Analysis of the Effect of Exchange Rate Fluctuations on Bitcoin Returns: A Time Series Approach in a Digital Finance Perspective

Dimitris N. Metaxas
Rutgers University–New Brunswick, United States

Cryptocurrencies, including Bitcoin, have been the subject of great attention in the media and academia due to their large price fluctuations. This study aims to analyze the effect 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 applied the ARMA model and the Maximum Likelihood Estimation method to analyze the data. The results showed that exchange rate fluctuations had no significant effect on Bitcoin’s returns when confidence was measured at a rate of 95 percent. However, when significance was measured at a rate of 90 percent, GBP was found to have a significant effect on Bitcoin returns. This may be due to common factors affecting the simultaneous returns of USD/GBP and Bitcoin in recent times. Future studies may consider investigating the effect of exchange rate fluctuations on other cryptocurrencies, other than Bitcoin, to gain a more comprehensive understanding of the effect of exchange rates on digital assets in a digital finance perspective.
1. 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 volatile price fluctuations have sparked a lot of debate and concern. This study will focus on analyzing the effect 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 influencing Bitcoin price fluctuations and to provide useful information for investors and decision makers in the digital financial markets. Previous studies have focused on the Bitcoin model in conjunction with factors such as publicity, technology, and economics. However, data fluctuations and the issues underlying the Bitcoin system are almost never studied. Therefore, this study will bring a new understanding of Bitcoin's price fluctuations and the factors that influence it. 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 expected that the results of this study can make a significant contribution to the development of digital financial markets and better investment decision making. However, the existence of cryptocurrencies such as Bitcoin also raises questions about their relationship with conventional economic factors, such as exchange rate fluctuations. An exchange rate is the price relative of one currency to another, 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 demand and supply, government regulation, and news or issues related to the cryptocurrency. We will use a time series approach to analyze the effect of exchange rate fluctuations on Bitcoin returns. The time series approach is an analytical method used to study patterns in sequential data or time series. In the context of finance, a time series approach has been used to study the relationship between financial variables such as stock prices, market indices, and interest rates.
The 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 from the Bitcoin to USD exchange rate 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, it is hoped that we can contribute to the understanding of the relationship between exchange rate fluctuations and Bitcoin returns, as well as their implications in the context of digital finance.

2. Research Method
In this study, the database used was monthly bitcoin returns collected from the yahoo finance website. This study examines the effect of exchange rates on bitcoin returns covering the period 2014 to 2019. Exchange rate data is also collected on a daily basis from the International Monetary Funds website.

3. Result and Discussion
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 of the Bitcoin series has an upward trend leading to high volatility. In general, the figures above show that the trend of all variables monotonously shows a decrease or increase in sing 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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AUD</td>
<td>0.758184</td>
<td>1.115516</td>
<td>1.393173</td>
<td>0.008846</td>
<td>0.003025</td>
<td>0.003025</td>
<td>0.003025</td>
<td>0.003025</td>
<td>0.003025</td>
<td>54</td>
<td>0.003025</td>
<td>2014-2019</td>
</tr>
<tr>
<td>EUR</td>
<td>0.759771</td>
<td>1.121472</td>
<td>1.386774</td>
<td>0.008733</td>
<td>0.00402</td>
<td>0.00402</td>
<td>0.00402</td>
<td>0.00402</td>
<td>0.00402</td>
<td>54</td>
<td>0.00402</td>
<td>2014-2019</td>
</tr>
<tr>
<td>GBP</td>
<td>0.851499</td>
<td>1.204651</td>
<td>1.588360</td>
<td>0.001014</td>
<td>0.040389</td>
<td>0.040389</td>
<td>0.040389</td>
<td>0.040389</td>
<td>0.040389</td>
<td>54</td>
<td>0.040389</td>
<td>2014-2019</td>
</tr>
<tr>
<td>JPY</td>
<td>0.685895</td>
<td>0.605950</td>
<td>0.851499</td>
<td>0.007960</td>
<td>0.010014</td>
<td>0.010014</td>
<td>0.010014</td>
<td>0.010014</td>
<td>0.010014</td>
<td>54</td>
<td>0.010014</td>
<td>2014-2019</td>
</tr>
</tbody>
</table>

Descriptive statistical findings for all variables used are shown in Table 1. It can be observed that Bitcoin's average return recorded a value of 0.003025 with a standard deviation value of 0.040389. Bitcoin's return ranges between the maximum value of 0.252472 and the minimum value - 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. In addition, 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 were used in this study. Therefore, it is important to investigate whether the unit root exists in the data series or not because non-stationary variables can cause false regression problems among unconnected variables [16]. The ADF results are shown in Table 2.

Table 2: Hasil ADF

<table>
<thead>
<tr>
<th>P-Value</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0053</td>
<td>&lt; 0.05 USD/AUD is stationary</td>
</tr>
<tr>
<td>0.1260</td>
<td>&gt; 0.05 USD/EUR is not stationary</td>
</tr>
<tr>
<td>0.4682</td>
<td>&gt; 0.05 USD/GBP is not stationary</td>
</tr>
<tr>
<td>0.3839</td>
<td>&gt; 0.05 USD/JPY is not stationary</td>
</tr>
<tr>
<td>0.0000</td>
<td>&lt; 0.05 Bitcoin Return is stationary</td>
</tr>
</tbody>
</table>
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: ADF Results on the First Difference**

<table>
<thead>
<tr>
<th>P-Value</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000 &gt; 0.05</td>
<td>USD/EUR is stationary</td>
</tr>
<tr>
<td>0.0000 &gt; 0.05</td>
<td>USD/GBP is stationary</td>
</tr>
<tr>
<td>0.0000 &gt; 0.05</td>
<td>USD/JPY is stationary</td>
</tr>
</tbody>
</table>

The finding of the root unit on the first difference is shown in Table 3. They showed that the variables did not move after accounting for the first difference that recorded a p-value of less than 5 percent significant level [19]-[21]. Therefore, the ARMA equation is estimated using Maximum Probability. The estimation results of the ARMA equation are illustrated in Table 4.

**Table 4: The Effect of Exchange Rates on Bitcoin Returns**
The results showed that the overall model was appropriate because of the acceptable F-statistic recorded a value of (2.567349) with a significant probability value of 0.001651. The findings also show that R² is 0.025239, which shows that bitcoin's return can be estimated at 2.5 percent using the selected exchange rates of USD/EUR, USD/GBP and USD/JPY. The effect of the exchange rate on bitcoin yields can be seen in table 4. It is tested for ARMA models using the Maximum Possible Estimation Type. The best model is the ARMA model (4.4) where Bitcoin returns, and the error term is significant up to 4 lags. The results show that Bitcoin's returns are not significantly affected by its value in foreign currencies (JPY, EUR, GBP, and AUD) when confidence is measured at the level of 95 percent. However, GBP is found to be significant when significance is measured at the level of 90 percent. That may be partly due to common factors affecting GBP and Bitcoin returns simultaneously these days. During the Brexit procedure, risk factors may have caused some investors to abandon GBP and invest in Bitcoin. In addition, the results showed that there is a negative relationship between JPY, GBP, and AUD with Bitcoin returns recording negative coefficient values - 3.076362, -0.026300 and -0.073824 respectively. In addition, a positive relationship was observed between the return of EUR and Bitcoin which recorded a positive value of 0.022102 coefficient.

4. Conclusion

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 affecting volume and price as a result of inactive investor demand. The mechanism of trading within the market is also considered an important aspect of the price formation process [22]. The 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 increased tremendously but the risks associated with the currency impact its liquidity with respect to the shares issued by the company.
The results showed a positive relationship between USD/EUR returns and Bitcoin but it was not significant. This is an indication that as the value of EUR increases, bitcoin's returns will increase and vice versa. In addition, a negative relationship between USD/JPY, USD/GBP and USD/AUD and Bitcoin returns was found. That means if the value of JPY, GBP and AUD depreciates, the price of Bitcoin will appreciate. This study also tried to examine the effect of exchange rates on bitcoin yields, the results showed that Bitcoin yields did not have a significant effect on the value in foreign currencies, namely USD/JPY and USD/AUD. This shows that changes in foreign currency do not significantly affect Bitcoin returns. In other words, the value of bitcoin is not determined by changes in foreign currency. However, GBP is found to be significant when significance is measured at the level of 90 percent. That may be partly due to common factors affecting GBP and Bitcoin returns simultaneously these days. In this context, interested parties can focus on the relationship between exchange rates and cryptocurrencies by taking some digital currencies. In addition, future studies may concentrate on the volatility of cryptocurrencies as well as explore the relationship between global financial market indices and cryptocurrencies. In addition, researchers can focus on the cryptocurrency market from a behavioral finance perspective [23].

5. References


