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A note on Bitcoin's price volatility

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Abstract

Cryptocurrencies such as bitcoin are sometimes referred to as the new gold and the buzz that surrounded bitcoins in last few years is akin to the old day's gold rush. Cryptocurrencies are not directly linked to any monetary policy instruments or fundamentals. Therefore, analysis of common factors between these virtual currencies and other financial asset classes is challenging. Towards the end of 2017, Bitcoin's price shot up to record high figures as cryptocurrency was gaining popularity not only for transactions but also for investments. This motivated us to investigate the relationship bitcoin prices has with Gold and stock index and crude oil. Historical prices were gathered from the start of 2017 to the end of the year, the Pearson's Correlation analysis was chosen to study the relationship of Bitcoin and 3 other economic indicators namely gold, crude oil, and stock market prices. Then we did a multiple regression. Bitcoin has a correlation coefficient of 0.966 when compared to the stock market index S&P 500 which means that they both share similar properties and characteristics. The t statistic for each variable was also significant. This paper explores the possible factors that are correlated with the surge in bitcoin prices and offer views on the relevance of bitcoin in today's world.

Abstrak

Cryptocurrency seperti bitcoin disebut juga sebagai emas baru dan buzz yang mengelilingi bitcoin dalam beberapa tahun terakhir ini mirip dengan demam emas di masa lalu. Cryptocurrency tidak secara langsung terkait dengan instrumen kebijakan moneter atau fundamental. Oleh karena itu, analisis faktor-faktor umum antara mata uang virtual ini dan kelompok aset keuangan lainnya menjadi tantangan. Menjelang akhir 2017, tercatat harga bitcoin melonjak mencapai angka tinggi karena cryptocurrency mendapatkan popularitas tidak hanya untuk transaksi tetapi juga untuk investasi. Ini memotivasi kami untuk menyelidiki hubungan harga bitcoin dengan emas dan indeks saham dan minyak mentah. Data harga historis dikumpulkan dari awal 2017 hingga akhir tahun, analisis Pearson's Correlation dipilih untuk mempelajari hubungan bitcoin dan 3 indikator ekonomi lainnya yaitu harga emas, minyak mentah, dan harga pasar saham. Kemudian kami melakukan regresi berganda. Bitcoin memiliki koefisien korelasi 0,966 bila dibandingkan dengan indeks pasar saham S&P 500 yang berarti keduanya memiliki sifat dan karakteristik yang sama. Statistik t untuk setiap variabel juga signifikan. Artikel ini mengeksplorasi kemungkinan faktor yang berkorelasi dengan lonjakan harga bitcoin dan menawarkan pandangan tentang relevansi bitcoin di dunia saat ini.

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1. Introduction

Bitcoin is one of the many cryptocurrencies present in the market today. Bitcoin first emerged over a decade ago as an open source software-based online payment system using the underlying technology of block chain. Recording every transaction securely in a shared public ledger, the transactions happen peer-to-peer without the need for a single central repository. Therefore, it was known to be a decentralized virtual currency that can be used anonymously.

New bitcoins are generated as rewards for the processing work when users offer their computing power to verify and record payments and transactions into the public ledger. This can also be referred to the term of "mining" where new blocks of bitcoins can be earned by individuals or corporate companies.

Cryptocurrencies are not directly linked to any monetary policy instruments or fundamentals. Therefore, analysis of common factors between these virtual currencies and other financial asset classes is challenging. Cryptocurrencies such as bitcoin are sometimes referred to as the new gold and the buzz that surrounded bitcoins in last few years is akin to the gold rush. A number of prior studies have analysed the volatility of bitcoin prices (for example Conrad, Custovic, & Ghysels (2018), Catania & Grassi (2017), Dyrberg (2016), Katsiampa (2017), and Chu et al. (2017)). Bitcoin prices experienced a boom in 2017. This paper aims to examine the possible factors that drove the price up within that period. This paper also tries to divulge the relationship of economic indicators such as the historical price of crude oil, gold and the stock market and the value of Bitcoin during the price fluctuations of 2017.

Bitcoin was created by Satoshi Nakamoto in 2009 (Nakamoto, 2009). The acceptance and resulting volatility of Bitcoin motivated academics to study Bitcoin's position in the economy and its likelihood to become a global currency. Mankiw (2007) defines

three criteria of successful currency: a medium of exchange, a unit of account and a store of value. The assessment of Bitcoin in relation to these criteria is shown in Yermack (2013), Lo & Wang (2014) or Kancs, Ciaian, & Rajcaniova (2015). These studies appraise the excessive volatility of bitcoins as the very barrier for Bitcoin to become a successful currency. This extreme volatility compared to standard currencies motivates the interest in studying the factors behind such volatility.

The price fluctuations of bitcoin versus national currencies such as the U.S. dollar, euro or Chinese yuan have been extremely volatile (Hayes, 2015). Therefore, the comparisons could not be as accurate as the extreme price volatility produces plenty of noise which will affect the results of the analysis.

It is also important to note that the total number of bitcoins in circulation can only reach 21 million bitcoins based on the known algorithm it uses. Therefore, bitcoins are sometimes referred to as digital gold as there is a limit to the supply that will be in circulation. Unlike fiat money, where central banks can issue more supply to control monetary policies in certain governments, this limit that bitcoin has makes it more attractive. This is due to the fact that the supply will remain the same whilst if the demand increases, the value of the digital currency will increase.

Bouoiyour & Selmi (2014) attempted to describe bitcoin value by regressing its market price against a number of independent variables including the market price of gold, and even the number of occurrences the word "bitcoin" was being searched on Google. Mostly, the variables were not statistically significant at the 5% or better level of significance. Another study by Kristoufek (2015) also mentions that one of the possible drivers of bitcoin price is its popularity. Results suggest that with increasing interest in the cryptocurrency, along with new investments, leads to an increasing demand thus increasing prices. In his research, he had also utilised

Google as well as Wikipedia engines for word queries for the word “Bitcoin”.

2. Method, Data, and Analysis

We explored the relationship bitcoin has with economic factors such as gold, crude oil and the stock market. After all, a pattern might surface from the historical prices of the aforementioned asset classes when compared with the historical price of bitcoin during the abnormal price fluctuations in the later months of 2017.

Firstly, using the historical prices gathered from the start of 2017 to the end of the year, the Pearson’s Correlation analysis was chosen to study the relationship of Bitcoin and 3 other economic indicators namely gold, crude oil and stock market prices. Then we did a multiple regression.

Data from the respective sources was extracted. Namely CoinDesk, a crypto asset and technology services company for historical bitcoin prices on its Bitcoin Price Index, Yahoo Finance for historical Standard and Poor (S&P) 500 prices, Gold.org for historical gold prices and Federal Reserve Bank of St. Louis for historical prices of crude oil. The S&P 500 is largely regarded as the best gauge for large-cap U.S. equities. With 500 leading companies, it covers a significant portion of the stock market and thus is widely used by investors as a benchmark of the overall market. For crude oil in particu-

lar, the West Texas Intermediate (WTI) crude oil was used as a benchmark in oil pricing in the U.S.

Using a Pearson’s Correlation analysis, the aim was to measure how strong the relationship of and association of two variables denoted by a coefficient value. The underlying mechanics behind it attempts to draw a best fit line through the data of both variables using its formula. The coefficient value determines the distance between the data points are to the aforementioned best fit line. The result, a coefficient, then shows how the two measurements vary together and move together.

One of the strength of the Pearson’s Correlation analysis lies in its ability to be able to accept two different variables that may not have share the same units. In this case, although all of the units are denominated in US Dollars, they might not share the same measurement per unit. For example, crude oil is measured per barrel whereas Bitcoin is measured per coin.

One key point to take note of is also the fact that the Pearson analysis does not consider if a variable is an independent or dependent variable. All variables are treated equally.

Before the analysis was executed it is also important to take note of five assumptions that the Pearson’s Correlation makes: (1) the variables must be either in interval or ratio measurements. (2) The variables must be roughly distributed normally. (3)

Field	Graph	Measurement	Min	Max	Mean	Std. Dev	Skewness	Unique	Valid
BTC Close Price		Continuous	775.980	18960.520	3962.677	3978.053	2.030	--	261
DCOILWTICO		Continuous	42.480	60.460	50.853	3.944	0.275	--	261
Gold Price (USD)		Continuous	1145.900	1346.250	1256.889	35.233	-0.379	--	261
S&P 500		Continuous	2238.830	2690.160	2447.386	111.071	0.370	--	261

Figure 1. Data quality of 4 main variables showing distribution and skewness

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The variables must have a linear relationship. (4) Outliers should be minimized or entirely removed. (5) Data must be of homoscedasticity, which means that the variances along the best fit line remain similar throughout.

Using IBM's SPSS Modeller, we are able to clean up the data before proceeding. As shown in the screenshot above, all the variables are of good quality except that of the Bitcoin (BTC) Close Price, which is positively skewed with the most number of outliers. It is important to reduce the number of outliers in the data as it can have a big impact on

the best fit line where the correlation coefficient is derived from. Therefore, the outliers for BTC Close Price needed to be reduced or removed entirely. As previously mentioned, the second assumption requires the variables to be approximately normally distributed. Hence, the BTC Close Price variable needed to go through a logarithmic transformation.

Figures 3 and 4 below shows the data after some minor transformations, ensuring that all outliers are reduced and that all the variables are more or less normally distributed.

Complete fields (%): Complete records (%):

Field	Measurement	Outliers	Extremes	Action	Impute Missing	Method	% Complete	Valid Records	Null Value
BTC Close Price	Continuous	10	0	None	Never	Fixed	100	261	0
DCOILWTICO	Continuous	0	0	None	Never	Fixed	100	261	0
Gold Price (USD)	Continuous	3	0	None	Never	Fixed	100	261	0
S&P 500	Continuous	0	0	None	Never	Fixed	100	261	0

Figure 2. Data quality of variables showing completeness and outliers of data

Audit Quality Annotations

Field	Graph	Measurement	Min	Max	Mean	Std. Dev	Skewness	Unique	Valid
BTC		Continuous	6.654	9.850	7.905	0.843	0.464	--	261
DCOILWTICO		Continuous	42.480	60.460	50.853	3.944	0.275	--	261
Gold Price (USD)		Continuous	1145.900	1346.250	1256.889	35.233	-0.379	--	261
S&P 500		Continuous	2238.830	2690.160	2447.386	111.071	0.370	--	261

Figure 3. Distribution after data transformation

Complete fields (%): Complete records (%):

Field	Measurement	Outliers	Extremes	Action	Impute Missing	Method	% Complete	Valid Records	Null Value
BTC	Continuous	0	0	None	Never	Fixed	100	261	0
DCOILWTICO	Continuous	0	0	None	Never	Fixed	100	261	0
Gold Price (...)	Continuous	3	0	None	Never	Fixed	100	261	0
S&P 500	Continuous	0	0	None	Never	Fixed	100	261	0

Figure 4. Data quality with reduced number of outliers

Table 1. Guideline of strength of relationship of variables

Strength of Association	Coefficient, <i>r</i>	
	Positive	Negative
Weak	0.1 to 0.3	-0.1 to -0.3
Medium	0.3 to 0.5	-0.3 to -0.5
Strong	0.5 to 1.0	-0.5 to -1.0

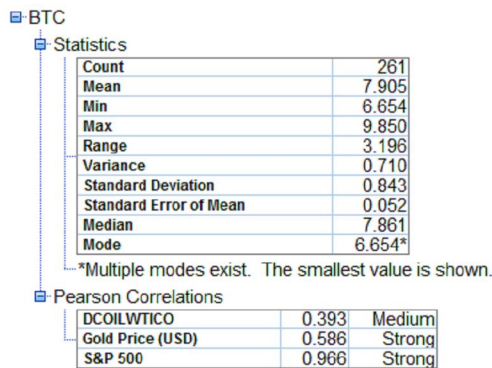


Figure 5. Statistical results of IBM SPSS Modeller 18

The results of the analysis in Figures 5 and Table 1 shows that bitcoin does not have a strong correlation to crude oil and gold prices when a comparison of 261 prices throughout 2017 was used. With a correlation coefficient of 0.39 for crude oil and 0.586 for gold price, it seems that bitcoin only has a correlation strength of “Medium”. Therefore, the results of this analysis should be more focused on the correlation of bitcoin to the stock market index S&P 500.

What is more interesting is that bitcoin has a correlation coefficient of 0.966 when compared to the stock market index S&P 500 which means that they both share similar properties and characteristics.

We performed multiple regression on the data and the results are as Table 3.

Table 2. Pearson’s Correlation Analysis from Microsoft Excel 2013

Correlation	BTC	DC-OIL-WTI-CO	Gold Price	S&P 500
BTC	1			
DC-OIL-WTI-CO	0.392814935	1		
Gold Price (USD)	0.585699941	0.035885708	1	
S&P 500	0.965752899	0.408836008	0.58235442	1

Table 3. Summary Output

Regression Statistics	
Multiple R	0.921358258
R Square	0.848901039
Adjusted R Square	0.847137238
Standard Error	1555.325821
Observations	261

ANOVA					
	df	SS	MS	F	Significance F
Regression	3	3.49E+09	1164260652	481.290685	4.0551E-105
Residual	257	6.22E+08	2419038.408		
Total	260	4.11E+09			

	Coefficients	Standard Error	t Stat	P-value
Intercept	-61464.50562	3646.853	-16.85412193	1.9462E-43
DCOILWTICO (USD)	248.8460964	27.8546	8.933752004	8.1487E-17
Gold Price (USD)	-18.62686501	3.500065	-5.321862543	2.238E-07
S&P 500 (USD)	31.12909868	1.215778	25.60425352	1.1206E-72

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Interestingly the regression model shows a good fit with R square being 0.84 and significant F value. The t statistic for each variable was also significant. The coefficient for gold was negative indicating that bitcoin does not behave as gold. This is in line with bitcoin moving in same direction as the stock market index according to the regression results. These results could be influenced by the short time period of the data as it was daily data over one-year period. A longer time period study should be carried out. It is likely that Bitcoin, stock market index, gold, and crude oil are also influenced by common economic factors.

3. Results

Based on the background of bitcoin, it was used to primarily for two purposes: for trading and purchasing as a currency. The initial intention was to develop a decentralized cash-like electronic payment system. Although it is seen as more of a digital asset that can represent digital property without the need for a central authority a new asset class was born. It has, no doubt, the potential to be a great hedging tool to be used for portfolio diversification as it has little to no correlation to the economy.

There are some assumptions that we can infer from analysis results. Bitcoin, with a high correlation coefficient of 0.966 with the stock market index S&P 500, might be affected more by investors more than other economic indicators such as gold or crude oil.

Assumption 1: Efficient Market Hypothesis

As an investment asset, bitcoin prices exhibit the same efficient market hypothesis as the one that the stock market is based on. Like the stock market, bitcoin prices showed no predictable pattern as seen in figure 7. With every passing day, the prices seemed to move up or down irrespective to the past performance. Therefore, it is difficult to predict

where the price might close the following day. This random fluctuation of price movements indicate an efficient market that is not irrational. As for bitcoin prices, it is closely linked to the semi-strong form hypothesis as all of its information is reflected in its price (Janakiramanan, 2015). Every investor would have had all the public information of Bitcoin as it is as transparent as it can be, with information such as number of bitcoins mined, time to mine between blocks, market price, trade volumes and a summary of transactions being publicly available on the Block chain website (<https://blockchain.info/stats>). With all the information available, any individual will not be able to make abnormal profits as implied by the efficient market hypothesis.

Assumption 2: Signalling Effect

The price of bitcoin reaching a peak of nearly USD 20 thousand could also be the cause of a signalling effect. Also known as the "announcement effect", it states that prices would change as a result of some announcement. The signalling effect may cause the prices to change drastically, depending on the type of information that was broadcasted. In the context of bitcoin, the rise of block chain technology and the buzz around cryptocurrencies helped contribute to the surge in popularity of Bitcoin (Barlin, 2017). With more investors being aware of its potential in earning profit, the demand grew, increasing its price. As described earlier, as the supply of bitcoin slows down with the increasing complexity of mining, the demand for it surpassed the supply, resulting in a surge in bitcoin price. This is also due to the fact that bitcoin is a derivative that does not derive its value from any asset, but purely from its supply and demand. Unlike gold or crude oil, it is not represented by a physical object.

Tessone et al. (2014) showed that Bitcoin's growing popularity led to higher search-engine volumes, which caused an increase in social media activity regarding Bitcoin. This generation of interest encouraged more individual investors to purchase

bitcoins, thus driving the prices up. The subsequent jump in prices causes more people to be more aware of the potential profit through news and media reporting, triggering more curiosity among the masses.

4. Discussions

Is Bitcoin an investment bubble waiting to burst?

One common sentiment that most investors must be wary of is that the Bitcoin bubble may burst

in the near future. Bitcoin is a speculative bubble given the investors are paying increasingly higher prices based on the belief that other investors will pay higher prices going forward. Also considering the fact that it has no inherent value derived from any physical asset, it is hard not to call Bitcoin a purely speculative asset (Clark, 2018). He then goes on to compare a few other speculative bubbles that have burst such as the tulip buying frenzy in Hol-

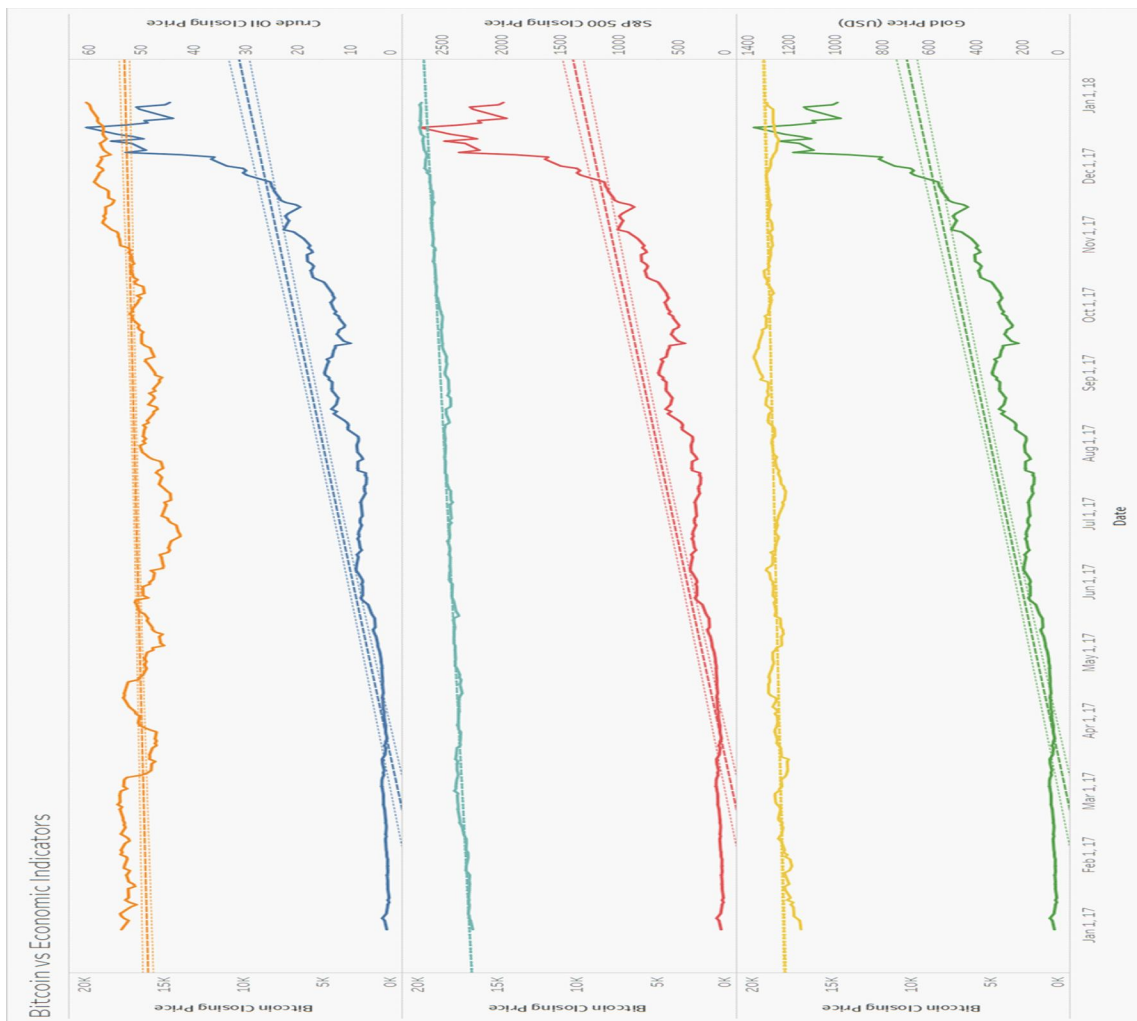


Figure 6. Historical price of bitcoin vs historical prices of crude oil, S&P 500, and gold

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land in the 1630s, the South Sea Bubble involving a trading company's stock that increased eight-fold and collapsed soon after and lastly the Japanese real estate and stock market bubble in 1990 which burst within 3 years after prices tripled in value.

There are several factors that could cause the bitcoin market to crash (Kawa, 2017). Firstly, with many forks of alternative coins being and upgraded versions of bitcoin, they might cause the bitcoin market to deflate. Secondly, as bitcoin is notoriously used for purchasing illicit items and might disrupt governments' control over monetary policies, it might one day be shut down by authorities. Thirdly, being a digital asset, bitcoin always faces the risk of hacking and getting stolen by professional hackers on the World Wide Web. Lastly, with the sharp rise in prices, it is also expected that a dip in price be as fast because of the nature of the way the prices are derived as discussed in this paper.

5. Conclusion, Limitations, and Suggestion

Conclusion

With most of the analysis and research that has been done pointing to the direction that bitcoin is largely a speculative instrument, it can be concluded that it is a currency that may not be the answer to our future in digital currencies. Although there are many benefits that it may bring into investments such as a risk hedging tool, decentralisation and more secure transactions, it still faces the risk of losing its value once the general public switch to better alternative coins in the market. As mentioned previously, the price of bitcoin is mostly governed by the demand versus the fixed supply. With no tangible valuable asset that it is derived from, there is a possibility that the one day it might be valueless. Therefore, Bitcoin should have remained as a virtual currency without crossing the boundaries of being exchanged for fiat money.

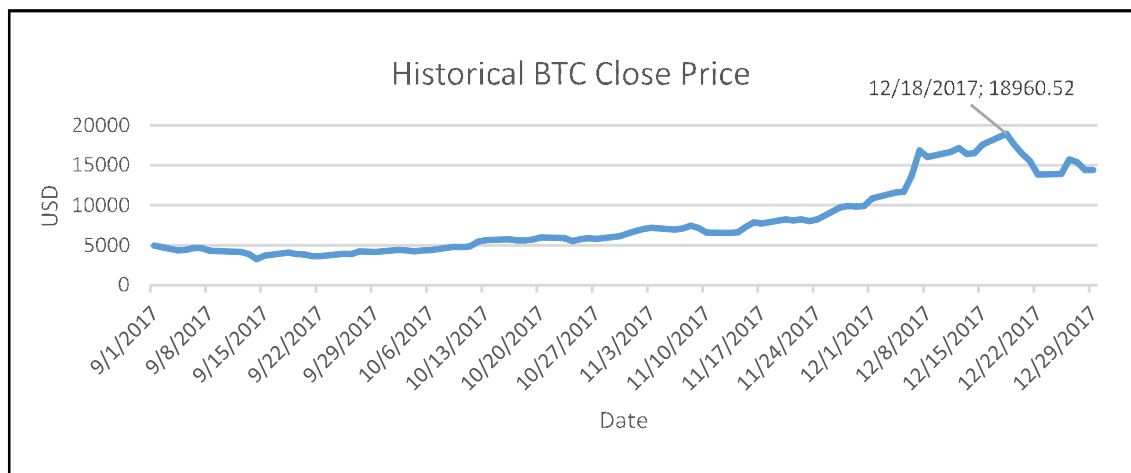


Figure 7. Historical bitcoin closing price showing volatility occurring in late 2017

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