

# The Impact Of Exchange Rates On Bitcoin Returns: Further Evidence From A Time Series Framework

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**Abstract:** Cryptocurrencies have received immense consideration in media and academia since the beginning of 2013 because of its huge prices' fluctuation. This study examined the effect of exchange rates (USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY) on bitcoins returns covering the period from 2014 to 2019 via ARMA model using Maximum Likelihood Type of Estimation. The results indicated that the Bitcoin returns is not significantly affected from the values in foreign currencies (USD/ JPY, USD/ EUR, USD/ GBP, and USD/ AUD) when confidence is measured at 95 percent level. However, the GBP is found to be significant when significance is measured at 90 percent level. That might be partially due to the common factors that affect both USD/ GBP and Bitcoin returns simultaneously in recent times. Interested parties may focus on investigating the effect of exchange rates on cryptocurrencies by taking several digital currencies not only bitcoin.

**Index Terms:** Cryptocurrencies, Bitcoin, Exchange Rates, ARMA

## 1 INTRODUCTION

The concept of cryptocurrencies has been widely recognized in last few years. These are digital currencies that make use of encryption for verification of a transaction. Bitcoin is a digital currency which was based on public key cryptography [1]–[3]. This cryptography was explained by a group of unidentified programmers called Satoshi Nakamoto. Initially the bitcoin's introduction in the paper by Nakamoto, the release of digital wallet took place in a matter of few months and hence did not gain much attention from researchers. Once it gained momentum, it attracted considered amount of interest from regulators, mainstream media, as well as acceleration in public and financial markets to the extent of calling "IPO moment" to that particular period (Forbes.com, 2018). Cryptocurrencies has received immense consideration in media and academia since the beginning of 2013 because of its huge prices' fluctuation. While there are a number of other cryptocurrencies, the Bitcoin happens to have gained the most popularity. Bitcoin became completely functional in January 2009. The easy adoption has been due to the availability of conversion with conventional currencies by the exchange markets. The Bitcoin price has increased from 0.07\$ US in 2009 to 20089\$ US in 2017. From 2017 onwards, there was a lot of focus on Bitcoin by the public funds, hedge funds and institutional money. The introduction of derivatives of Bitcoin led to the culmination of success of Bitcoins [3]. Despite the many indications of Bitcoin being used as currency, it has been suggested by some of the researchers such as [4] that the properties of Bitcoin are similar to a speculative investment whereby the price fluctuates relentlessly with a lot of uncertainty.

The rise and culmination of Bitcoin represents an extremely volatile financial phenomenon and to understand this volatility, it is important to understand how the Bitcoin system works and the factors that affect the pricing of this currency [4]. There has been an increase in research studies related to cryptocurrencies. Studies such as that of [1]–[3] have focused on bitcoin models with respect to factors such as publicity, technology and economics. However, the data fluctuations and the issues underlying bitcoin system have hardly been studied. Currently, more than 40 exchanges for bitcoin are functioning where traditional currencies are exchanged for bitcoins at different quotes. Over the last couple of years, it is observed that the number of investors has been increased significantly. There are a number of arguments with regards to the type of investors who dominate the bitcoin market such as liberalists in search of national currency alternatives, technology enthusiasts or criminals who can take advantage of anonymity of transaction [4]. The extreme fluctuation in prices of bitcoin between the years 2013 and 2014 can be seen displayed in Figure 1. Some interesting facts can also be discovered by putting a glance. In the April of 2013, the value of bitcoin dropped by 160 USD within a matter of one day, However the value of bitcoin had increased from USD 20 to USD 265 in just two months right before this day [3].

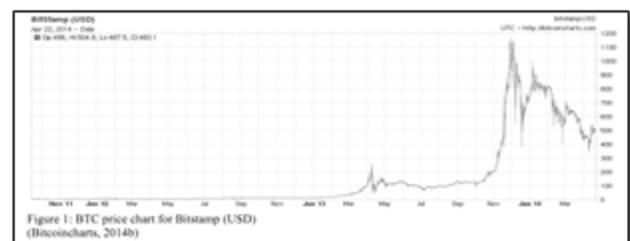


Fig. 1: Fluctuation in Prices of Bitcoin

The bitcoin market was faced with more problems in 2014 when one of the largest platform for bitcoin trading was hacked and later got bankrupt which led to a loss of 6 percent of bitcoin supply; leading many to raise questions on bitcoin's legitimacy (Forbes.com, 2018). The trade for bitcoin takes

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place across different currencies on numerous exchanges across the world. Some exchanges deal with bitcoin only while some deal with other digital currencies. The principal currency used for trading bitcoin is USD and the three largest exchanges i.e. BTC-e, Bitfinex and Bitstamp also allow trade of Bitcoin in USD. According to [5] who stated that the turbulence in financial markets is what led most investors to search for new opportunities for investment and the lack of correlation between bitcoin and other assets is what makes bitcoin an attractive market for investors. Therefore, there is a development in this market where more bitcoin is gaining more attention from institutional investors. The market for bitcoin is still emerging and there has been debate with regards to the unique characteristics of bitcoin market. There are governments and institutions doing heavy discussions on this currency and hence researchers have been inclined to investigate the particulars of this market. The purpose of this research is aimed at exploring the influence of several exchange rates on bitcoin returns, which that gives a better understanding of the linkage between these exchange rates and bitcoin returns. Furthermore, the aim of this research is to investigate the impact of exchange rates on bitcoin returns. The finding of this study will be benefiting investors in understanding the dynamics of bitcoin pricing in order to make such investment decisions in cryptocurrencies market.

## 2 LITERATURE REVIEW

Demand for investment alternatives and investor acceptance combined with creation of supply of new instruments by the market actors determines the success of such developments. The recent creation of virtual currencies is an example of such developments and these virtual currencies are now being used for exchanges all across the world [6]. Some virtual currencies operate within the virtual communities only while other currencies tend to have a wider reach as well as two-way exchange flow with the traditional currencies. There is a subset of digital currencies within the wider category of virtual currencies [5]. The digital currencies function without a counterparty's control and their use is wider within the general system of economy [2]. According to [7] declared that the bitcoin was the first digital currency of its kind and maintained its integrity through cryptography and peer-peer networking. The Bitcoin was introduced by its creator in an attempt to drift away from the models of traditional currencies based on trust and in fact create a system which was secure owing to cryptographic verification [8]. It has been suggested by [4] that the properties of bitcoin resemble speculative investments. There is a high fluctuation in price and other uncertainties in investing bitcoins, this is indicating the high volatility of bitcoin returns. If bitcoin still manages to surface as a feasible currency, it holds the potential of serving as a stage for financial innovation in future (The Economist, 2014). It is argued that the value of bitcoin is not determined by fundamentals of macroeconomics such as GDP, inflation or interest rate. It is not attached against any other currency either. The exchange rate of bitcoin is instead based completely on the basis of demand and supply. Understanding the microstructure of bitcoin market is of utter importance owing to these factors; if the price formation of bitcoin market is to be comprehended [7], [9]. [10] Argued that the volatility of bitcoin price is considerably larger compared to bonds, stocks, commodities and other currencies. Additionally, the lack of regulation and fundamental value suggest varying

characteristics as compared to traditional assets. He declared that that the correlation between bitcoin prices and other assets is extremely low. In other words, there is no relationship between bitcoin prices and other assets in the financial markets. The information for bitcoins can be collected by the investors from a number of sources. There is ample presence of unacquainted noise traders in bitcoin markets which implies erroneous possibility assessment which can also explain the excessive volatility in bitcoin prices. The market liquidity also increases due to the noise traders' presence in market. This liquidity can offer the explanation for a speedy hike in volume of bitcoin trading since the introduction of this currency to the market [11]. The exchange risk is therefore significant for bitcoin investors. It has also been suggested by evidence that bitcoin prices have experienced further volatility when there is a criminal activity has affected an exchange. Hence, there is a connection between exchange risk, lack of liquidity and consequential price volatility. Through the course of exchange risk, the theoretical argument pertaining to market microstructure holds value which suggested that a low liquidity leads to increase in volatility of price [12]. It has been found by [13] that gold return's volatility reacts opposite to negative shocks which means the increase in uncertainty also increases the gold prices volatility. However there has been no evidence found for an asymmetric instability of the bitcoins' prices in the cryptocurrencies market. [14] Investigated the effect of macroeconomic factors on bitcoin return. The macroeconomic variables employed were stock exchange indices, exchange rates, and oil prices. The results indicated that macroeconomic factors play important role in determining the value of bitcoin. Furthermore, he found that bitcoin prices are predicted by stock exchange indices, exchange rates, and oil prices. [15] Studied the relationship between macro financial indicators and bitcoin prices. Based on the results, a negative association between macro financial indicators and returns on bitcoin. A decrease in stock prices influences shareholders to sell their assets in the financial market. This will necessarily lead to rapid decline in the current currency, but may increase bitcoin price incase investors directed their money to buy it. In all cases, stock exchange indices have a positive relationship with bitcoin price. In other words, in the world of money, investors always search for new opportunity to increase their wealth, so they actually pull their money out of stock market and get attracted to the new promising investment in this will cause a negative impact on other sectors. Based on the related literature, there is no studies have been investigated on the relationship between exchange rates currencies and bitcoin returns as a time series analysis. According to [11] who recommended to investigate the effect of exchange rates on bitcoin prices as they documented that the exchange rate can reflect the development of inflation and therefore have a positive effect on the price of bitcoin.

## 3 RESEARCH METHODOLOGY

### 3.1 Data Sources

In this study, the database consists of monthly bitcoins returns which were collected from yahoo finance website. This study examined the effect of exchange rates on bitcoins returns covering the period from 2014 to 2019. The exchange rates data are also gathered in daily basis from the website of the International Monetary Funds.

### 3.2 The Research Design

The purpose of this study is to analyze the effect of exchange rates for pairs of currencies on bitcoin return. The dependent variable in this research is the bitcoin returns, the performance of bitcoin can be measured by calculating return using the historical data which that gives a better understanding to investors to forecast the future prices movement of bitcoin in the market [16], [17]. The independent variables in this study are the exchange rates namely are USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY. The selected exchange rates have been governed by the time series covering the period from 2014 to 2019. The dependent variable is Bitcoin returns. Hence, the research formwork is as constructed follows:

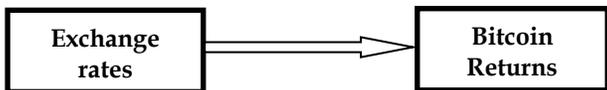


Fig. 2: Research Framework

### 3.3 The Model

This paper is aimed at investigating the influence of exchange rates for pairs of currencies on bitcoin's returns. In order to explore this effects, two econometric models are employed, the first model is ARMA which is aimed to investigate the impact of exchange rates for pairs of currencies on bitcoin returns. The general ARMA equation is estimated using Maximum Likelihood as follows:

$$BITR_t = \beta_0 + \beta_1 EXCHG + \beta_2 EXCHG(-1) + BITR_t(-1) + \varepsilon_t \quad (1)$$

Where,

BITR:	Bitcoin Return
EXCHG:	Exchange Rates
e :	Error
B0	Constant

The second model is Granger Causality, This approach is based on analysis of multiple regression. The Granger Causality Analysis (GCA) is a tool to examine whether one time series can predict another correctly [18]. This model is intended to test the bidirectional relation between individual exchange rate and the returns of bitcoin.

$$Y_t = \sum_{n=1}^p A_n X_{(t-p)} + \sum_{n=1}^p B_n Y_{(t-p)} + CZ_t + E_t \quad (2a)$$

$$X_t = \sum_{n=1}^p A'_n Y'_{(t-p)} + \sum_{n=1}^p B'_n X'_{(t-p)} + C'Z_t + E'_t \quad (2b)$$

So as to utilize the statistical tools for time series data, investigating the spurious regression is necessary when that the data is stationary. The Augmented Dickey-Fuller analysis ought to be employed to investigate time series data based on unit roots test. If the results of the Augmented Dickey-Fuller test indicate that any of the variables is non-stationary, the first difference should be taken before employing the ARMA model as well as the Granger Causality Test. Moreover, if the findings of unit roots test for the first difference show that the data is non-stationary, then the second difference of the variables must be taken into account before conducting the ARMA model as well as the Granger Causality Test. This can be expressed as follows:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^p \alpha_j \Delta Y_{t-j} + \beta t + \omega_t \quad (3a)$$

Where,

$\mu$ :	The drift term
$t$ :	The time trend
$p$ :	The largest lag length used

According to [15] who adapted the version of the likelihood ratio which recommended the following regression model which is as follows:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^p \alpha_j \Delta Y_{t-j} + \beta t + \omega_t \quad (3b)$$

$$\hat{\tau}_\beta, H_0: \gamma = 0, H_a: \gamma < 0; \varphi_3, H_0: \gamma = 0, \beta = 0, H_a: \gamma \neq 0, \text{ and/or } \beta \neq 0$$

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^p \alpha_j \Delta Y_{t-j} + \omega_t \quad (3c)$$

$$\hat{\tau}_\mu, H_0: \gamma = 0, H_a: \gamma < 0; \varphi_1, H_0: \mu = 0, \gamma = 0, \beta = 0, H_a: \mu \neq 0, \text{ and/or } \gamma \neq 0$$

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{j=1}^p \alpha_j \Delta Y_{t-j} + \beta t + \omega_t \quad (3d)$$

$$\tau, H_0: \gamma = 0, H_a: \gamma < 0$$

## 4 EMPIRICAL RESULTS

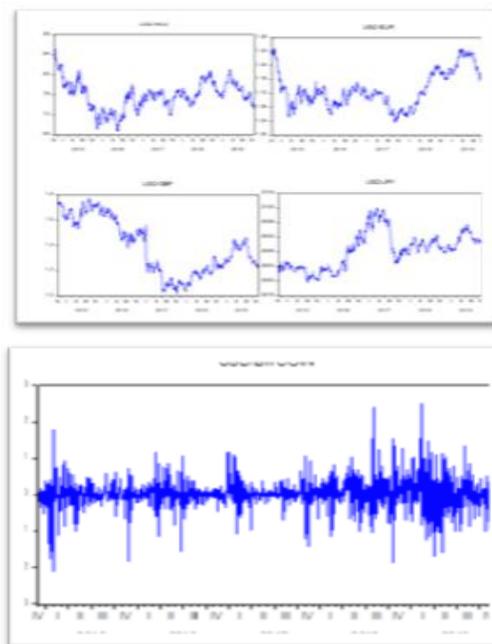


Fig. 2. Graphical Line of Variables

The evaluation of Bitcoin, USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY are reflected in figure 2 between the years 2014 and 2019. It is observed that the return of Bitcoin series has an increasing trend which that lead to a high volatility. In general, the figures above showed that the trend of all variables has monotonically displayed decreasing or increasing sing over the period 2014 to 2019. The basic descriptive statistics for all variables are illustrated in Table 1.

**Table 1: Descriptive Statistics for Dependent and Independent Variables**

	AUD	EUR	GBP	JPY	BITCOIN
Mean	0.758184	1.131561	1.393173	0.008846	0.003025
Median	0.759821	1.121152	1.386741	0.008873	0.002402
Maximum	0.851499	1.249645	1.588360	0.010014	0.252472
Minimum	0.685895	1.036914	1.205298	0.007960	-0.211449
Std. Dev.	0.028252	0.051596	0.109718	0.000489	0.040389
Skewness	0.036181	0.520402	0.132949	0.244859	0.014639
Kurtosis	3.060601	2.427525	1.672123	2.322888	8.626441
Jarque-Bera	0.483676	76.60550	99.56867	37.91206	1718.749
Probability	0.785183	0.000000	0.000000	0.000000	0.000000
Sum	987.9133	1474.424	1815.305	11.52640	3.940983
Sum Sq. Dev.	1.039211	3.466127	15.67340	0.000312	2.123924
Observations	1301	1301	1301	1301	1301

The findings of descriptive statistics for all employed variables are shown in Table 1. It can be observed that the average return of Bitcoin records a value of 0.003025 with a standard deviation value of 0.040389. The Bitcoin returns range between a maximum value of 0.252472 and a minimum value of -0.211449. The maximum values of the USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY are 0.851499, 1.249645, 1.588360 and 0.010014 respectively. Moreover, the minimum values of the USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY are 0.685895, 1.036914, 1.205298 and 0.007960 respectively. The financial time series data is employed in this research. Therefore, it is important to investigate whether unit root exists in the data series or not as non-stationary variables can cause the problem of spurious regression among unconnected variables [16]. The results of ADF is shown in Table 2.

**Table 2: Result of ADF**

P- Value	Results
0.0053 < 0.05	USD/ AUD is stationary
0.1260 > 0.05	USD/ EUR is not stationary
0.4682 > 0.05	USD/ GBP is not stationary
0.3839 > 0.05	USD/ JPY is not stationary
0.0000 < 0.05	Bitcoin Return is stationary

The unit roots results illustrated in Table 2 indicate that the p-values for USD/ EUR, USD/ GBP and USD/ JPY are higher than the significant level of 5 percent. In conclusion, the results indicate that the null hypothesis are accepted. That said, the USD/ EUR, USD/ GBP and USD/ JPY are not stationary. As mentioned earlier, the first difference of these variables are taken into account before conducting the ARMA model. Moreover, the findings show that the remaining two variables, namely, USD/ AUD and Bitcoin returns are stationary variables because their p-values are less than 5 percent. The ADF test result at first difference is shown in Table 3.

**Table 3: Result of ADF at First Difference**

P- Value	Results
0.0000 > 0.05	USD/ EUR is stationary
0.0000 > 0.05	USD/ GBP is stationary
0.0000 > 0.05	USD/ JPY is stationary

The findings of the unit's roots at first difference are shown in Table 3. They indicate that the variables are stationary after taking the first difference into account which record a p-value less than 5 percent significant level [19]–[21]. Therefore, the ARMA equation is estimated using Maximum Likelihood. The results of estimated ARMA equation are illustrated in Table 4.

**Table 4: The Effect of Exchange Rates on Bitcoin Returns**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.097831	0.052247	1.872478	0.0614
D(JPY)	-3.076362	4.302520	-0.715014	0.4747
D(EUR)	0.022102	0.033200	0.665735	0.5057
D(GBP)	-0.026300	0.015553	-1.690985	0.0911
AUD	-0.073824	0.053125	-1.389621	0.1645
AR(1)	0.452321	0.007973	56.73083	0.0000
AR(2)	0.242831	0.007275	33.37731	0.0000
AR(3)	0.463542	0.006537	70.90981	0.0000
AR(4)	-0.983034	0.008422	-116.7258	0.0000
MA(1)	-0.457822	0.063339	-7.228163	0.0000
MA(2)	-0.257928	0.012526	-20.59188	0.0000
MA(3)	-0.451721	0.030848	-14.64357	0.0000
MA(4)	0.996111	0.073425	13.56642	0.0000
SIGMASQ	0.001589	0.000118	13.50566	0.0000
R-squared	0.025239	Mean dependent var		0.003025
Adjusted R-squared	0.015408	S.D. dependent var		0.040385
F-statistic	2.567349	Durbin-Watson stat		1.996911
Prob(F-statistic)	0.001651			

The results show that the overall model is appropriate because of an acceptable F-statistics which records a value of (2.567349) with a significant probability value of 0.001651. The findings also indicated that the R<sup>2</sup> is 0.025239, which indicated that the bitcoin returns can be estimated at 2.5 percent using the selected exchange rates namely USD/ EUR, USD/ GBP and USD/ JPY. The effect of exchange rates on bitcoin returns can be seen in table 4. It is tested for ARMA model using Maximum Likelihood Type of Estimation. The best model is the ARMA (4,4) model where both the Bitcoin returns, and the error terms are significant up to 4 lags. The results indicated that the Bitcoin returns is not significantly affected from the values in foreign currencies (JPY, EUR, GBP, and AUD) when confidence is measured at 95 percent level. However, the GBP is found to be significant when significance is measured at 90 percent level. That might be partially due the common factors that affect both GBP and Bitcoin returns simultaneously in recent times. During the Brexit procedure, the risk factors might have caused some investors to leave GBP and invest in Bitcoin. Moreover, the results indicated that there is negative relationships between JPY, GBP, and AUD with Bitcoin returns which records coefficient negative values of -3.076362, -0.026300 and -0.073824 respectively. Moreover, a positive relationship was observed between EUR and Bitcoin returns which records coefficient positive value of 0.022102.

**5 CONCLUSION AND RECOMMENDATIONS**

The “Market Microstructure Theory” provides a theoretical foundation for developing an understanding of price formation within financial markets. It tends to understand the emergence of new transactions that affect volumes and price as a result of dormant investor demand. The trading mechanisms within a market are also considered as a vital facet of the process for price formation [22]. This study has explored the association between exchange rates for pairs of currencies and Bitcoin's returns. The Bitcoin was introduced in 2009 and since then the market of the Bitcoin is increasing rapidly but the associated risk with the currency is impacting its liquidity with respect to the stocks issued by the companies. The results showed a

positive relationship between USD/EUR and Bitcoin returns but not significant. This is an indication that when EUR value increased, the bitcoin returns would be increased and vice versa. Moreover, negative relationships between USD/JPY, USD/GBP, and USD/AUD and Bitcoin returns were found. That means if the value of JPY, GBP and AUD depreciated, the Bitcoin prices would be appreciated. This study also attempts to examine the effect of exchange rates on bitcoin returns, the results showed that the Bitcoin returns is not significantly affected from the values in foreign currencies namely USD/JPY and USD/AUD. This indicated that the changes in foreign currencies is not significantly affect Bitcoin returns. In other words, the value of bitcoin is not determined by the changes of foreign currencies. However, the GBP is found to be significant when significance is measured at 90 percent level. That might be partially due the common factors that affect both GBP and Bitcoin returns simultaneously in recent times. In this context, interested parties may focus on the relationship between exchange rates and cryptocurrencies by taking several digital currencies. Moreover, future studies may concentrate on the volatility of cryptocurrencies as well as on exploring the association between global financial markets indices and cryptocurrencies. Moreover, researchers may focus on cryptocurrency market from the perspective of behavior finance [23].

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