest. The average yield of gold is much higher than that of

crude oil, but the standard deviation is much lower, indicating that gold is a more stable investment in the long run. The skewness of bitcoin and crude oil is less than 0 and the kurtosis is greater than 3, indicating that there is a peak and fat tail phenomenon.

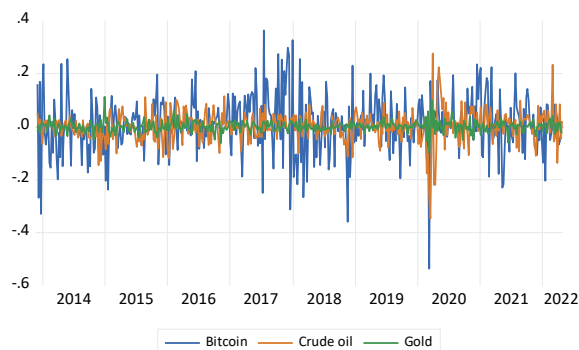


Figure 1: log returns of Bitcoin, Crude oil and Gold.

Table 1: data descriptive and statistics

	Bitcoin	Crude oil	Gold
Mean	0.008796	0.000267	0.000949
Median	0.007207	0.003809	0.001517
Maximum	0.363420	0.275756	0.112555
Minimum	-0.536031	-0.346863	-0.098970
Std. Dev.	0.107931	0.057744	0.020281
Skewness	-0.308070	-0.501723	0.247949
Kurtosis	4.979572	9.073209	7.466234
Jarque-Bera	78.62373	693.0854	369.3666
Probability	0.000000	0.000000	0.000000
Observations	439	439	439

3 Methodology

Autoregressive moving average (ARMA)-GJR-GARCH models are employed for the long-run return by reason that the indices used in this essay exhibit time-varying risk clustering. Presented by Glosten et al, on account of allowing for leverage effects, the ARMA-GJR-GARCH model has been widely adopted to filter time series data. When it comes to leverage effect, it seems to be more vital during crisis periods. Specifically speaking, the ARMA (r, m) process is defined as:

$$y_t = c + \sum_{k=1}^r \varphi_k y_{t-k} + \sum_{k=1}^m \rho_k \varepsilon_{t-k} + b\sigma_t + \varepsilon_t \quad (1)$$

where y_t means the conditional mean and ε_t represents the error term. The GJR-GARCH (p, q) model can be defined as below:

$$\sigma_t^2 = \omega + \sum_{i=1}^p (\alpha_i + \gamma_i I_{t-i}) \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (2)$$

where:

$$I_{t-1} = \begin{cases} 0 & \text{if } \varepsilon_{t-1} \geq 0, \\ 1 & \text{if } \varepsilon_{t-1} < 0 \end{cases} \quad (3)$$

In addition, γ represents the leverage effect and ζ_t represents the i.i.d standard innovation variables. As a result, the error term can be computed by $\varepsilon_t = \sigma_t \zeta_t$, and ζ_t is assumed to be Student's-t distribution.

The proposed dynamic correlation structure is:

$$Q_t = (1 - \sum_{m=1}^M \theta_{1m} - \sum_{n=1}^N \theta_{2n}) \bar{Q} + \sum_{m=1}^M \theta_{1m} (\varepsilon_{t-m} \varepsilon_{t-m}^i) + \sum_{n=1}^N \theta_{2n} Q_{t-n} \quad (4)$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \quad (5)$$

where \bar{Q} is the unconditional covariance of the standardized residuals resulting from the first stage estimation, and

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sqrt{q_{kk}} \end{bmatrix} \quad (6)$$

So that Q_t^* is a diagonal matrix composed of the square root of the diagonal elements of Q_t . The typical element of R_t will be of the form $\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{ii}q_{jj}}}$

4 Empirical results

Figure 2 shows that the correlation between bitcoin and crude oil has obvious volatility. In most instances during the study period, the two have alternating positive and negative correlations. The data reflects that in the long run the correlation between bitcoin and crude oil is generally weak, and there is basically no strong positive correlation with regard to rise and fall in the same time period. Additionally, there is no strong negative correlation with one another. However, when affected by the market environment, a strong correlation between bitcoin and crude oil in a specific short cycle period is not to be excluded. It is obvious from the image that during the

early period of the COVID-19 pandemic, bitcoin and crude oil showed a strong positive correlation, which lasted for a relatively long period of time. During this period, the demand for crude oil plummeted and bitcoin weakened. In the context of such extreme events as COVID-19, the financial market is in a high-uncertainty and high-risk stage. In order to prevent losses that impact portfolios, investors should pay more attention to the function of bitcoin in the portfolio. Bitcoin has the characteristics of high yield and high risk and can provide significant decentralized portfolio income.

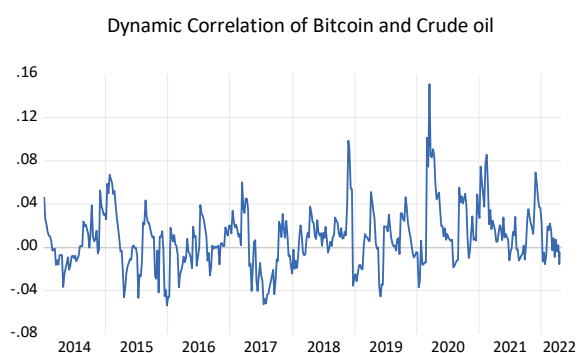


Figure 2: Dynamic correlation between Bitcoin and Crude oil

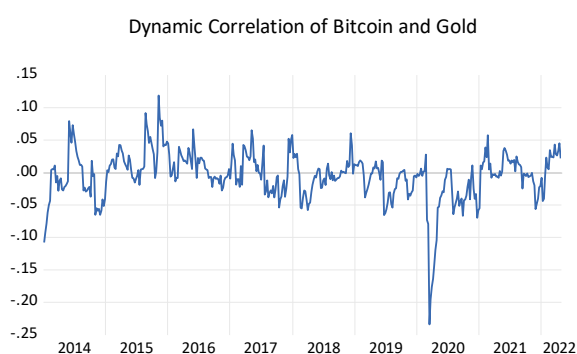


Figure 3: Dynamic correlation between Bitcoin and Gold

Figure 3 shows the obvious correlation volatility between bitcoin and gold, with alternating positive and negative correlation between them. Therefore, bitcoin can be regarded as a hedging asset of gold. From a broader research cycle, there is little correlation between bitcoin and gold. Bitcoin and gold also have different degrees of correlation in different market backgrounds. Most of the time, bitcoin is used for the purpose of diversified investment to obtain higher risk returns. In the context of extreme events, bitcoin and gold can be used as hedging assets to hedge financial risks. It is obvious from the figure that during the early period of the COVID-19 pandemic, bitcoin and gold showed a strong negative correlation. At this time, gold performed very well and bitcoin weakened. In the context of extreme events, gold is still an excellent, traditional hedging tool, which can effectively hedge inflation. Over a longer period, the

alternating correlation between the two shows that bitcoin and gold can be used as risk hedging tools. In the portfolio, bitcoin can replace gold to obtain higher risk returns.

5 Conclusions

In this paper, the DCC-GARCH model is used to measure the dynamic correlation between bitcoin and crude oil and between bitcoin and gold, with consideration of the market environment that existed during the early period of the COVID-19 pandemic. The research of this paper is beneficial to investors and financial institutions' investment and risk management of bitcoin, crude oil and gold to a certain extent. The research confirms that bitcoin and gold have alternating positive and negative correlation, that is, bitcoin can be regarded as a hedging asset of gold. In the early period of the COVID-19 pandemic, bitcoin and gold showed a strong negative correlation, while bitcoin and crude oil showed a strong positive correlation. As a result of the COVID-19 pandemic, international trade and energy demand decreased in the first half of 2020. This may be the reason for the positive correlation between bitcoin and crude oil. During this period, the price of gold rose, which led to the negative correlation between bitcoin and gold. In general, bitcoin has a higher risk than crude oil and gold. But once crude oil incurs risk, it is a riskier asset than bitcoin. When we encounter phased risks in the future, the conclusions of this paper are of constructive significance to risk hedging and portfolio performance.

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