



Cite this article: Esteria. G. 2024. "Analysis of the Effect of Exchange Rate Fluctuations on Bitcoin Returns: a Time Series Approach in a Digital Finance Perspective." International Journal of Distance Learning and Science Innovation 1(1):22–29.

Article History

Received: May-2024
Published: August 2024

Author for correspondence:
Gloria Esteria
e-mail: hallo@jasonleonard117.com

ANALYSIS OF THE EFFECT OF EXCHANGE RATE FLUCTUATIONS ON BITCOIN RETURNS: A TIME SERIES APPROACH IN A DIGITAL FINANCE PERSPECTIVE

Gloria Esteria

DePaul University, Chicago, United States

Abstract: Cryptocurrencies, including Bitcoin, have been the subject of great attention in the media and academia due to their large price fluctuations. This research aims to analyze the influence of exchange rate fluctuations (USD/AUD, USD/EUR, USD/GBP, and USD/JPY) on Bitcoin returns in the period 2014 to 2019 using a time series approach. We apply the ARMA model and the Maximum Likelihood Estimation method to analyze the data. The results show that exchange rate fluctuations do not have a significant effect on Bitcoin returns when trust is measured at the 95 percent level. However, when significance is measured at the 90 percent level, GBP is found to significantly influence Bitcoin returns. This may be due to common factors influencing the returns of USD/GBP and Bitcoin together in recent times. Future studies may consider investigating the influence of exchange rate fluctuations on other cryptocurrencies, besides Bitcoin, to gain a more comprehensive understanding of the influence of exchange rates on digital assets from a digital finance perspective.

Keywords: Cryptocurrency, Bitcoin, Exchange Rates, ARMA

INTRODUCTION

Cryptocurrencies have become an increasingly popular topic in recent years. Bitcoin is one of the most popular types of cryptocurrency and attracts the attention of the media and academics. However, Bitcoin's huge and unstable price fluctuations have sparked a lot of debate and concern. This study will focus on analyzing the influence of exchange rate fluctuations on Bitcoin returns. Relevant time data will be analyzed using time series methods in a digital financial perspective. The goal is to understand the factors that influence Bitcoin price fluctuations and to provide useful information for investors and decision makers in digital financial markets. Previous studies have focused on the Bitcoin model in relation to factors such as publicity, technology, and economics. However, the data fluctuations and underlying issues of the Bitcoin system have hardly been studied. Therefore, this study will bring new understanding regarding Bitcoin price fluctuations and the factors that influence them. The study will be conducted by Bashar Yaser Almansour, Assistant Professor of Finance at Skyline University College, Ammar Yaser Almansour, Assistant Professor of Finance at Amman Arab University,

and Mohammad In'airat, Professor at Skyline University College. It is hoped that the results of this study can make a significant contribution to the development of digital financial markets and make better investment decisions. However, the existence of cryptocurrencies such as Bitcoin also raises questions about their relationship to conventional economic factors, such as exchange rate fluctuations. The exchange rate is the relative price of one currency against another currency, and exchange rate fluctuations can be influenced by factors such as monetary policy, inflation rates, and political uncertainty. In the context of Bitcoin, exchange rate fluctuations can be influenced by various factors such as supply and demand, government regulations, and news or issues related to cryptocurrencies.

We will use a time series approach to analyze the effect of exchange rate fluctuations on Bitcoin returns. The time series approach is an analysis method used to study patterns in sequential or time series data. In a financial context, time series approaches have been used to study the relationship between financial variables such as stock prices, market indices, and interest rates. A time series approach can also be used to study the relationship between exchange rate fluctuations and Bitcoin returns. In this study, we will use daily data of the Bitcoin exchange rate against USD during the period January 2016 to December 2022. We will test the hypothesis that exchange rate fluctuations can affect Bitcoin returns by examining the relationship between exchange rate changes and Bitcoin price changes. We will use various time series analysis methods such as stationarity tests, cointegration tests, and VAR (Vector Autoregression) models. Through this analysis, we hope to contribute to the understanding of the relationship between exchange rate fluctuations and Bitcoin returns, as well as its implications in the context of digital finance.

LITERATURE REVIEW

Demand The demand for investment alternatives and investor acceptance combined with the creation of a supply of new instruments by market players determine the success of such developments. The recent creation of virtual currencies is an example of such development and these virtual currencies are now used for exchange throughout the world [6]. Some virtual currencies operate within virtual communities only, while others tend to have a wider reach and also a two-way exchange flow with traditional currencies. There are several subsets of digital currencies within the broader category of virtual currencies [5]. Digital currencies function without counterparty control and their use is wider in the general economic system [2]). According to [7] states that bitcoin is the first digital currency of its kind and maintains its integrity through cryptography and a peer-to-peer network. Bitcoin was introduced by its creators in an attempt to move away from the traditional currency model based on trust and in fact created a secure system due to cryptographic verification [8]. It has been suggested by [4] that the properties of bitcoin resemble speculative investments. There are high price fluctuations and other uncertainties in bitcoin investments, indicating high volatility of bitcoin returns. If bitcoin still manages to emerge as a viable currency, it has the potential to become a stage for financial innovation in the future (The Economist, 2014). It is said that the value of bitcoin is not determined by macroeconomic fundamentals such as GDP, inflation or interest rates. Bitcoin is also not tied to other currencies. The bitcoin exchange rate is completely based on supply and demand. Understanding the microstructure of the bitcoin market is essential because of these factors; if bitcoin market price formation is to be understood [7], [9]. [10] argue that bitcoin's price volatility is much greater compared to bonds, stocks, commodities and other currencies. Additionally, the lack of regulation and fundamental value show variations compared to traditional assets. He stated that the correlation between the price of bitcoin and other assets is very low. In other words, there is no relationship between the price of bitcoin and other assets in the financial market. Information for bitcoin can be gathered by investors from a number of sources. There are a large number of unknown traders in the bitcoin market which implies a false assessment of probability which may also explain the excessive volatility in the price of bitcoin. Market liquidity also increases due to the presence of unknown traders in the

market. This liquidity may provide an explanation for the rapid increase in bitcoin trading volume since the introduction of this currency to the market [11]. Therefore, exchange risks are significant for bitcoin investors.

It has also been shown by evidence that bitcoin prices experience further volatility when there is criminal activity affecting exchanges. Therefore, there is a relationship between exchange risk, lack of liquidity, and the resulting price volatility. Through exchange risk, theoretical arguments relating to market microstructure have value stating that low liquidity leads to increased price volatility [12]. It has been found [13] that gold return volatility reacts opposite to negative shocks meaning that increasing uncertainty also increases gold price volatility. However, no evidence has been found for asymmetric volatility of bitcoin prices in the cryptocurrency market. [14] Investigating the influence of macroeconomic factors on bitcoin returns. The macroeconomic variables used are the stock market index, exchange rate, and oil prices. Research result shows that macroeconomic factors play an important role in determining the value of bitcoin. Furthermore, he found that the price of bitcoin was predicted by stock exchange indices, exchange rates, and oil prices. [15] Studying the relationship between macrofinancial indicators and bitcoin prices. Based on research results, there is a negative relationship between macro financial indicators and bitcoin returns. A decline in share prices influences shareholders to sell their assets in the financial market. This would cause a rapid decline in the current currency, but could increase the price of bitcoin if investors direct their money towards purchasing it. In all cases, stock exchange indices have a positive relationship with the price of bitcoin. In other words, in the world of money, investors are always looking for new opportunities to increase their wealth, so they actually withdraw their money from the stock market and are attracted to new promising investments and this will cause a negative impact on other sectors. Based on related literature, there has been no research that examines the relationship between currency exchange rates and bitcoin returns as a time series analysis. According to [11] who recommend to investigate the influence of exchange rates on bitcoin prices because they document that exchange rates can reflect inflationary developments and therefore have a positive effect on bitcoin prices.

RESEARCH METHODOLOGY

1. Data Sources

In this research, the database used is monthly bitcoin returns collected from the Yahoo Finance website. This research examines the effect of exchange rates on bitcoin returns covering the period 2014 to 2019. Exchange rate data is also collected daily from the International Monetary Funds website.

2. Research Design

The aim of this research is to analyze the effect of currency pair exchange rates on bitcoin returns. The dependent variable in this research is bitcoin returns, bitcoin performance can be measured by calculating returns using historical data which provides investors with a better understanding to predict future bitcoin price movements in the market [16], [17]. The independent variables in this research are exchange rates, namely USD / AUD, USD / EUR, USD / GBP, and USD / JPY.

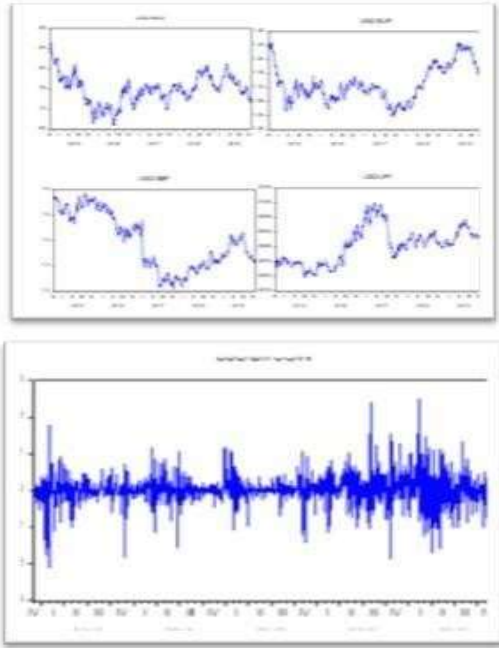
3. Model

This paper aims to investigate the influence of exchange rates for currency pairs on bitcoin returns. To explore this effect, two econometric models are used, the first model is ARMA which aims to investigate the impact of exchange rates for currency pairs on bitcoin returns. The general ARMA equation is estimated using Maximum Likelihood as follows: (1)

$$\begin{array}{ll} \text{BITR:} & \text{Pengembali} \\ & \text{anBitcoin} \\ \text{EXCHG:} & \text{Nilai tukar} \\ e : & \text{Error} \end{array}$$

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

RESEARCH RESULTS AND DISCUSSION



(3d)

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

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

To utilize statistical tools for time series data, investigating spurious regression is necessary when the data is stationary. Augmented Dickey-Fuller analysis should be used to investigate time series data based on unit root test. If the results of the Augmented Dickey-Fuller test show that one of the variables is not stationary, the first difference must be taken before using the ARMA model as well as the Granger Causality Test. In addition, if the unit root test findings for the first difference indicate that the data is not stationary, then the difference in the two variables must be taken into account before carrying out the ARMA model and the Granger Causality Test. This can be stated as follows:

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

□

: The drift term

t : The time trend

p : Panjang lag terbesar yang digunakan

According to which adapted a version of the likelihood ratio that recommends the following regression model, namely as follows:

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

$$= 0, \beta = 0, H_a: \gamma \neq 0,$$

$$\hat{\tau}_{\beta}, H_0: \gamma = 0, H_a: \gamma < 0; \varphi_3, H_0: \gamma$$

$$\beta \neq 0$$

$$\sum_{j=1}^p$$

The evaluation of Bitcoin, USD/ AUD, USD/ EUR, USD/ GBP, and USD/ JPY is reflected in figure 2 between 2014 and 2019. It is observed that the return series of Bitcoin has an increasing trend leading to high volatility. In general, the figures above show that the trends of all variables monotonically show a decrease or increase during the period 2014 to 2019. 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	1303	1303	1303	1303	1303

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

Table 2: 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 pvalues 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: ADF

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 unit root findings on first differences are shown in Table 3. They show that the variable does not move after taking into account the first differences recording a p-value of less than 5 percent significant level [19]–[21]. Therefore, the ARMA equation is estimated using Maximum Likelihood. The ARMA equation estimation results are illustrated in Table 4.

Table 4: 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	0.032000	0.665745	0.5057
D(GBP)	-0.026300	0.015553	-1.690983	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	33.27731	0.0000
AR(3)	0.463542	0.006587	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	-14.64387	0.0000
MA(4)	0.996111	0.073425	13.56642	0.0000
SIGMA ² Q	0.001589	0.000118	13.50566	0.0000
R-squared	0.025239	Mean dependent var	0.003022	
Adjusted R-squared	0.015408	S.D. dependent var	0.040385	
F-statistic	2.567349	Durbin-Watson stat	1.996915	
Prob(F-statistic)	0.001651			

The results show that the overall model is suitable due to the e of the acceptable F-statistic which records the value (2.567349) with a significant probability value of 0.001651. The findings also show that R² is 0.025239, which indicates that bitcoin returns can be estimated of 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. This was tested for the ARMA model using the Maximum Likelihood Estimation Type. The best model is the ARMA(4,4) model where Bitcoin returns, and the error term is significant up to 4 lags. The results show that Bitcoin returns are not significantly affected by the values in foreign currencies (JPY, EUR, GBP, and AUD) when confidence is measured at the 95 percent level. However, GBP was found to be significant when significance was measured at the 90 percent level. That may be partly due to common factors influencing GBP and Bitcoin returns together recently. During the Brexit procedure, risk factors may have caused some investors to abandon GBP and invest in Bitcoin. In addition, the research results show that there is a negative relationship between JPY, GBP and AUD with Bitcoin returns which recorded negative coefficient values of -3.076362, -0.026300 and -0.073824 respectively. Additionally, a positive relationship is observed between EUR and Bitcoin returns recording a positive coefficient value of 0.022102.

CONCLUSIONS AND RECOMMENDATIONS

Market Microstructure Theory provides a theoretical foundation for developing an understanding of price formation in financial markets. He tends to understand the emergence of new transactions that affect volume and price as a result of inactive investor demand. Trading mechanisms in the market are also considered an important aspect of the price formation process [22]. This study has explored the relationship between exchange rates for currency pairs and Bitcoin returns. Bitcoin was introduced in 2009 and since then the Bitcoin market has risen rapidly but the risks associated with the currency impact its liquidity with respect to shares issued by companies. The results show a positive relationship between USD/EUR returns and Bitcoin but it is not significant. This is an indication that when the EUR value increases, bitcoin returns will increase and vice versa. Additionally, a negative relationship between USD/JPY, USD/GBP, and USD/AUD and Bitcoin returns is found. That means if the value of JPY, GBP and AUD depreciates, the price of Bitcoin will appreciate. This research also tries to examine the influence of exchange rates on Bitcoin returns, the results show that Bitcoin returns do not have a significant effect on the value in foreign currencies, namely USD/JPY and USD/AUD. This shows that foreign currency changes do not significantly affect Bitcoin returns. In other words, the value of bitcoin is not determined by changes in foreign currency. However, GBP was found to be significant when significance was measured at the 90 percent level. That may be partly due to common factors influencing GBP and Bitcoin returns together recently. In this context, interested parties can focus on the relationship between exchange rates and cryptocurrencies by taking several digital currencies. Additionally,

future studies could concentrate on cryptocurrency volatility as well as explore the relationship between global financial market indices and cryptocurrencies. Additionally, researchers can focus on the cryptocurrency market from a behavioral finance perspective.

References

- H. A. Aalborg, P. Molnár, and J. E. de Vries, —What can explain the price, volatility and trading volume of Bitcoin?,*J. Financ. Res. Lett.*, vol. 29, pp. 255–265, 2019, doi: 10.1016/j.frl.2018.08.010.
- P. Ciaian, M. Rajcaniova, and d'Artis Kancs, —The economics of BitCoin price formation,*J. Appl. Econ.*, vol. 48, no. 19, pp. 1799–1815, 2016, doi: 10.1080/00036846.2015.1109038.
- F. Kjaerland, M. Meland, A. Oust, and V. Øyen, —International Journal of Economics and Financial Issues How can Bitcoin Price Fluctuations be Explained?,*Int. J. Econ. Financ. Issues*, vol. 8, no. 3, pp. 323–332, 2018.
- D. Yermack, —Is Bitcoin a Real Currency? An Economic Appraisal,*J. Handbook of Digital Currency: Bitcoin, Innovation, Financial Instruments, and Big Data*, 2015, pp. 31–43.
- A. Chowdhury and B. K. Mendelson, —Virtual Currency and the Financial System: The Case of Bitcoin,*Work. Pap.*, 2013.
- A. Rogojanu and L. Badea, —The issue of competing currencies. Case study – Bitcoin,*J. Theor. Appl. Econ.*, vol. 21, no. 1, pp. 103–114, 2014.
- L. Kristoufek, —BitCoin meets Google Trends and Wikipedia: Quantifying the relationship between phenomena of the Internet era,*Sci. Rep.*, vol. 3, 2013, doi: 10.1038/srep03415.
- S. Nakamoto, —Bitcoin: A Peer-to-Peer Electronic Cash System | Satoshi Nakamoto Institute,*2008*.
- L. Kristoufek, —What are the main drivers of the bitcoin price? Evidence from wavelet coherence analysis,*PLoS One*, vol. 10, no. 4, 2015, doi: 10.1371/journal.pone.0123923.
- A. Chowdhury, —Is Bitcoin the ‘Paris Hilton’ of the Currency World? Or Are the Early Investors onto Something That Will Make Them Rich? ,*J. Invest.*, vol. 25, no. 1, pp. 64–72, 2016, doi: 10.3905/joi.2016.25.1.064.
- E. Palombizio, —Forecasting Exchange Rates using Leading Economic Indicators,*J. Stock Forex Trading*, vol. 01, no. 08, 2012, doi: 10.4172/scientificreports.402.
- J. Li and C. Wu, —Stochastic volatility, liquidity and intraday information flow,*J. Appl. Econ. Lett.*, vol. 18, no. 16, pp. 1511–1515, 2011, doi: 10.1080/13504851.2010.543077.
- D. G. Baur and T. K. J. McDermott, —Safe Haven Assets and Investor Behaviour Under Uncertainty,*SSRN Electron. J.*, 2012, doi: 10.2139/ssrn.2004796.
- D. van Wijk, —What Can Be Expected from the Bitcoin?,*2013*.
- D. D., —The Relationship between Exchange Rates and Stock Prices,*Issues Polit. Econ.*, vol. 14, no. August, pp. 1–25, 2005.
- A. Y. Almansour and B. Y. Almansour, —Macroeconomic Indicators and Saudi Equity Market: A Time Series Analysis,*2016*.
- K. Hussainey and L. Khanh Ngoc, —The impact of macroeconomic indicators on Vietnamese stock prices,*J. Risk Financ.*, vol. 10, no. 4, pp. 321–332, 2009, doi: 10.1108/15265940910980632.
- S. Satchell, —Introductory Econometrics for Finance,*J. Econ. J.*, vol. 113, no. 488, pp. F397–F398, 2003, doi: 10.1111/1468-0297.13911.
- H. Elrehail, —The relationship among leadership, innovation and knowledge sharing: A guidance for analysis,*Data Br.*, vol. 19, pp. 128–133, 2018, doi: 10.1016/j.dib.2018.04.138.
- B. Almansour, Y. Almansour, and A. Almansour, —Small and medium size enterprise: Access the financial and nonfinancial factors,*J. Manag. Sci. Lett.*, vol. 9, no. 5, pp. 687–694, 2019,

doi: 10.5267/j.msl.2019.2.003.

A. Y. Almansour, N. Alrawashdeh, and B. Y. Almansour,

—The impact of capital structure on the performance of microfinance institutions, *Manag. Sci. Lett.*, vol. 10, no. 4, pp. 881–888, 2020, doi: 10.5267/j.msl.2019.10.008.

A. Madhavan, —Market microstructure: A survey, *J. Financ. Mark.*, vol. 3, no. 3, pp. 205–258, 2000, doi: 10.1016/S1386-4181(00)00007-0.

B. Y. Almansour, —Investment decision making among Gulf investors: behavioural finance perspective, *Int. J. Manag. Stud.*, vol. 24, no. 1, pp. 41–71, 2017.