Research on the Relationship between the Price of Bitcoin and the Stock Market Base on Linear Regression

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Abstract-In recent years, people's investment interest has spread from the stock market to Bitcoin. There is a trend implying the correlation between Bitcoin and the stock market. This paper investigates the relationship between the price of Bitcoin and the stock market. The indexes data gathered from FRED and the Bitcoin price gathered from Kaggle. This research uses linear regression to analyze the correlation between three representative indexes which are S&P500, Nasdaq, and Dow Jones. These three indexes have an essential impact on the global stock market. This research only uses the indexes as an independent variable for univariate regression analysis since introducing too many variables will make linear regression too complicated. The results of the research show that in the basic linear regression model, Bitcoin and the stock market have many similarities and correlations. Although the correlation became unclear and bias after adding more variables into the linear regression, in the long run, the trend of stocks will affect the price of Bitcoin, and it is a positive linear relationship.

Keywords-Bitcoin, Cryptocurrency, Stock Market, Linear Regression

1 INTRODUCTION

The cryptocurrency has developed rapidly in the past ten years. The original purpose of cryptocurrency is to create a completely safe, secret, and clean currency for users. More and more consumers, businesses, and institutions are willing to employ cryptocurrency as a payment method. Among the numerous cryptocurrencies available to date, Bitcoin seems to be leading market capitalization and transaction volume. Bitcoin, since its birth, has been full of controversy regarding whether Bitcoin is an emerging digital currency or an investment asset. Baur, Hong and Lee had pointed out that the rapid increase in the number of new users of Bitcoin is mainly due to its investment attributes rather than currency attributes, so user transactions have exposed intense speculation [1]. The Bitcoin price from 2017 to now and the stock markets, including the Dow Jones, S&P 500 indexes, and NASDAQ shows an exciting similarity: the stock market is rapidly soaring to new highs, and Bitcoin also soared to a record high. Then both markets began to fall; the first was Bitcoin. The price gradually dropped, and the stock market fell even faster. These rises and falls in the same trend in the price of Bitcoin and the stock market imply that the stock market and Bitcoin may have a certain correlation. This paper will adopt linear regression to analyze the correlation between the price of Bitcoin and stock market. First, this research will indicate if there is a correlation between Bitcoin price and the stock market. Then this paper will figure out what kind of correlation, positive or negative, if the correlation exists. There are two

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main significances, if this study can find the correlation between Bitcoin price and stock market: (1) extending the diversified characteristics of Bitcoin to a wider market (2) using the correlation between the stock market and Bitcoin price to hedge the risk from the global stock market.

2 DATA

In order to examine the relationship between the stock market and Bitcoin, this research will do linear regression analyses for Bitcoin price and select three main indexes that have an essential impact on the stock market: Dow Jones Industrial Average, S&P500 Index, and Nasdaq. The Bitcoin price data used in this research was an opening dataset gathered from the Kaggle. Kaggle is a website owned by Google which provides a data science community. The dataset contains the daily open, highest, lowest, and close prices for Bitcoin from 2015 to 2020. For this dataset, there is a significant limitation: there is only the Bitcoin price in USD. Woo (2017) shows that in 2017 nearly 80% of Bitcoin trades were in the Chinese market [2]. Nevertheless, Kristoufek (2015)'s research shows that the trades prices for Bitcoin have the same trend in USD and Chines Yuan [3]. Therefore, the trading price for Bitcoin in USD can represent the trend of the whole Bitcoin market. The index datasets were gathered from FRED. In order to map Bitcoin and stock market data one-to-one, the data on the day of the market holiday and part of the missing data are excluded.

3 EMPIRICAL RESULT

The first regression use Bitcoin as Y and Dow Jones Industrial Index as the independent variable for univariate regression analysis [Figure 1].

```
Call:
lm(formula = Close ~ DJIA, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-4069.0 -1383.9  -168.5   803.9 12312.4

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.529e+04  4.169e+02  -36.69   <2e-16 ***
DJIA         8.859e-01  1.812e-02   48.88   <2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2224 on 1131 degrees of freedom
Multiple R-squared:  0.6787,    Adjusted R-squared:  0.6784
F-statistic:  2389 on 1 and 1131 DF,  p-value: < 2.2e-16
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Figure 1. The result for regression of Bitcoin and Dow Jones Industrial Average

The fitting formula is Bitcoin close price =-15290+0.8859× Dow Jones Industrial Average. R-square is 0.67, which shows that Bitcoin has a strong linear relationship with the Dow Jones Industrial Index. The result passed the F test, and the p-value was less than 0.01, indicating that

the overall data is significant at the α=1% level [Figure 2].

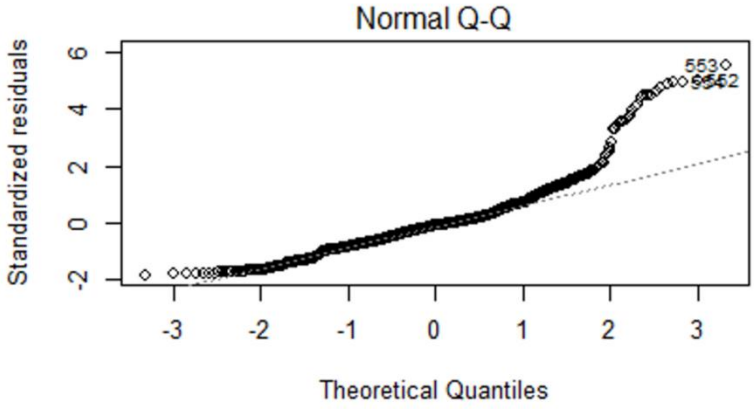

Figure 2. The QQplot for Influential Points for regression 1

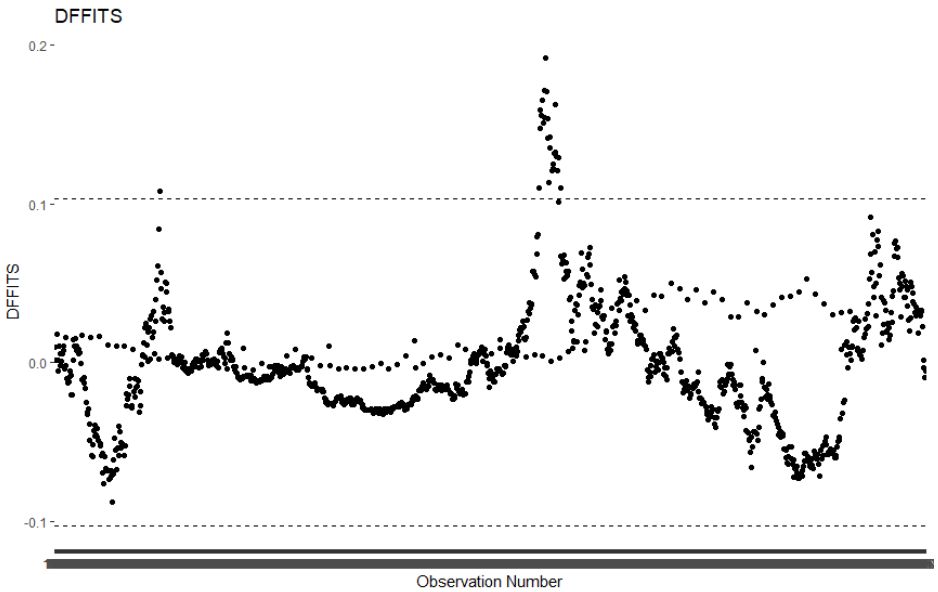

Figure 3. The DFFITS for Influential Points for regression 1

QQplot and DIFFITS were used to analyze the outliers. The result is that there are many outliers in a specific area that were concentrated in the months around December 15, 2017, which is the violent Bitcoin bull market period [Figure 3].

The second regression uses Bitcoin as Y and NASDAQ Composite Index as the independent

variable for univariate regression analysis [Figure 4].

```
Call:
lm(formula = Close ~ NASDAQCOM, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-3644.6 -1355.5  -495.0   630.9 14070.8

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.118e+04  3.071e+02  -36.39   <2e-16 ***
NASDAQCOM    2.394e+00  4.504e-02   53.15   <2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2361 on 1593 degrees of freedom
Multiple R-squared:  0.6394,    Adjusted R-squared:  0.6392
F-statistic:  2825 on 1 and 1593 DF,  p-value: < 2.2e-16
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Figure 4. The result for regression of Bitcoin and NASDAQ Composite Index

The fitting formula is Bitcoin close price =-11180+2.394× NASDAQ Composite Index. R-square is 0.6394, which shows that Bitcoin has a strong linear relationship with the NASDAQ Composite Index. The F test passed, and the p-value was less than 0.01, indicating that the overall data is significant at the α=1% level [Figure 5].

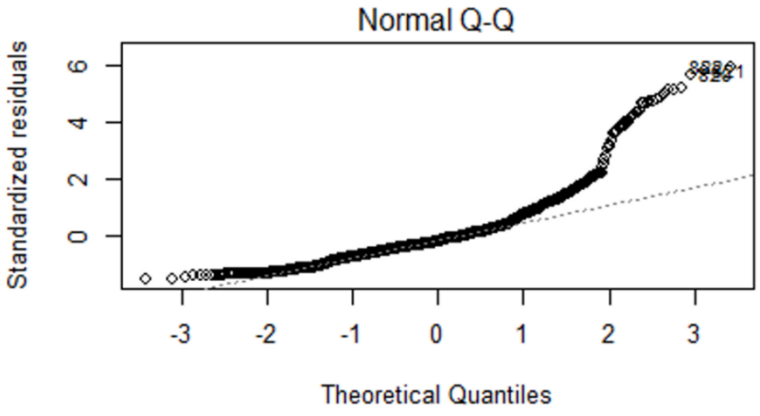

Figure 5. The QQplot for Influential Points for regression 2

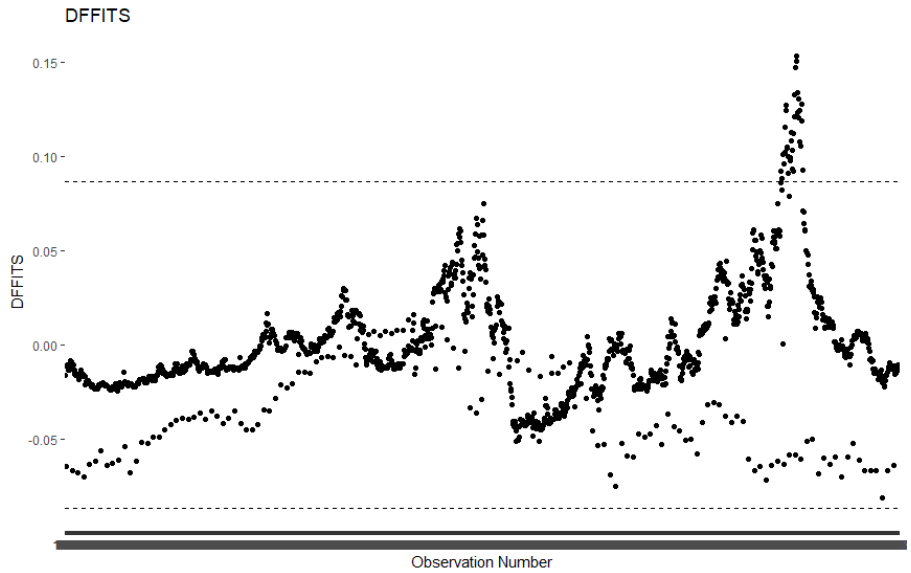

Figure 6. The DFFITS for Influential Points for regression 2

The result is that there are many outliers in a specific area concentrated in the months around May 2019 when Bitcoin started a new round of skyrocketing [Figure 6].

The third regression uses Bitcoin as Y and NASDAQ Composite Index as the independent variable for univariate regression analysis [Figure 7].

```
Call:
lm(formula = Close ~ SP500, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-4033.8 -1409.6  -395.4   885.6 13601.0

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.745e+04  4.152e+02  -42.04   <2e-16 ***
SP500        8.727e+00  1.609e-01   54.24   <2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2331 on 1590 degrees of freedom
Multiple R-squared:  0.6492,    Adjusted R-squared:  0.649
F-statistic:  2942 on 1 and 1590 DF,  p-value: < 2.2e-16
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Figure 7. The result for regression of Bitcoin and S&P500

The fitting formula is Bitcoin close price =-17450+8.727× S&P500. R-square is 0.6492, which shows that Bitcoin has a strong linear relationship with the S&P500. The F test passed, and the p-value was less than 0.01, indicating that the overall data is significant at the α=1% level. The

outliers have the same trend as the outliers in NASDAQ regression.

4 ANALYSIS

The three previous simple linear regression show that at the daily level, Bitcoin and the stock market have a correlation. In the long run, the trend of US stocks will affect the trend of Bitcoin, and it is a positive linear relationship. However, it is the simplest model, and it will have many omitted variables and biases. The stock market and Bitcoin belong to the traditional investment market and the emerging Internet investment market, respectively. Changes in stock prices are completely different from Bitcoin's "mining" and have different trading modes, price formation mechanisms, and market maturity. In addition, compared to virtual currencies stored in computers, the price of stocks is easier to evaluate. When Bitcoin's value cannot be measured, its price is more likely to fluctuate sharply with investment expectations and market sentiment. López-Cabarcos, Pérez-Pico, and Šević (2019) provide a deeper analysis about the correlation between Bitcoin price, market volatility, and investor emotion [4]. They used VIX (CBOE Volatility Index) return and a special measure of the investor emotion. Their research indicated that both these variables would impact the Bitcoin price. The coefficient of S&P500 is significantly higher than the coefficient of investor's emotion, which means that S&P500 has a greater impact on Bitcoin's price. Their research corroborates this research's result, which Bitcoin price correlates with S&P500. The investor's emotion has a higher coefficient than the VIX return. This indicates that the influence of investor sentiment is stronger than VIX. It shows that investor sentiment is an omitted variable missed in regression and may cause bias. The investor sentiment is based on the information disclosure level. Generally speaking, the degree of information disclosure is related to the length of time the market exists. Unlike stocks, as a new type of virtual currency commodity, the acceptability of Bitcoin, the complex technical requirements behind it, transaction mode, and security are still full of mystery to many people. At the same time, the lack of information disclosure caused by the short existence of the bitcoin market has made the speculative sentiment in the bitcoin market obvious, and the price has shown a state of violent fluctuations. The degree of information disclosure in the stock market is higher than in the Bitcoin market, and the market performance is more mature than the Bitcoin market. Based on the fundamental information disclosure of the market, rational investors will make detailed comparisons between the market prices of assets and their actual values and rationally adjust their asset portfolios based on the analysis results and their own investment experience. Unlike rational investors, speculators tend to search for non-fundamental noise information. This noise information is usually exaggerated or even rumors and spread quickly within a short period of time, causing substantial fluctuations in asset market prices. Considering the value of assets, development history, market maturity, and information disclosure, there are more rational traders in the stock market. In contrast, the number of speculators in the Bitcoin market is enormous. Investors only pay attention to bitcoin data to invest and ignore other market information. Furthermore, speculative behavior is affected by investor sentiment, which spreads among different investors. Bonelli (2020) got an identical result with regression model and indicated that the correlation coefficient between NASDAQ is not stable from 2013 to now; However, form 2017, there is a strong correlation between Bitcoin price and NASDAQ; especially during COVID-19, the correlation has continued to be strong, but it reversed the trend in the two periods [5]. These two periods can be easily seen in Figure 6. Although adding more variables into the

three linear regression models may make the strong correlation unclear, the result from other research papers can eliminate these biases.

5 DISCUSSION

The skyrocketing Bitcoin is closely related to the skyrocketing stock market. The astronomical rise of cryptocurrencies may be the driving force behind the success of the stock market. In the stock market, investors who trade in cryptocurrencies are more willing to take more risks in the stock market than investors who do not invest in cryptocurrencies. As of the morning of October 13, 2021, the transaction price of Bitcoin in Europe was approximately $55,181 per coin, which has risen by more than 400% in the past six months. At the same time, despite the impact of the new crown, global stock markets have approached or surpassed historical highs in recent weeks. Bitcoin holders are bolder, more aggressive, and more adventurous investors. People whose wealth has increased sharply due to Bitcoin now feel rich, and these investors who feel rich are more willing to invest their money in the stock market. Chu, Chan, and Zhang's research (2021) shows that the relationship between Bitcoin price and technology stocks is more close [6]. On the other side, the cause of the stock market crash is very different from the cause of Bitcoin's decline. Many factors outside the market can cause Bitcoin to plummet. Closing the Bitcoin exchange company and China announced that it would set up a firewall to restrict people from investing in Bitcoin are two examples. Judging from these external events, there is no apparent relationship between the simultaneous decline of the Bitcoin market and the stock market. However, from a data perspective, it is still a certain connection. Looking at the stock market in 2020, the global stock market collapsed first, followed by Bitcoin, which fell to less than US$3,800 for several days. 2020 is the Bitcoin halving year, and everyone's original expectation is a bull market. Nevertheless, the crash of the stock market has also greatly affected the cryptocurrency market.

6 CONCLUSION

This paper utilizes linear regression to analyze the correlation between the price of Bitcoin and stock market, and it shows that the price of Bitcoin and the stock market have a strong relationship. Although the linear regression models this research used missed many important omitted variables, it still gives a credible result that Bitcoin correlates with the stock market supported by much other research's results. As Bitcoin's halving and all the hype surrounding it slowly pass, the price of Bitcoin seems to have stabilized, and the correlation between Bitcoin and the stock market is getting higher and higher. The increased correlation between Bitcoin and the stock market shows that this asset class is maturing and increasingly appearing in traditionally structured investment portfolios. Since the limitation of these regression models, it is impossible to dig deeper to find more detailed relationships and factors that influence the correlation between Bitcoin and the stock market. The correlation between gold price, Bitcoin price, and stock market are worth continuing to study in the future.

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