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Has the Price of Bitcoin Changed during COVID-19?

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Abstract:
Cryptocurrency has become popular in recent years and the volume of transactions with it has increased enormously. Under this situation, COVID-19 occurred., however, Bitcoin prices have not seemed to decline but rather, have increased in 2020. This paper focuses on Bitcoin among cryptocurrencies. On the contrary to past deterministic elements of the prices, exchange rates and stock prices have influenced Bitcoin prices and the spreading of COVID-19 has also had effects on the prices.
Background: *To examine the deterministic elements of cryptocurrencies could be important to promote sound financial markets and economic growth. Also, impacts of the spreading COVID-19 on cryptocurrency prices would be important with the current popularity of this type of payment system.*
Materials and methods: *Among some kinds of cryptocurrencies, Bitcoin is selected and the prices are examined. The daily data before and after COVID-19 are employed for estimations. Empirical analyses including GARCH are used for examining the deterministic elements of the prices.*
Results: *The results are contrasting. From the year of 2017 to the year of 2019, Bitcoin prices had not been influenced by exchange rates and stock prices, however, the correlation between Bitcoin prices and such asset prices exists recently (the year of 2020). Moreover, there exists an influence of COVID-19 on Bitcoin prices.*
Conclusion: *Bitcoin prices had previously been decided independently, however, some asset prices began to have impacts on Bitcoin prices recently. Moreover, COVID-19 has promoted risk-on attitudes in financial markets, so Bitcoin prices has gone up.*
Key word: *Bitcoin, cryptocurrency, exchange rate, gold, stock*

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I. Introduction

Cryptocurrency has attained a lot of attention from its beginning and the volume of transactions has increased rapidly and enormously. Serious events have happened around the world repeatedly, however, cryptocurrency could have cleared such serious incidents. In 2020, COVID-19 occurred and hit economies all over the world; however, the Bitcoin transactions and the prices have not seemed to reduce and decline but have increased and gone up instead. Recently, blockchain which is used in Bitcoin's trading system, has been employed in many ways.

This study examines the deterministic elements of Bitcoin prices. A lot of studies have begun to tackle this problem, however, they do not seem to have reached a consensus yet about this problem. One reason is that Cryptocurrency is not a legal currency but it is like a private financial system which is not related with central banks or governments (Dowd and Hutchinson, 2015). Similar financial instruments have not existed before. Also, there have not been strict regulations and controls for transactions.

There seems to be consensus on this point; that cryptocurrencies have speculative elements. In reality, the prices have fluctuated largely compared with other financial commodities including gold. Recently, as central banks have conducted low or zero interest rate policies in developed countries, investors have focused on risky assets such as cryptocurrencies. There is no common understanding on deterministic elements of cryptocurrency prices not only on the field of business world but also in the field of academia.

In 2020 COVID-19 hit the world and has changed our daily lives and financial markets. There is a possibility that deterministic elements have also changed. Examining this problem is important not only to investors but also to sound financial and economic growth. Brandvold et al. (2015) showed that sound trading and economic growth using cryptocurrency is expected.

Following this, section 2 reviews existing studies related with this study. Section 3 provides methods for empirical analyses. Empirical analyses are conducted, and the results are examined in section 4. Finally, this study ends with a summary.

II. Existing studies

Cryptocurrency has not had a long history, so there are not many academic papers on it regardless of its popularity. Despite this, much attention has been focused on it and papers have rapidly begun to be published. This trend has not changed thus far. From its inception, the on it focuses have been changing constantly.

Market efficiency has been one of the main issues discussed on cryptocurrency price. Urquhart (2016) and Cheah et al. (2016) showed that the Bitcoin market is efficient, but Nadarajah and Chu (2017) showed that it was not. Kurihara and Fukushima (2017) focused on daily anomalies of Bitcoin prices and found that there were none. Vidal-Thomas et al. (2019) showed that the cryptocurrency market has weak-form inefficiency. Qiao et al. (2020) found that there are evidences of co-movements, hedging effects, and a positive relationship between Bitcoin and other cryptocurrencies. On the other hand, the scope of analyses seems to expand gradually.

In the previous section, cryptocurrencies' speculative elements are mentioned. However, the role of cryptocurrency is different from that of traders. Investors expect cryptocurrency for use in many ways. Seigh (2015,) and Baeck and Elbeck (2015) indicate that Bitcoin is employed for speculation; however, Dyhrberg (2018) shows that Bitcoin provides a hedging means. Nguyen et al. (2020) showed that the cryptocurrency market portfolio outperforms better in some large equity markets in terms of risk-adjusted return than other markets. Conlon et al. (2020) showed that Bitcoin is not a safe haven for major stock markets. Demir et al. (2020) found hedging capabilities of cryptocurrencies against the uncertainty occurring from COVID-19. From this issue, it can be said that finding deterministic elements of cryptocurrency is difficult; however, there would be some possibility that there are some common features between cryptocurrency and foreign exchange transactions. Moreover, Liu and Serletis (2019) found spillover influences from cryptocurrency to other financial markets.

Other studies are strongly related with this study. Price movements should be considered in examining cryptocurrency prices. Dwyer (2014) found that the price volatility of Bitcoin is higher than the one of gold prices. Kurihara and Fukushima (2018) indicated that investors should see not only short-term price changes but also long-term price changes. Price fluctuations of Bitcoin are sometimes erratic.

Vassilladis et al. (2017) discovered that there is a significant relationship between Bitcoin prices and stock prices. There could be some impacts of stock prices on cryptocurrency prices. Gold prices should also be taken into accounts. Zhu et al. (2017) found that the Custom price index, U.S. dollar index, Dow Jones industry average, Federal Funds Rate, and gold price have effects on the Bitcoin price. Malladi and Dheeriva (2021) showed that profits from stock markets and from gold do not have impacts on Bitcoin profits. When analyzing asset prices, COVID-19 should not be ignored. Shaen et al. (2020) showed that returns of cryptocurrency related significantly with negative stress. There is, however, little study on this issue.

Transaction volume is sometimes important to analyze prices. Urquhart (2017) found that Bitcoin's price and its volume have a positive relationship. This study employs this volume as a dependent variable instead of the price.

Finally, shock continuity on prices is important to be considered in examining cryptocurrency. Katsiampa (2019) showed that the conditional variances of cryptocurrencies are influenced by both squared errors and conditional volatilities. Caporale and Plastun (2020) showed that abnormal returns are observed on the following day. This study focuses on these issues empirically.

III. Methods for empirical analyses

This study examines Bitcoin's price among cryptocurrencies. Gurrib et al. (2019) found interdependence between cryptocurrencies. There are many cryptocurrencies including newer ones, however, this study uses Bitcoin's price for data availability. Daily data are used for estimation. Bitcoin transaction is performed 24 hours a day. On the other hand, stock, gold, and foreign exchange transactions are not conducted 24 hours a day in the markets. Such transactions have not been conducted on national holidays or at the end of/at the beginning of the year, for example. So this study employs data which all can be obtained on the same day. For example, almost of all the weekends' data are omitted for estimations due to lack of data.

COVID-19 mainly occurred in 2020 and hit economies worldwide. The data employed in this study is divided into two periods. One is during the year of 2020. The other is a less recent one from 2017 to 2019. It is possible to expand the data for the latter case, however, the less recent three years are used for estimations to compare to the newest one, the year of 2020. The statistical descriptions are in Table 1.

Table 1: Statistical descriptions

	2017-2019	2020
Average	7525.169	10906.66
Standard Error	117.8811	252.5576
Median	7488.3	9702.265
Standard Deviation	2458.604	3728.969
Variance	6044735	13905208

Kurtosis	-0.01099	1.918978
Skewness	0.245158	1.493619
Range	13412.88	18240.36
Minimum	3298.89	5302.02
Maximum	16711.77	23542.38

It is easy to confirm that Bitcoin prices have been rising. Along with this trend, volatilities of the prices have been expanding.

In reality, levels of the data would contain unit roots. They sometimes prevent estimating correctly, so rates of the data are used for estimation. The PCR positive numbers of COVID-19 were used as they are (level; not rate), not the changed rate. The Augmented Dickey-Fuller test (ADF) was used for examining whether the null hypothesis of a unit roots exists or not.

The return (rate) of Bitcoin and other variables is used for estimation. They are calculated as follows in equation (1).

$$Rt=\ln(pt/pt-1) \quad (1)$$

where Rt is the return. ln (pt) and ln (pt-1) are contained the actual logs of the levels (for example, prices) at time t and t-1 (t denotes time). Price denotes Bitcoin price. Volume is the trading volume in a day. The data are from the BitcoinAverage database. Exchange rate denotes average Yen/US dollar exchange rate for the day. The exchange rate, S&P (stock price), and gold (price) are from Nikkei Financial Quest. Finally, the difference between the one of three days prior to and the day is employed for analysis. Data that are changed from levels into rates are employed. The results are in Table 2. All of the data are stationary according to an augmented Dickey-Fuller (ADF) test.

Table 2: Unit root tests

	t-statistic	Prob.
Price	-20.8821	0.0000
Volume	-31.1764	0.0000
Exchange rate	-27.8047	0.0000
S&P	-25.1766	0.0000
Gold	-24.4712	0.0000
Difference	-7.1188	0.0000

There do not exist unit roots at all. The rate of the data except for the PCR positive number are used for estimation. The estimated equation is in (2).

$$\text{Price} = \alpha + \beta 1\text{Difference} + \beta 2\text{Exchange rate} + \beta 3\text{S\&P} + \beta 4\text{Gold price} + \beta 5\text{Price(-1)} + \beta 6\text{PCR positive} \quad (2)$$

In the previous section, existing studies that are related with these variables are listed. It is difficult to decide the time lag of the difference. There are no theoretical backgrounds why three days prior was selected. The most suitable from one day to six days was chosen. Depreciation of the US dollar against other currencies (for example, yen) promotes US dollar Bitcoin buying as much more can be purchased. So the coefficient would be negative. In the case of stock prices, they cannot be judged easily. Both assets are risky-ones, so the coefficients could be positive, however, there would be some possibilities that investors do not regard them as substitute assets. In this case, the coefficient would be negative. Markets use gold transaction as risk-off, recently. So the coefficient could be negative. Finally, the PCR positive number would increase Bitcoin prices as nesting demands become strong as many people have to stay at home longer than before. People use more time for trading Bitcoin, therefor, the coefficient could be positive. The predictions are in Table 3.

Table 3: Predictions of coefficients

Difference	Exchange rate	S&P	Gold	PCR positive
plus/minus	minus	plus/minus	minus	positive

In examining the data volatility, the GARCH model is useful. The GARCH model was invented by Engle (1982) and Bollerslev (1986), and Taylor (1986). An agent in financial markets sometimes predicts the periods' variance by making a weighted average from a long-term average, the predicted variance from last period (GARCH term), and information about volatility obtained in the previous period (ARCH term). Along with OLS (Ordinary Least Squares), the GARCH is employed for estimations.

IV. Empirical analyses and the results

Regression analyses were conducted and the results are in Table 4. The empirical methods used were OLS and GARCH. The sample periods are 2017-2-19 and 2020 when COVID-19 become a serious issue.

Table 4: Regression analysis: Price

Period	2020	2017-2019	2020	2017-2019
Method	OLS	OLS	GARCH	GARCH
Difference	-2.51E-09 (-1.0567)	0.1866*** (3.8944)	-7.92E-09*** (-5.5096)	-2.86E-09* (-1.6649)
Exchange rate	-1.7457*** (-4.0715)	-0.2586 (-0.4528)	-1.3481*** (-2.7266)	0.1260 (0.2333)
S&P	0.4667*** (4.0899)	-0.2790 (-1.1104)	0.3866*** (3.5772)	-0.1497 (-0.6462)
Gold price	-0.1996 (-0.9460)	-0.3680 (-1.0660)	0.0082 (0.0422)	-0.5020* (-1.6668)
Price (t-1)	0.1319** (1.9967)	-5.06E-09* (-1.6773)	0.1729** (2.2271)	0.1815*** (3.1689)
PCR positive	6.44E-06** (2.2972)		9.14E-06*** (3.5815)	
Adj.R2	0.1219	0.0372	0.0938	0.0336
D.W.	1.9980	1.9811	2.0018	1.9756
Resid(-1)~2			0.1818*** (3.4092)	0.1752*** (3.1604)
GARCH(-1)			0.7696*** (13.0219)	0.4770*** (3.7422)

Note) Parentheses are t-statistic (OLS) and Z-statistic (GARCH) respectively.

The results are not robust, however, almost all of the results are as expected, shown in Table 3. For the variable, and the difference, the coefficients are not certain, however, market participants take past data and differences between past and current data. It is interesting to note that the coefficients were significantly negative in 2020, but not in 2017-2019. There are no data, however, on transactions of Bitcoin seeming to be become globally used. Kinds of currencies have expanded, so this issue should be examined from this point on. Moreover, the results of stock prices are also interesting. There is a difference between the two sample periods. In 2020, the coefficients are positive and significant, however, the coefficients are negative (not significant) for 2017-2019. Recently, monetary expansion by central banks has been ongoing in developed countries, so large amounts of money has flawed into not only equities but also into Bitcoin. The US also recovered a zero interest rate policy recently. Market participants have become risk-on. The coefficients of gold prices are negative as expected, however, positive during the years of 2017-2019 (insignificant). Gold has been accepted as a safe asset so, becomes positive in risk-on periods and negative in risk-off periods.

From the view of risk-on and risk-off, the coefficients of PCR positive have been able to be applied to similar things. Investors take the year of 2020 as risk-on. Monetary expansion in developed countries may have promoted this trend. Moreover, COVID-19 has travelled all over the world. The spread of COVID-19 has increased people's stay home time. Some cities have lockdowns. In the stock market, the transaction amounts of individual investors are increasing. The same thing may have happened to Bitcoin. There is some possibility that if the situation of COVID-19 becomes more serious, markets would become risk-off.

Instead of prices, volumes are employed as a dependent variable. The methods of empirical analyses are the same with the case of prices. The results are in Table 5.

Table 5: Regression analysis: volume

Period	2020	2017-2019	2020	2017-2019
Method	OLS	OLS	GARCH	GARCH
Difference	1.68E-08 (0.2938)	-1.32E-08 (-0.2841)	-8.13E-08 (-0.8262)	-7.56E-09 (-0.0963)
Exchange rate	14.6729 (1.4228)	6.4029 (0.7293)	-1.2233 (-0.1148)	9.9031 (1.1543)
S&P	-1.7594 (-0.6410)	-1.3812 (-0.3559)	-0.9133 (-0.3621)	-1.9045 (-0.4362)
Gold price	-4.2833 (-0.8455)	5.6677 (1.0685)	11.8898** (2.1382)	6.8947 (1.2558)
Volume (t-1)	-3.5292** (-2.2088)	-2.0258*** (-2.7513)	0.9744 (0.4955)	-2.1646*** (-4.0667)
PCR positive	0.0001* (1.7526)		0.0001 (1.1720)	
Adj.R2	-0.0045	-0.0224	-0.1255	-0.0230
D.W.	2.2249	2.4223	2.1981	2.4225
Resid(-1)~2			-0.0203***	0.0159**

			(-13.3541)	(2.1679)
GARCH(-1)			1.0178***	0.9226***
			(162.283)	(27.5766)

Note) Parentheses are t-statistic (OLS) and Z-statistic (GARCH) respectively.

It should be noted that almost all of the results are not significant. A relationship between the trading volume and variables that shows a significant relationship with the prices cannot be found. To analyze the volume of Bitcoin, other theoretical analyses must be employed. For example, regulations and controls may have affected transaction volume. This paper does not further consider this problem, however, the distinction between prices and volumes should be examined and should be made clearer.

V. Shock continuity

Via the previous sections, deterministic elements of Bitcoin prices have been examined. In this section, the span of shock on the prices is examined. The equation in (2) is regressed.

$$\text{Price} = \gamma \, \text{Price}(-1) + \varepsilon$$

ε denotes the error term. The empirical method is OLS. The results are in Table 6.

Table 6: Regression analysis for continuity

Period	2020	2017-2019
Price(t-1)	0.1668***	0.1541***
	(4.2813)	(3.2123)
Adj.R2	0.0274	0.0234
D.W.	1.9198	1.9070

Note) Parentheses are t-statistic (OLS).

The coefficients are 0.1668 and 0.1541 respectively for each sample period. The disappearance period is x. 10% and is employed for the disappearance period of the shock. It means that $0.1668^x=0.1$ and $0.1541^x=0.1$. For the first case x=1.2857 and in the second one x=1.2312. So the dispersion disappears for only one day or so.

VI. Conclusion

This study examined Bitcoin prices' deterministic elements empirically. It is difficult to find strong patterns on some cases, however, almost all of the results are clear. From the year of 2017 to the year of 2019, Bitcoin prices had not been influenced by exchange rates and stock prices, however, the correlation between Bitcoin prices and such asset prices exists recently (the year of 2020). The departure from most recent prices has not impacted Bitcoin prices in 2020, however, had impacted prices during the period of 2017-2019. Also, there exists an influence from COVID-19 on Bitcoin prices. Bitcoin prices had been decided independently, however, some asset prices began to have impacts on Bitcoin prices. Moreover, continuity from the shock on prices does continue slightly.

In general, deterministic elements of Bitcoin prices have been changing. They began to correlate with macroeconomic variables. The reason seems to be unclear. There is room for further study.

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