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Pearson Product Moment Correlation Diagnostics Between two types of crypto-currencies: A case study of Bitcoin and Ethereum

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ABSTRACT

The purpose of this study is to develop robust estimation of association between two types of crypto-currencies namely Bitcoin and Ethereum. Daily data of crypto-currencies are collected from https://coinmarketcap.com. The period for data analysis is started from January 2017 until October 2018. The value of mean return for Bitcoin is 13.18 %. Meanwhile, the value of mean return for Ethereum is 27.85 %. The standard deviation for Bitcoin is 30.27 % and Ethereum is 64.24 %. Then, this study performed Person product moment coefficient analysis to evaluate the correlation between these two crypto-currencies. Result indicates the association coefficient value is 0.50. The correlation shows there is strong positive correlation between Bitcoin return and Ethereum return. As conclusion, there is significant relationship between Bitcoin and Ethereum return data with strong positive correlation (r = 0.503, n = 21, p =0.020).The significant of this study is to help investors to make better decision in selecting appropriate investment portfolio for their investment fund that contributes better return and lower risk.

Key Words: *Crypto-currency, Bitcoin, Ethereum, Correlation, Investment.*

1. INTRODUCTION

The emerging of crypto-currencies becomes a milestone in innovation of financial technology (FinTech) revolution. Emerging technology also give more advantage in the banking and financial area. For example, technology has changed the banking industry from paper and branch based banks to digitized and networked banking services by using an internet system (Abu Bakar, et al., 2017; Reid and Harrigan, 2013; Moore and Christin, 2013). Consequently in 2008, Satoshi Nakamoto proposed an electronic payment system based on cryptographic proof (blockchain) (Nakamoto, 2009). The idea was to produce coin exchange without any central authority, in electronic form, more or less instantly, with minimal cost (Ivashchenko, 2016). A cryptocurrency is a decentralized digital currency which uses encryption the process of converting data into code to generate units of currency and validate transactions independent of a central bank or government (Nakamoto, 2008). Currently, Bitcoin network became functional and now it is the most traded crypto-currencies in the world (Dumitrescu, 2017). Bitcoin has grown from an experimental commodity traded between enthusiasts, to a booming economy receiving substantial media attention (Brandvold, et al., 2015). However, crypto-currencies have no physical image in reality. Crypto-currencies is created, stored and transacted electronically only.

The system for crypto-currencies transaction is known as blockchain. The blockchain is blocks of transaction history that shared publicly using secured cryptography. Each block contains the previous transaction information, timestamp and new transaction data in secured cryptographic hash programming language. The process of chaining started with the first block of transaction. Then, the current has code need to link with previous code to validate the content of transactions. Next, the current hash code in second block of transaction is created using hash programming. This hash code need to link with previous hash code which is in first block. Again, when the hash code for third block is created, it must be evaluated and synchronized with hash code in previous block (Abu Bakar and Rosbi, 2018).

Most of crypto-currencies are maintained by a community of crypto-currency miners who are members of the public. Crypto-currencies are derived from one of two protocols: proof-of-work (POW) or proof-of-stake (POS). In POW systems, the probability of mining a block is dependent on how much work is done by the miner. In POS systems, users can “mine” depending on how many coins they hold. For example, a user owning 5 per cent of a coin-base can mine 5 per cent of the blocks in the same way that a user owning 5 per cent of the mining network can theoretically mine 5 per cent of the blocks (Irwin and Turner, 2018; Graydon, 2014).

In early 2014, Ethereum was introduced. Ethereum has received a lot of attention since its announcement at the North American Bitcoin Conference by Vitalik Buterin (Christoforou, 2017). The applications of Ethereum are run on its platform-specific cryptographic token known as ether (Browne, 2018). Abu Bakar and Rosbi (2018) examine the Ethereum exchange rate to validate the dynamic behavior of price movement. The result indicates there are suspected outliers in the Ethereum exchange rate data. They concluded that first difference of Ethereum exchange rate data is highly volatile and high risk. Today, hundreds of crypto-currencies are widely offered, differing by issuance scheme, block time or supply. Bitcoin and ether are the most common form of digital currencies. But there are other forms of virtual cash, such as Litecoin, Ripple and Dash. The advantages of using crypto-currency are low transaction cost, data protection and high speed of the transfer process. Even there are many advantage of using crypto-currencies, but problem using crypto-currencies as a medium of exchange still remain unsolved. The disadvantage of using crypto-currency such as high volatility and high risk might be a risky to the investors that involving in Bitcoin crypto-currency investment. Study from Abu Bakar and Rosbi (2017) regarding volatility of Bitcoin found that the standard error of Bitcoin is 4.458 % showed high volatility. While, Ivashchenko (2016) highlight Bitcoin is not secured by anything, it is pure mathematics. Anyone in the world can run the bitcoin mining script on his/her computer and be like a mini Central Bank. Source Code of the script is posted in the clear, everyone can see how it works. Another specific feature of Bitcoin is that instead of trusting that the central bank is guaranteeing the value of your money, as is common for fiat currencies, you trust that the cryptographic proofs provided by the network is correct (Brandvold, et al., 2015).

Therefore, this study tries to develop robust estimation of association between two types of crypto-currencies namely Bitcoin and Ethereum. Daily data of crypto-currencies are collected from January 2017 until October 2018. The main purposed of this study is to understand the dynamic correlation behavior between two types of crypto-currencies.

2. LITERATURE REVIEW

There is a growing literature in finance that focuses on the study of crypto-currencies. Crypto-currencies is defined as a digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, operating independently of a central bank. There are many study focus on crypto-currencies. The concept of a crypto-currency has created different opinions on whether it should be perceived as a real currency or something even more valuable. Bitcoin was initially created as a decentralized currency with its own way of generating and transferring money (Law and Vahlqvist, 2018). While Abu Bakar, et al., (2017) mentioned crypto-currency has no physical form and exists only in the network. Bitcoin also has no intrinsic value in that it is not redeemable for another commodity, namely gold.

Nowadays, crypto-currencies become a new phenomenon in the investment portfolio. Bitcoin was initially created as a decentralized currency with its own way of generating and transferring money. However, recent studies have had a contradictory perception of its positioning in the field of finance. Study by Wegberg, et al., (2018) regarding in which ways cybercrime proceeds that are obtained in the form of bitcoin or converted to bitcoin can be laundered. This study found in the current imagery of bitcoin as a criminal currency might lead to regulation of bitcoin exchange services. However, that will not stop criminals in using bitcoin exchange services that are located in jurisdictions that have no or less strict regulations. The degree to which banning or regulating will have any effect on the facilitating role currently plays in the criminal enterprise, has yet to be determined.

Virtual currencies have been well-cited and well-discussed in the near past. Due to the loss of trust in the banking sector and the fear of loss of capital, low interest rates and uncertainty of existing currencies, the ground for a virtual currency was given. Virtual currencies and the money flows are controlled only online by the anonymous group of volunteers (also called peer); every single transaction is documented. Approximately 10,000 businesses worldwide accept payments with virtual currencies already, and the number is increasing steadily (Richter, et al., 2015).

There is a substantial body of research examining the relationship between two variables. This study used correlation method in investigate the correlation between Bitcoin and Ethereum. There are many study focus on correlation. Correlation is one of technique in measuring the relationship between two variables. Study by Abu Bakar and Rosbi (2017) regarding correlation between volatility and return found that the p-value of share price is 0.198 and normally distributed according to normality test (Shapiro-Wilk). Pearson correlation analysis shows there is a strong, positive correlation between return and volatility, which was statistically significant ($r = 1.000$, $n = 43$, $p = 0.005$) (Abu Bakar and Rosbi, 2017). Sankaran, et al., (2012) examine the relation between extreme return correlation and return volatility, in the context of US stock indexes. They found that the correlation

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positive extreme returns within overlapping clusters significantly increases with volatility between DJIA and S&P 500. They also did not find any significant change in the pair-wise correlation between the positive extreme returns within overlapping clusters in each of these indexes with those of NASDAQ composite. Besides the study that focuses on the relationship between return and volatility, Abu Bakar and Rosbi (2017) investigate the correlation between Exchange rate of Malaysian Ringgit (USD to MYR) and crude oil price. Therefore, this study try to fulfill this gap by investigate the correlation between Bitcoin and Ethereum.

Overall, the empirical research on crypto-currencies has been focused on different angles. However, from the previous literature review, it is suggested to know the framework of crypto-currencies in the global context that might help to explore the avenues of further research on the correlation between crypto-currencies. Hence, this study aims to resolve research question whether crypto-currencies namely, Bircoin and Ethereum have a significant correlation or not. This paper attempts to develop robust estimation of association between two types of crypto-currencies namely Bitcoin and Ethereum. Moreover, it could play a vital role for the development of crypto-currencies market regulations across the countries.

3. RESEARCH METHODOLOGY

Main objective of this study is to evaluate the correlation between two types of crypto-currencies namely Bitcoin return and Ethereum return. Therefore, this study implemented statistical normality test namely Shapiro-Wilk method. Then, this study validate the correlation between Bitcoin return and Ethereum return using Pearson product moment correlation analysis.

3.1 Return calculation for crypto-currency

This study collected daily price of crypto-currencies from *https://coinmarketcap.com*. Then, rate of return for each crypto-currency is calculated using Equation (1).

$$\mathrm{Re}_i = \frac{P_i - P_{i-1}}{P_{i-1}} \times 100\% \quad \text{…… (1)}$$

In Equation (1), Re_i is return of crypto-currency on period *i*,

P_i is crypto-currency price on period *i*, and

P_{i-1} is crypto-currency price on period *i-1*.

3.2 Normality analysis for crypto-currency return using Shapiro-Wilk statistical test

Next, this study evaluates the normality distribution of data. The probability density of the normal distribution is represents by Equation (2).

$$f\left(x\middle|\mu,\sigma^2\right) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad \text{…… (2)}$$

In Equation (2), x is variable, μ is mean of variable, σ is standard deviation and σ^2 is variance.

A normal distribution with a mean of 0, $(\mu = 0)$ and a standard deviation of 1, $(\sigma = 1)$ is called a standard normal distribution. The variable with the standard normal distribution, 68% of the observations fall between -1 and 1 (within 1 standard deviation of the mean of 0), 95% fall between -2 and 2 (within 2 standard deviations of the mean) and 99.7% fall between -3 and 3 (within 3 standard deviations of the mean).

Then, Equation (2) can be re-arranged to Equation (3) using probability density function.

$$\varphi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \quad \text{…… (3)}$$

DOI: 10.31695/IJASRE.2018.32997

The factor $\frac{1}{\sqrt{2\pi}}$ in this expression ensures that the total area under the curve $\varphi(x)$ is equal to one. The factor $\frac{1}{2}$ in the exponent ensures that the distribution has unit variance and therefore also unit standard deviation. This function is symmetric around $x=0$, where it attains its maximum value $\frac{1}{\sqrt{2\pi}}$ and has inflection points at $x=+1$ and $x=-1$.

Next, Shapiro–Wilk test is selected to evaluate whether the distribution of variables is follow normal distribution or non-normal distribution. The null-hypothesis of this test is that the population is normally distributed. The Shapiro–Wilk test tests the null hypothesis that a sample $x_1, x_2, x_3, ..., x_n$ came from a normally distributed population. The test statistic is described in below Equation (4).

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2} \quad \text{.......} \quad (4)$$

In Equation (4), the parameters are described as follows:

$x_{(i)}$ is order statistics, represents $x_{(1)}$ is smallest value in the sample,

$\bar{x} = \frac{x_1, x_2, x_3, ..., x_n}{n}$ is sample mean , with n is number of data in the sample,

The constant a_i are described in Equation (5).

$$(a_1, a_2, a_3, ..., a_n) = \frac{m^{\mathrm{T}} V^{-1}}{\sqrt{m^{\mathrm{T}} V^{-1} V^{-1} m}} \quad \text{.......} \quad (5)$$

In Equation (5), the parameters are described as follows:

$$m = (m_1, m_2, m_3, ..., m_n)^{\mathrm{T}} \quad \text{.......} \quad (6)$$

The parameters in Equation (6) are described as follows:

$m_1, m_2, m_3, ..., m_n$ are the expected values of the order statistics of independent and identically distributed random variables sampled from the standard normal distribution,

V is covariance matrix of those order statistics.

If the test statistic W is smaller than the critical threshold (0.05) the assumption of a normal distribution has to be rejected.

In this study, number of data for return rate is 21 observations. Therefore, the W-value should larger than 0.905 to accept the data distribution is follow normal distribution.

3.3 Pearson correlation mathematical derivation

This study implemented Pearson product moment correlation in developing the correlation among two types of crypto-currencies. The bivariate Pearson Correlation produces a sample correlation coefficient, *r*, which measures the strength and direction of linear relationships between pairs of continuous variables. By extension, the Pearson Correlation evaluates whether there is statistical evidence for a linear relationship among the same pairs of variables in the population, represented by a population correlation coefficient, *ρ*.

The Pearson correlation equation for population is described in Equation (7).

$$\rho_{XY} = \frac{\operatorname{cov}(X, Y)}{\sigma_X \sigma_Y} \quad \text{.......} \quad (7)$$

DOI: 10.31695/IJASRE.2018.32997

In Equation (7), the parameters are described as follows:

ρ_{XY} is Pearson product moment correlation coefficient,

$\text{cov}(X,Y)$ is covariance element between two variables namely *X* and *Y*,

σ_X is standard deviation of X variable, and

σ_Y is standard deviation of *Y* variable.

Next, the Equation (7) can be re-arranged to become Equation (8) in in terms of mean and expectation.

$$\rho_{XY} = \frac{\mathrm{E}\left[(X-\mu_X)(Y-\mu_Y)\right]}{\sigma_X \sigma_Y} \quad \text{(8)}$$

In Equation (8), the parameter is explained as below:

μ_X is mean of *X* variable,

μ_Y is mean of *Y* variable,

E is expected is each possible value the random variable can assume is multiplied by its probability of occurring, and the resulting products are summed to produce the expected value.

The formula for ρ_{XY} can be expressed in terms of uncentered moments. The following parameters are described as follows:

$$\mu_X = \mathrm{E}[X],$$

$$\mu_Y = \mathrm{E}[Y],$$

$$\begin{aligned}\sigma_X^2 &= \mathrm{E}\left[\left(X-\mathrm{E}[X]\right)^2\right] = \mathrm{E}\left[\left(X^2 - 2X\mathrm{E}[X] + \left(E[X]\right)^2\right)\right] = \mathrm{E}\left[X^2\right] - 2\mathrm{E}\left[X\mathrm{E}[X]\right] + \left(\mathrm{E}[X]\right)^2 \\ &= \mathrm{E}\left[X^2\right] - 2\left(\mathrm{E}[X]\right)^2 + \left(\mathrm{E}[X]\right)^2 \\ &= \mathrm{E}\left[X^2\right] - \left(\mathrm{E}[X]\right)^2\end{aligned}$$

$$\sigma_Y^2 = \mathrm{E}\left[Y^2\right] - \left(\mathrm{E}[Y]\right)^2,$$

$$\begin{aligned}\mathrm{E}\left[(X-\mu_X)(Y-\mu_Y)\right] &= \mathrm{E}\left[\left(X-\mathrm{E}[X]\right)\left(Y-\mathrm{E}[Y]\right)\right] = \mathrm{E}\left[XY - X\,\mathrm{E}[Y] - Y\,\mathrm{E}[X] + \mathrm{E}[X]\mathrm{E}[Y]\right] \\ &= \mathrm{E}[XY] - \mathrm{E}[X]\mathrm{E}[Y] - \mathrm{E}[X]\mathrm{E}[Y] + \mathrm{E}[X]\mathrm{E}[Y] \\ &= \mathrm{E}[XY] - 2\mathrm{E}[X]\mathrm{E}[Y] + \mathrm{E}[X]\mathrm{E}[Y] \\ &= \mathrm{E}[XY] - \mathrm{E}[X]\mathrm{E}[Y]\end{aligned}$$

Therefore, Equation (8) can be re-structured to Equation (9):

$$\rho_{XY} = \frac{\mathrm{E}[XY] - \mathrm{E}[X]\mathrm{E}[Y]}{\sqrt{\mathrm{E}\left[X^2\right] - \left(\mathrm{E}[X]\right)^2}\sqrt{\mathrm{E}\left[Y^2\right] - \left(\mathrm{E}[Y]\right)^2}} \quad \text{(9)}$$

Next, the sample Pearson correlation can be expresses as Equation (10). Consider, there are two variables of paired data, $\{(x_1,y_1),(x_2,y_2),\ldots,(x_n,y_n)\}$

DOI: 10.31695/IJASRE.2018.32997

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \overline{y})^2}} \quad \text{.......... (10)}$$

Therefore, the parameters in Equation (10) are described as below:

n is sample size,

x_i is variable *x* at period *i*, y_i is variable *x* at period *i*,

$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$ is for mean value of x variable, and $\overline{y} = \frac{\sum_{i=1}^{n} y_i}{n}$ is for mean of *y* variable.

4. RESULT AND DISCUSSION

This study is to analyze the correlation between Bitcoin price and Ethereum price. The methodologies implemented in this study are graphical and numerical analysis for normality distribution. In addition, Pearson correlation calculated using return rate between two types of crypto-currencies namely Bitcoin and Ethereum.

4.1 Bitcoin data analysis

This study collected the daily crypto-currency price from *https://coinmarketcap.com*.The collected data is started from 1st January 2017 until 31st October 2018. Next, the daily prices are transferred to monthly data using averaging method. Figure 1 shows dynamic data behavior of Bitcoin price. The starting value of first month observation is USD 915 for each Bitcoin. Then, the maximum value of Bitcoin price is on December 2017 with value of USD 15294 for each Bitcoin. Finally, the value of Bitcoin price attained at USD 6485 for the last observation (October 2018).

Next, this study calculated the rate of return for Bitcoin price. Figure 2 shows Bitcoin return distributions. The maximum value of Bitcoin return is 95.75 % in December 2017. Meanwhile, the minimum value of Bitcoin return is -27.62 % in February 2018. The value of Bitcoin return in second month observation (February 2017) is 16.13 %. The value of Bitcoin return on the last observation (October 2018) is -1.90 %.

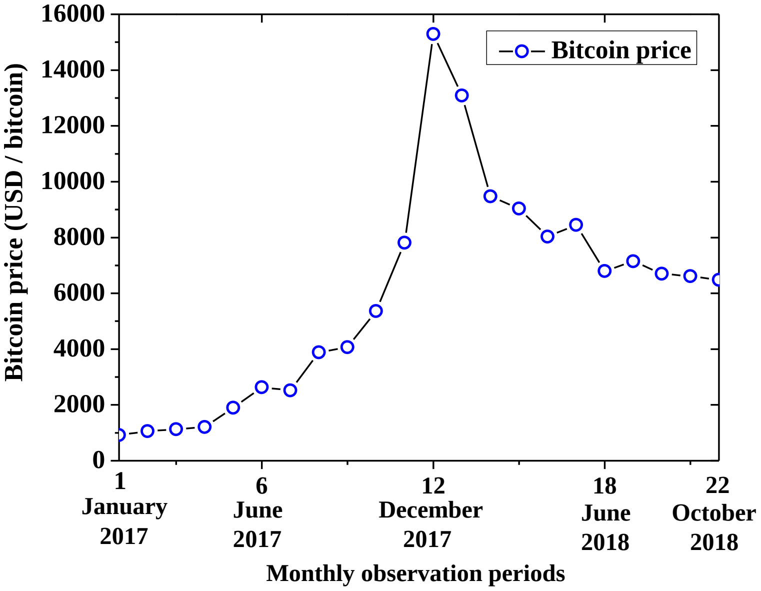

Figure 1: Dynamic data behavior of Bitcoin price

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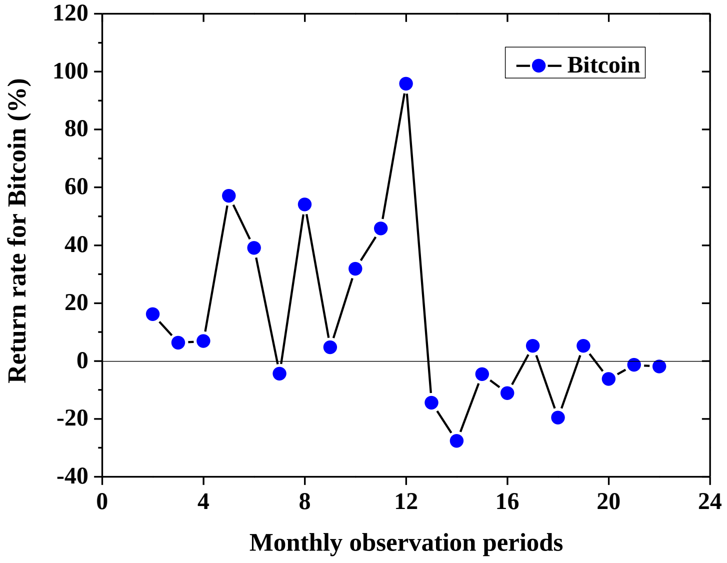

Figure 2: Bitcoin return distributions

Then, this study evaluated the normal data distribution for Bitcoin return. Figure 3 shows normal probability plot for Bitcoin return. Figure 3 indicates the average Bitcoin return is 13.18% and the standard deviation is 30.27%. Data for Bitcoin return are distributed near the normal reference line. However, there is one data point that deviated from normal reference line. Therefore, this indicates the distribution of Bitcoin return is not follow normal distribution.

Next, this study implemented numerical statistical approach for evaluating normal distribution of Bitcoin return. Table 1 shows the Shapiro-Wilk normality statistical test for Bitcoin return. The significant value of Bitcoin return data distribution is 0.023. The p-value of Bitcoin return is less than 0.05. Therefore, the data distribution of Bitcoin return follows non-normal distribution. Figure 3 show Box-Whisker plot for Bitcoin return. Figure 3 shows there is one data point (12^{th} month observation, December 2017) is outliers that contributed to non-normal distribution.

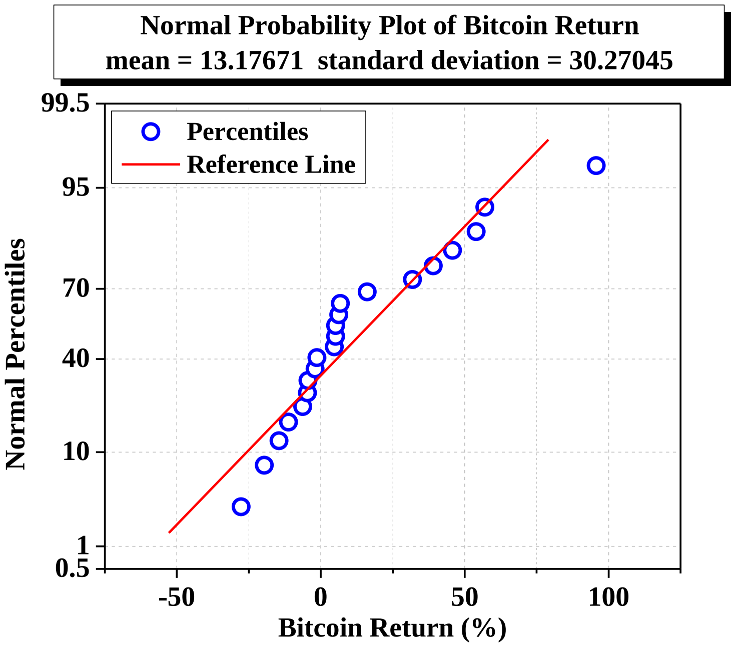

Figure 3: Normal probability plot for Bitcoin return

DOI: 10.31695/IJASRE.2018.32997

Table 1: Statistical normality test for Bitcoin return

Shapiro-Wilk normality test		
W-Statistics	Degree of freedom	Significant
0.891	21	0.023

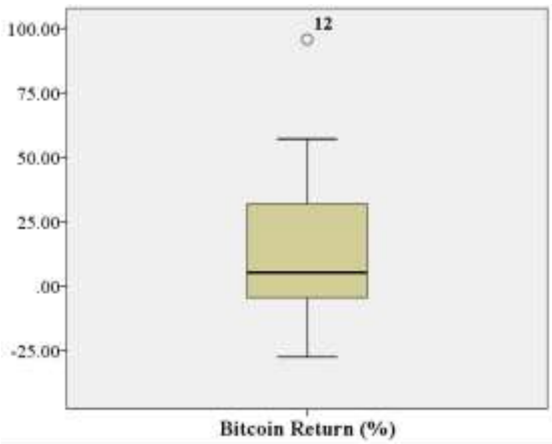

Figure 3: Box-Whisker plot for Bitcoin return

4.2 Ethereum data analysis

This study collected the daily crypto-currency price from *https://coinmarketcap.com*.The collected data is started from 1st January 2017 until 31st October 2018. Next, the daily prices are transferred to monthly data using averaging method. Figure 4 shows dynamic data behavior of Ethereum price. The starting value of first month observation is USD 10 for each Ethereum. Then, the maximum value of Ethereum price is on January 2018 with value of USD 1104 for each Ether. Finally, the value of Ethereum price attained at USD 210 for the last observation (October 2018).

Next, this study calculated the rate of return for Ethereum price. Figure 5 shows Ethereum return distributions. The maximum value of Ethereum return is 181.23 % in March 2017. Meanwhile, the minimum value of Bitcoin return is -30.49 % in August 2018. The value of Ethereum return in second month observation (February 2017) is 21.27 %. The value of Ethereum return on the last observation (October 2018) is -7.69 %.

Then, this study evaluated the normal data distribution for Ethereum return. Figure 6 shows normal probability plot for Ethereum return. Figure 6 indicates the average Ethereum return is 27.85 % and the standard deviation is 64.24 %. There are data points for Ethereum returns are deviated from the normal reference line. Therefore, this indicates the distribution of Ethereum return is follow non- normal distribution.

Next, this study implemented numerical statistical approach for evaluating normal distribution of Ethereum return. Table 2 shows the Shapiro-Wilk normality statistical test for Ethereum return. The significant value of Ethereum return data is 0.002. The p-value of Ethereum return is less than 0.05. Therefore, the data distribution of Ethereum return follows non-normal distribution. Then, this study develop box-whisker plot to detect outliers in the data distribution. Figure 7 shows Box-Whisker plot for Ethereum return data. The non-normal distribution is contributed by three outliers that exist in Ethereum return data.

DOI: 10.31695/IJASRE.2018.32997

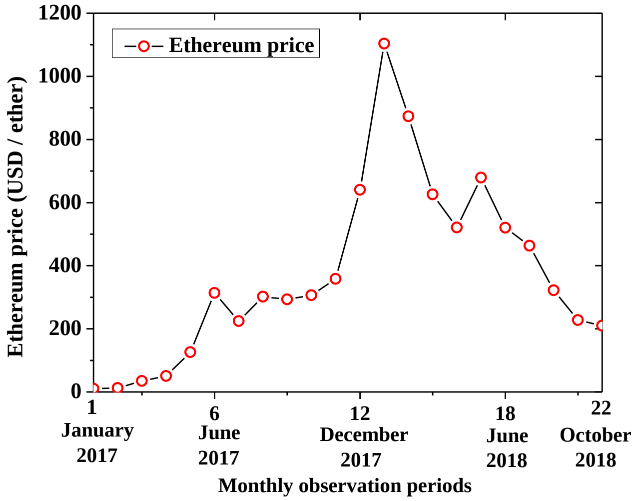

Figure 4: Dynamic data behavior of Ethereum price

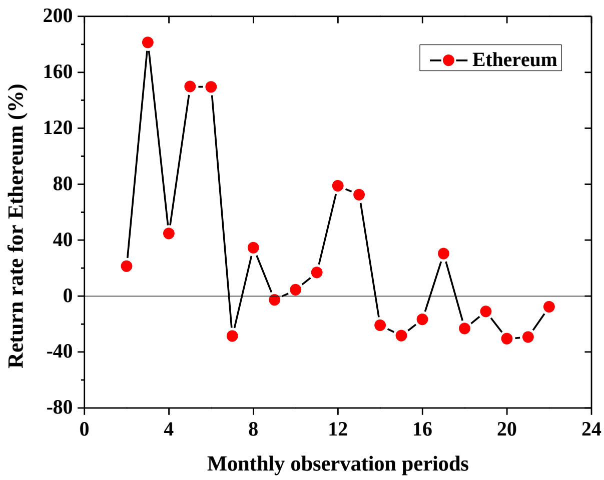

Figure 5: Ethereum return distributions

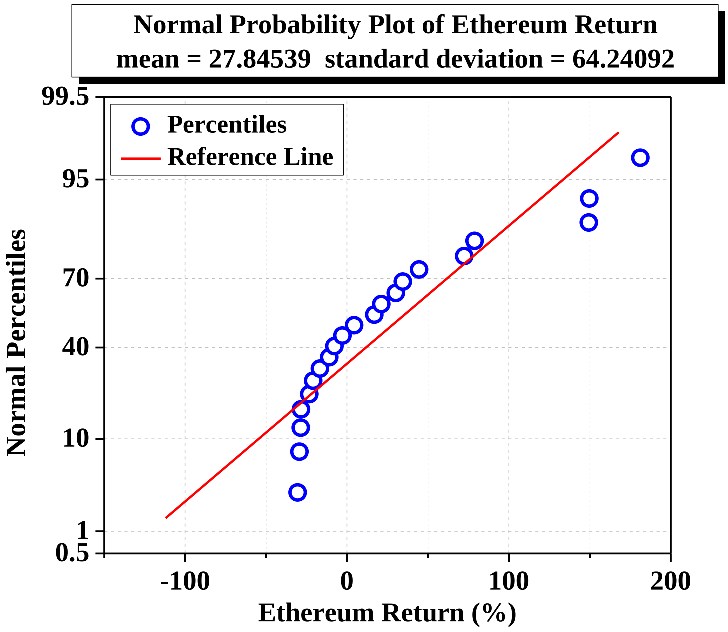

Figure 6: Normal probability plot for Ethereum return

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Table 2: Statistical normality test for Ethereum return

Shapiro Wilk normality test		
W-Statistics	Degree of freedom	Significant
0.823	21	0.002

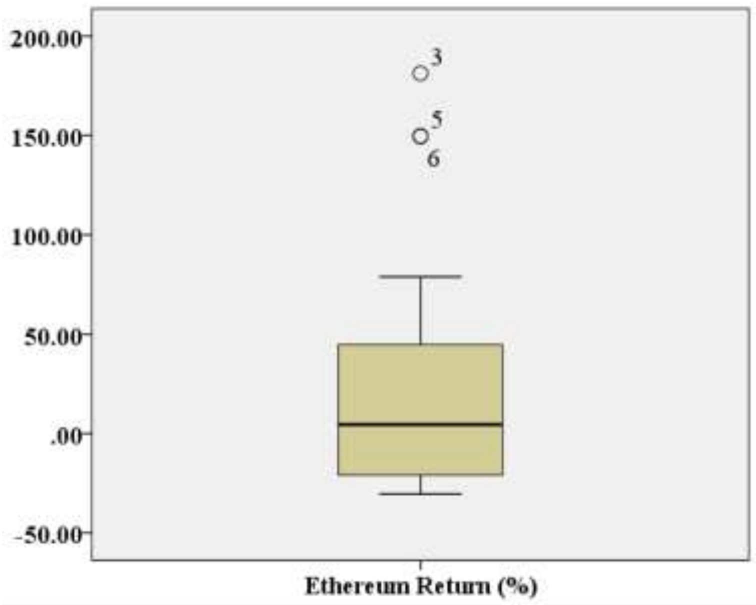

Figure 7: Box-Whisker plot for Ethereum return

4.3 Correlation data analysis

This section describes Pearson correlation analysis using graphical and numerical statistical approach. Figure 7 shows correlation plot between Bitcoin return and Ethereum return. The linear relationship between these two variables is represented by Equation (1).

$$(Ethereum\ return) = 1.068(Bitcoin\ return) + 13.77 \quad \ldots\ldots\ldots\ldots (1)$$

Equation (1) indicates for 1.068 % increment in Bitcoin return, it will contribute to 1% increment in Ethereum return.

Next, this study evaluated the Pearson correlation between Bitcoin and Ethereum return. Table 3 shows the statistical analysis for correlation between Bitcoin and Ethereum return. Table 3 indicates the correlation coefficient is 0.503 that concludes there is strong positive correlation between Bitcoin and Ethreum return. Table 3 shows the significant value is 0.02 less than 0.05. Therefore, this study rejected null hypothesis of Pearson correlation statistical test. As conclusion, there is significant relationship between Bitcoin and Ethereum return data with strong positive correlation (r = 0.503, n = 21, p =0.02).

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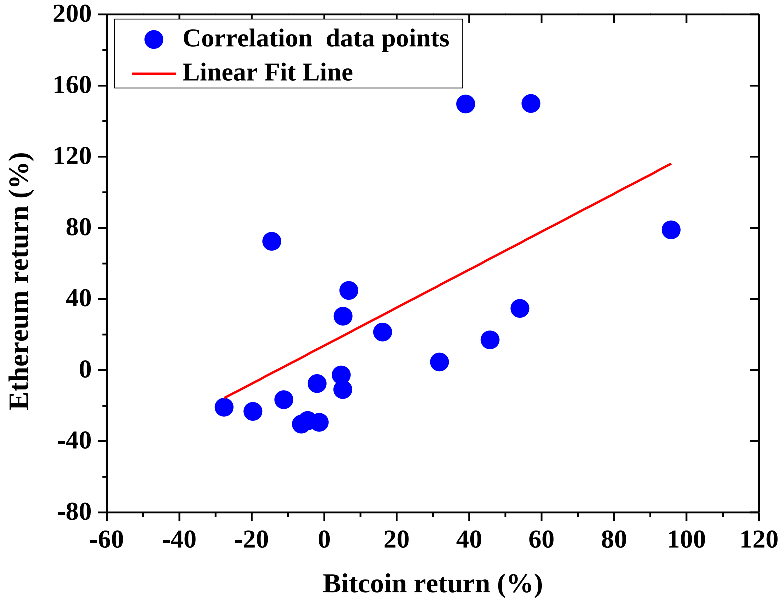

Figure 7: Correlation plot for Bitcoin and Ethereum return

Table 3: Statistical analysis for correlation between Bitcoin and Ethereum return

Pearson product moment correlation analysis	
Pearson correlation	0.503
Significant (2-tailed)	0.020
Number of data	21

4. CONCLUSION

The main objective of this study is to develop correlation test between Bitcoin and Ethereum return. This study collected daily data from 1st January 2017 until 31st October 2018. The main findings of this study are:

(a) The maximum value of Bitcoin return is 95.75 % in December 2017. Meanwhile, the minimum value of Bitcoin return is -27.62 % in February 2018. The significant value of Shapiro Wilk normality test for Bitcoin return data distribution is 0.023. The p-value of Bitcoin return is less than 0.05. Therefore, the data distribution of Bitcoin return follows non-normal distribution

(b) The maximum value of Ethereum return is 181.23 % in March 2017. Meanwhile, the minimum value of Bitcoin return is -30.49 % in August 2018. Next, this study performed Shapiro Wilk normality test. The significant value of Ethereum return data is 0.002. The p-value of Ethereum return is less than 0.05. Therefore, the data distribution of Ethereum return follows non-normal distribution.

(c) Then, this study evaluated the Pearson correlation between Bitcoin and Ethereum return. The correlation coefficient is 0.503 that concludes there is strong positive correlation between Bitcoin and Ethreum return. In addition, the significant value is 0.020. Therefore, this study rejected null hypothesis of Pearson correlation statistical test. As conclusion, there is significant relationship between Bitcoin and Ethereum return data with strong positive correlation (r = 0.503, n = 21, p =0.020).

REFERENCES

[1] A. I. Ivashchenko, "Using Cryptocurrency in the Activities of Ukrainian Small and Medium Enterprises in order to Improve their Investment Attractiveness." *Problems of Economy*, 2016, Issue 3, pp. 267-273.G. C. Dumitrescu, "Bitcoin – A Brief Analysis of the Advantages and Disadvantages." *Global Economic Observer; Bucharest*, 2017, vol. 5 (2), pp. 63-71.

[2] A. S. M. Irwin and A. B. Turner, "Illicit Bitcoin Transactions: Challenges in Getting to the Who, What, When and Where." *Journal of Money Laundering Control*, 2018, vol. 21 (3), pp. 297-313.

DOI: 10.31695/IJASRE.2018.32997

[3] A. Christoforou, “Understanding the Difference between Ethereum and Bitcoin.” available at: http://theduran.com/understanding-thedifference-between-ethereum-and-bitcoin/, 2017.

[4] C. Law and M. Vahlqvist, “Can Bitcoin be Used as a Hedge Against the Swedish Market?.” 2018, Available at: https://su.diva-portal.org/smash/get/diva2:1183765/FULLTEXT01.pdf (access: 28 November 2018)

[5] C. Graydon, “What is Cryptocurrency?” *CryptoCoin News*, 16 September 2014, available at: www.cryptocoinsnews.com/cryptocurrency/ (accessed 28 November 2018).

[6] C. Richter, S. Kraus and R.B. Bouncken, “Virtual Currencies Like Bitcoin as a Paradigm Shift in the Field of Transactions.” *International Business & Economics Research Journal*, 2015, Vol. 14 (4), pp. 575-586.

[7] F. Reid and M. Harrigan, "An Analysis of Anonymity in the Bitcoin system." *International Conference on Social Computing*, 2011, pp. 1318-1326.

[8] G. C. Dumitrescu, “Bitcoin – A Brief Analysis of the Advantages and Disadvantages.” *Global Economic Observer; Bucharest*, 2017, vol. 5 (2), pp. 63-71.

[9] H. Sankaran, A. Nguyen and J. Harikumar, "Extreme Return Correlation and Volatility: A Two-threshold Approach." *American Journal of Business*, 2012, vol. 27 (2), pp. 154-173.

[10] M. Brandvold and P. Molnár, K. Vagstad and O. C. A. Valstad, “Price discovery on Bitcoin exchanges.” *Journal of International Financial Markets, Institutions & Money*, 2015, vol. 36, pp. 18–35.

[11] N. Abu Bakar, and S. Rosbi, “High Volatility Detection Method Using Statistical Process Control for Cryptocurrency Exchange Rate: A Case Study of Bitcoin.” *The International Journal of Engineering and Science*, 2017, vol. 6 (11), pp. 39-48.

[12] N. Abu Bakar and S. Rosbi, “Robust Outliers Detection Method For Ethereum Exchange Rate: A Statistical Approach Using High Frequency Data.” *The International Journal of Engineering and Science*, 2018, vol. 7 (4), pp. 1-8.

[13] N. Abu Bakar and S. Rosbi, “Robust Framework Diagnostics of Blockchain for Bitcoin Transaction System: A Technical Analysis from Islamic Financial Technology (i-FinTech) Perspective.” *International Journal of Business and Management*, vol. 2 (3), pp. 22-29.

[14] N. Abu Bakar, and S. Rosbi, “Statistical Non-parametric Correlation Diagnostic for Dynamic Behavior of Malaysian Currency with World Crude Oil Price.” *International Journal of Economics, Commerce and Management* 2017, vol. V (5), pp. 1-13.

[15] N. Abu Bakar and S. Rosbi, “Robust Pearson Correlation Analysis of Volatility for the Islamic Bank in Malaysia: An Arithmetic Approach in Islamic Financial Engineering.” *International Journal of Economics, Commerce and Management*, 2017, vol. V (3), pp. 1-15.

[16] N. Abu Bakar, S. Rosbi, S. and K. Uzaki, “Cryptocurrency Framework Diagnostics from Islamic Finance Perspective: A New Insight of Bitcoin System Transaction.” *International Journal of Management Science and Business Administration*, 2017, vol. 4 (1), pp. 19-28.

[17] R. V. Wegberg, J. J. Oerlemans and O.V. Deventer, "Bitcoin Money Laundering: Mixed Results?: An explorative study on money laundering of cybercrime proceeds using bitcoin." Journal of Financial Crime, 2018, vol. 25 (2), pp. 419-435.

[18] R. Browne, “Cryptocurrencies ‘Could Drop to Near-zero at any Time,’ Ethereum Founder Warns.” 2018, Retrieved from: https://www.cnbc.com/2018/02/19/ethereum-creator-vitalik-buterin-warns-about-cryptocurrency-investment.html (accessed 25 March 2018)

[19] S. Nakamoto, "Bitcoin: A Peer-to-peer Electronic Cash System." 2009. Retrieved from http://www.bitcoin.org /bitcoin.pdf.

[20] T. Moore and N. Christin, “Beware the Middleman: Empirical Analysis of Bitcoin-exchange Risk.” *International Conference on Financial Cryptography and Data Security*, April 2013, pp. 25-33. Springer, Berlin, Heidelberg.

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