Abstract

This paper analyzes the traditional asset markets, in order to verify which of these markets have the greatest capacity to impact the cryptocurrency market. This paper also tested the hypotheses of the impact of the investor's attention on the cryptocurrency market. To do this a proxy for the complete cryptocurrency market with more than 6 thousand cryptocurrencies was utilized. First, a VAR(1) model was estimated to verify how the shock of the traditional market, the internal shocks, and the investors' attention shocks impact the market. Second, the Granger causality test and Wavelet Coherence were used to test this hypothesis. The results showed that the Bitcoin price and the average price of the coins have a mild impact in a short time in the cryptocurrency market, between 1 and 4 weeks. In addition, it was possible to verify that investors' attention is generated by market growth. About the traditional asset market, it was possible to verify that the commodity has a leading relation to the cryptocurrency market in the long term. The results found in this paper reinforce the thesis of the independence of the cryptocurrency market presented by other authors and brings new information that this is a market that is most influenced by its internal dynamics and has few impacts on investors.

Text for this section.

Introduction

Recent technological advances have impacted the daily life of society as a whole bringing some social and practical issues, which have been discussed in the academic and financial fields. Themes such as Open Bank, GDPR, and medical ethics, among others, are some examples of this relevance. In finance and economics, it is no different, a major current issue is digital currencies.

Digital currencies were introduced by [1] and since then, many coins have been built year after year, thus creating the cryptocurrency market, a relevant asset market nowadays. Figure 1 shows the number of digital currencies traded yearly from 2014 to 2023.

The rapid growth of the digital currency market forced governments and central banks to monitor the evolution of this market closely.

Many scholars try to understand how the cryptocurrency market impacts the macroeconomics ambient, works such as [2] and [3] are examples of the attention that scholars and regulators have been paying to the growth of this market. In the same sense, private banks and the financial system have been looking close this issue. Examples of this interest are the creation of digital financial indices such as the Bloomberg Galaxy Crypto Indices and the growing number of digital currency exchanges.

Strong evidence on the investor's side is the evolution of the Market Cap of the cryptocurrency market. In 2023 the Market Cap of the digital currency market is approximately 1 trillion dollars. Figure 2 shows the evolution of the market cap of the cryptocurrency market from 2014 to 2023. The higher the market cap, the greater the trading volume and average coin value.

With the growth and consolidation of the cryptocurrency market, it is crucial to understand how the traditional markets, Commodity markets, Stock markets, Foreign Exchange markets, and Government Bonds, relate to the cryptocurrency market

[hb!]

Figure 1: Number of coins traded per year between 2014 and 2023
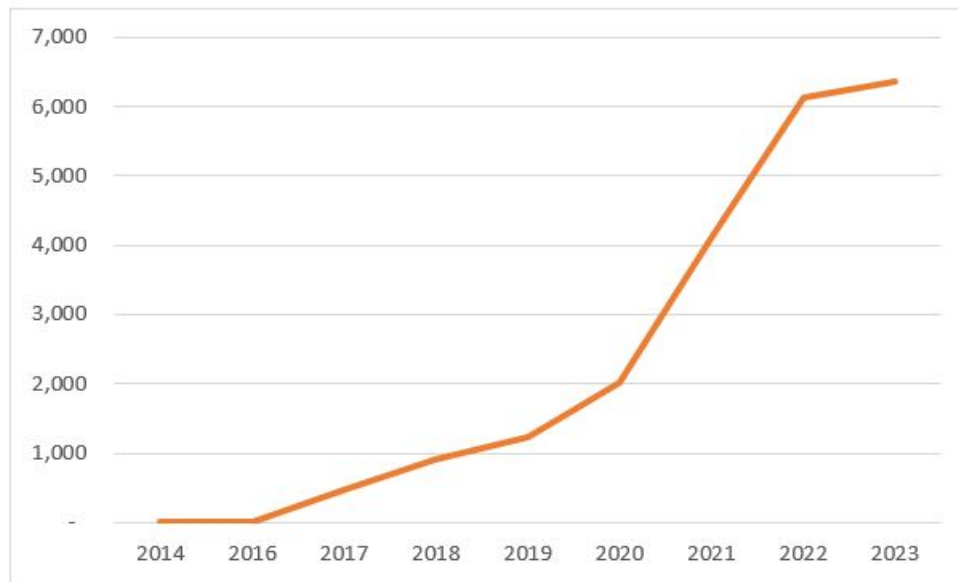
since the cryptocurrency market becomes a viable investment alternative. Some papers state a cryptocurrency market is a hedge option for investor's in relation to the risk of traditional markets, [4] and [5].

Some recent studies such as [4], [6], and [7], among others, analyze the relationship between the cryptocurrency market, and the traditional market. However, a common point of most of these articles is don't consider the cryptocurrency market, as a whole. In general, only the main digital currencies such as Bitcoin, and Ethereum, among others, are considered, leaving out of the analysis, an important part of the market. Considering the market as a whole it is crucial to have a more realistic analysis.

The two relevant contributions of this paper will be: Using the whole cryptocurrency market to verify the impact of the traditional markets in it. And investigating the relevance of investors' attention in the cryptocurrency market. To represent the complete cryptocurrency market two variables will be used, the average price of all cryptocurrencies, and the traded volume of all cryptocurrencies. To represent the investor's attention, one variable based on the number of searches for the word "Bitcoin" in the Google search engine will be used. To represent the traditional markets, the variables NASDAQ Index, VIX Index, US Short and Long Term Bonds, and the S&P GSCI Commodity Index will be used.

The results of this research point out that in general, the traditional market has no impact on the cryptocurrency market. The exception is the commodities market, which had a leading position in the cryptocurrency market for long-term periods from 12 to 32 weeks. Regarding the internal dynamic of the market, it was possible to verify that the Bitcoin price and the average price of the coins have a relevant impact in a short time, between 1 and 4 weeks. And finally, it was possible to show that the investor's attention is caused by the growth of the market, and it is not the investor's attention that causes the market growth.

The rest of the paper is organized as follows: In the section, Literature Review a quick summary of some of the most current and relevant texts on the subject is presented. In the section Methodology, the methods used to analyze the data are presented. In the Data and Analysis section, the data used in this work are presented. After that, the data are analyzed by the methods described in the previous section, and the section Conclusion presents a summary of the relevant findings of this research.

Figure 2: Market Cap Evolution of the Cryptocurrency Market from 2014 to 2023

Literature Review

As a relatively new phenomenon, the cryptocurrency market has drawn scholars' attention, and several types of research have been conducted with the objective of clarifying its behavior. In order to give the readers an organized view of this research field, here, I will divide these researches into three blocks. The first block is compounded by researches that focused only on the internal dynamics of the cryptocurrency market. Some examples of this field of research are the papers [8] and [9].

The main cryptocurrencies and their relations were studied in, [8]. This paper found evidence that the average return of cryptocurrencies is very time-varying and that market integration is a continuing and persistent phenomenon. The paper [9], in the same sense, found that Ethereum is likely to be the independent coin, while Bitcoin tends to be the spillover effect recipient, furthermore, this paper found, that any current and past changes in one coin might negatively cause the movement of the other coins.

The second block is the block where the research goes a little bit further, studying the relationship between the cryptocurrency market and the traditional asset market. Some examples of this researches are, [10], [11], [4] and [6].

The paper [10] found that the relation, between the movement of the Bitcoin price, could be predicted by the price of the aggregate commodity index and gold prices. The paper [11] indicates that the global financial stress index strongly causes Bitcoin returns at the left and right tail of the distribution of the Bitcoin returns, and also shows limited directional predictability from the global financial stress index to Bitcoin returns in the medium term. Using 300 cryptocurrencies and 9 traditional market assets indexes, [4], found a mild relationship between returns on commodities, and precious metals, but the relationship does not imply volatility spillover effects. An interesting study using the variable M2 (cash, demand, and time deposits), inflation, and economic policy uncertainty (EPU) for UK and Japan was made in [6]. This study found some adverse results, in Japan and the U.K., the short-term effects of M2 on Bitcoin prices are negative.

And finally, in the third and more complete block, the research includes the investors' attention. The paper [12] shows that the number of tweets is a significant driver of next-day trading volume and realized volatility for Bitcoin. The paper [13] points out that the past performances of the cryptocurrencies Bitcoin, Ethereum, and Litecoin influence investors' future attention. In the same line [14], found that investors' attention is related to higher returns, volatility, and liquidity in cryptocurrency markets, using Google trends as a measure of the attention of the consumer. Again, [15], using google trends and Twitter, found that the media network has a partial impact on Bitcoin prices. Other two interesting studies about the relation of the investors' attention, to the cryptocurrency market, are [16] and [17]. The paper [16], shows that if a cryptocurrency has higher past performance, then investor's pay more attention to the market, and a more recent study, [17], analyzing Dogecoin and Ehtereum, fund evidence supporting the hypothesis of a strong effect of Twitter investor engagement on Dogecoin returns, however, no potential impact is identified for Ethereum.

In general, all studies indicate that the coins in the cryptocurrency market are more impacted by other cryptocurrencies than by the traditional asset market. Another common point was that a mild relationship between the cryptocurrency market with commodities was observed. In relation to the investors' attention the main point is that the investors' attention is caused by the market movement.

Except for [4] all other studies use few cryptocurrencies, mainly focusing on Bitcoin and other few well know coins. The

fact of considering few coins in these studies leads the papers incomplete letting space to improve and validate their conclusions in a more complete way. As mentioned before the aim of this paper is to fill this gap, using proxies to consider more than 6 thousand coins in this study, and in this way, I will have a more complete cryptocurrency market, which will permit a better understanding of its relation with the traditional asset market and the behavior of the investors' attention in the cryptocurrency market.

1 Methodology

Wavelet Coherence

Wavelet methodology is a powerful framework to study time series where exists changes in frequency across time. This method was first applied in signal and image processing, medicine, geophysics, astronomy, and economics. Regarding the cryptocurrency market, some studies use this framework to analyze cryptocurrency behavior. Some examples of the application of wavelet in the cryptocurrency market are, [18] which uses the wavelet methodology to study the connection between Bitcoin and the Chinese market indices, [19] uses wavelet to analyze whether Bitcoin can hedge uncertainty, and [20] uses to confirm the presence of fractal dynamics in their prices.

Here I will use the ability of the wavelet methodology, to capture the joint movements of two-time series of assets that are traded in different markets at different times and with different magnitudes of values.

Where I will follow the same methodology applied in [21] that was derived from [6]. Two-time series $b(t)$ and $c(t)$ can explain the cross-wavelet transformation in a temporal sequence by the formula below:

$$W_{bc}(m, n) = W_b(m, n)W_c^*(m, n)$$

Where $W_{bc}(m, n)$ and $W_b(m, n)$ are continuous wavelet transformations of the time series $b(t)$ and $c(t)$ and where m and n are the position and scale of the series and the $*$ combined component. The value of $W_{bc}(m, n)$ is the strength of the correlation between the time series $b(t)$ and $c(t)$. In the same way as [6], modified wavelet coherence will be used here to show the local covariance of the two transformations between pairs of time series at each frequency.

$$W_{bc}^2(m, n) = \frac{|S(n^{-1}W_{bc}(m,n))|^2}{S(n^{-1}|W_b(m,n)|^2)S(n^{-1}|W_c(m,n)|^2)}$$

Since $W_{bc}^2(m, n)$ varies between 0 and 1, where the closer is to 0 the smaller the correlation, and the closer is to 1 the greater the correlation between the time series. To deal with the question of negative and positive correlation, here, I will apply the wavelet phase difference to reveal the positive or negative correlation.

Autoregressive Vector - VAR and Granger Causality Test

VAR models are widely used in economics due to their interesting feature of dealing with systems of equations of simultaneous variables. This methodology was introduced by Sims in a series of works between the 70s and 80s.

Below is presented a VAR(1) model, where x and y are the variables of interest, y_{t-1} and x_{t-1} are the respective legged variable in the system. As a regression model the coefficients a_{11}, a_{12}, b_{21} and b_{22} can be estimated by OLS method, and the elements ϵ_t and χ_t are the white noise of the process. A more

$$\begin{pmatrix} y_t \\ x_t \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_t \\ \chi_t \end{pmatrix}$$

Utilizing the VAR model will permit me to perform shocks between the traditional market and the investor's attention to the cryptocurrency market and verify how these external variables impact the cryptocurrency and for how long this impact will persist.

The Granger causality is widely used to verify if one variable has any predictive power before another. It means that a variable x causes another variable y, in the Granger sense if the past values of x help to predict the values of y. For VAR models, Granger causality occurs in the coefficients of the equations, so that the current and past values of the variables in the model have the necessary information for forecasting future values. Thus, it can be shown that x causes y in the Granger sense, if in the equation of y, one of the coefficients associated with x is not zero, [22]. This test will be used here to verify which external variables can predict the cryptocurrency market.

Data and Analisys

Data description

In this section, the data used in this paper and the analysis performed with them will be presented in detail.

Many different series were used to represent different financial markets, in order to understand which market has the bigger impact in the cryptocurrency market. Below the series is presented in a more detailed way.

To represent the stock market, the NASDAQ index, variable **NASDAQ**, was used, to represent the bond market, the 13-week US Treasury Bonds and the 5-year US Treasury Bonds were chosen, which will be called **Short Treasure** and **Long Treasure** respectively. The quotation of the dollar for the euro represents the exchange variation, is the variable **Dollar**, and the S&P GSCI, variable **GSCI**, and variable **VIX** will represent the commodities market and the risk of the American market respectively.

To represent the Cryptocurrency market, which is the interest of the study, the value of Bitcoin, **BTC_USD**, the total market trading volume, **Volume**, and the average value of the coins, **Average Values**, will be used. The variable, average price coin, considers more than 6,000 coins traded between 2014 and 2023, excluding the value of Bitcoin. And the total market trading volume considers the transaction of the same 6,000 coins traded between 2014 and 2023. Here I chose to work with two variables for price in order to verify if Bitcoin is in fact the most influential coin in the market.

The search information for the term "Bitcoin" in the Google search tool, **Bitcoin Trends**, will be the proxy for the investors' attention. The use of only the word Bitcoin is due to the fact this is the most popular cryptocurrency, and this word is 2 times more relevant than the others associated with the cryptocurrency according to data from Google Trends.

All series, except for the search series for the term "Bitcoin", were obtained from the "Yahoo finance" website and comprised the window between 09/17/14 and 06/16/23. The data has a weekly frequency. The search series for the term "Bitcoin" was obtained from the Google Trends website. All series were transformed as follows, $R_T = (V_t - V_{t-1})/V_{t-1}$, where V_t are the values of the series in the week, V_{t-1} are the values in the previous week and R_T is the return or variation of the series.

Descriptive Analysis

Table 1 presents the descriptive summary of the variables used in the study. In the last column, the ADF test to verify the stationarity of the series is presented.

Table 1: Descriptive Statistics

| Variable	Mean	Standard Deviation	Symmetry	Kurtosis	ADF Test P-Value
Average Values	0.00	0.02	-1.28	57.85	0.05
BTC_USD	0.02	0.10	0.09	4.28	0.01
NASDAQ	0.00	0.03	-0.67	6.10	0.01
Short Treasure	0.11	0.72	6.57	55.91	0.01
Long Treasure	0.00	0.07	-0.02	18.68	0.01
VIX	0.02	0.21	4.11	36.28	0.01
Dollar	0.00	0.01	0.20	4.43	0.01
GSCI	3.13	64.37	20.49	421.00	0.01
Volume	0.11	0.61	6.77	6.60	0.01
Bitcoin Trends	0.03	0.24	1.47	83.12	0.01

As the series have different scales and are impacted by different shocks, the descriptive statistics tend not to be very similar. The most important point of this table is the results of the ADF Test.

It can be seen in the last column, that all series are stationary, for a significance of 10%. This fact is of paramount importance as it will allow the application of the traditional Granger Causality Test in the VAR model that will be built to better understand which markets have the ability to influence the cryptocurrency market.

Figure 3 below shows the correlation between the variables.

Figure 3 shows low values for the correlations of the variables, as my focus is the cryptocurrency market, the main analyses will be on its variables. The correlations are low, between Bitcoin Trends and BTC_USD variable, and between Bitcoin Trends and Volume. BTC_USD variable and VIX have a low negative correlation, which can indicate that Bitcoin already is a hedge for the market risk. A positive correlation between NASDAQ and BTC_USD may indicate, some comovement between bitcoin

Figure 3: Correlation between study variables
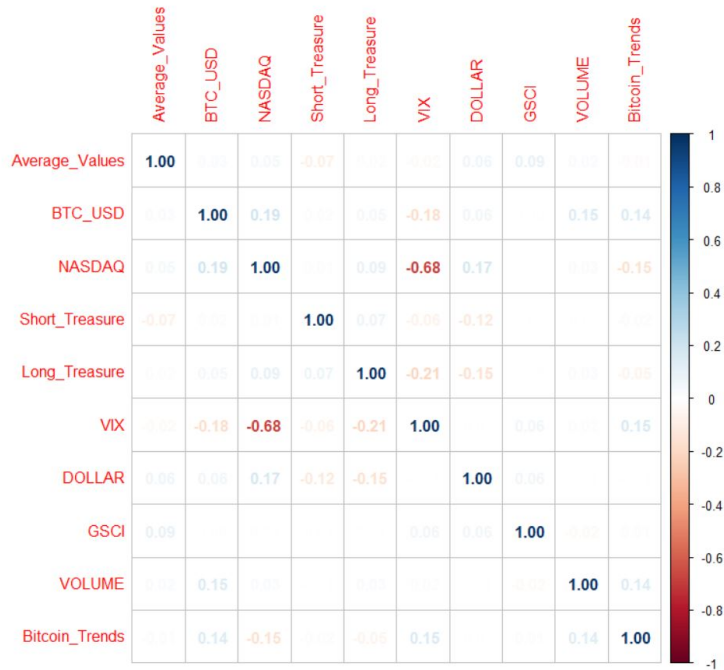
and the stock market is starting. The most important point here is that all correlations are very low, which means, that the variables are not closely related, and consequently the markets are not closely related too.

VAR Model

As seen in Table 1, the variables are all stationary, and thus the VAR model was estimated considering the lag found by the AIC criterion. Then, the final model VAR(1) was estimated. Based on this model an exercise with the impulse-response function to verify the impact of the traditional asset markets and the investors' attention in the cryptocurrency market.

All shocks were generated by impacting only the variable total volume of traded digital currencies, as this variable is a proxy for the complete market and with 12 weeks of persistence. Figures from 4 to 7, present the results of this exercise.
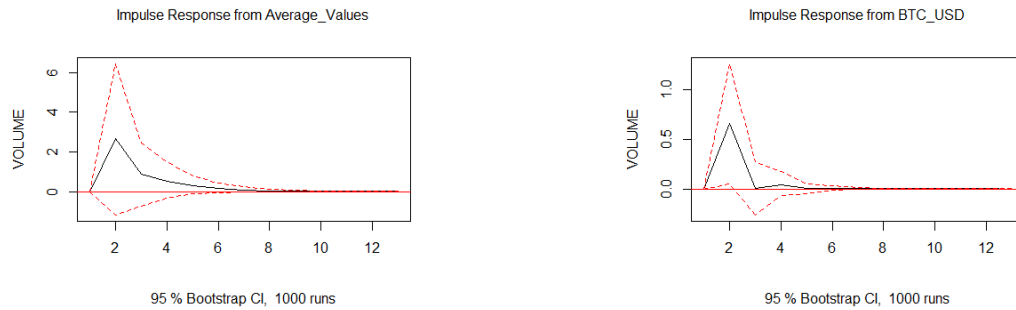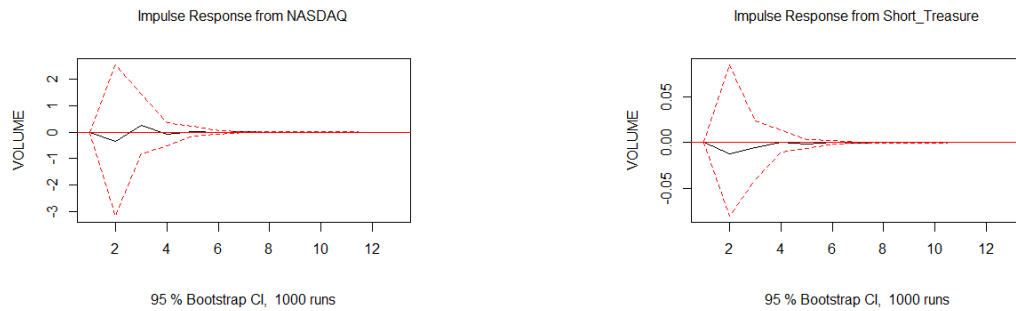
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Figure 4: Positive one standard deviation shocks

Impulse Response from Average_Values

95 % Bootstrap CI, 1000 runs

Impulse Response from BTC_USD

95 % Bootstrap CI, 1000 runs

Figure 5: Positive one standard deviation shocks

Impulse Response from NASDAQ

95 % Bootstrap CI, 1000 runs

Impulse Response from Short_Treasure

95 % Bootstrap CI, 1000 runs

The shocks for the variables of the traditional market, NASDAQ, Short and Long Treasure, Dollar, GSCI, and VIX, had values close to 0 with a large confidence interval, showing that the traditional market has no impact on the cryptocurrency market.

For the variables of the cryptocurrency market and investor's attention, the results indicate some positive impacts in the cryptocurrency market for the variables Average Value, BTC_USD, and Bitcoin Trend. All of them indicate an increase in the
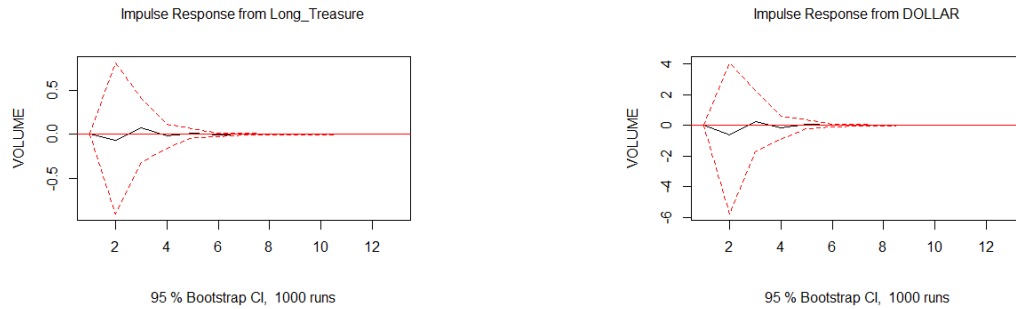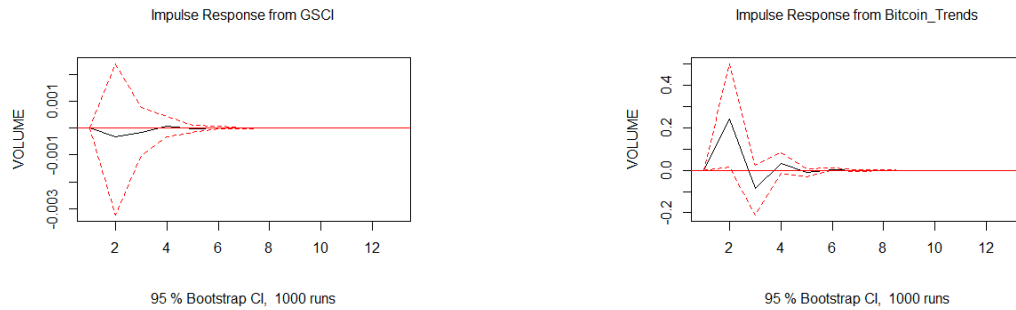
Figure 6: Positive one standard deviation shocks

Impulse Response from Long_Treasure

Impulse Response from DOLLAR

95 % Bootstrap CI, 1000 runs

95 % Bootstrap CI, 1000 runs

Figure 7: Positive one standard deviation shocks

Impulse Response from GSCI

Impulse Response from Bitcoin_Trends

95 % Bootstrap CI, 1000 runs

95 % Bootstrap CI, 1000 runs

first three weeks and stabilize the impact around the sixth week. Being that most relevant in terms of impact the variable BTC_USD. The confidence interval contains 0 in most of the shocks, but they seem to be more softly than for the traditional variables.

This indicates that the chance of contagion from the traditional market to the cryptocurrency market is almost none. Besides that, the investors' attention and the price of cryptocurrencies have a relevant impact on the cryptocurrency market which means that this is a market that is protected from the traditional asset market and has its own internal impact factors.

Granger Causality Test

The Granger Causality test was applied to the volume of traded currencies, in the same way that was made in the last section. The test results can be seen in Table 2 below.

Table 2: Result of the Granger Causality Test for the Volume Currencies Traded

Variable A	Test	Variable B	P-value	
Average Values	Cause	Volume	0.082	-
BTC_USD	Cause	Volume	0.0002	***
NASDAQ	Cause	Volume	0.329	
Short Treasure	Cause	Volume	0.5594	
Long Treasure	Cause	Volume	0.8144	
VIX	Cause	Volume	0.2515	
Dollar	Cause	Volume	0.1359	
GSCI	Cause	Volume	0.817	
Bitcoin Trends	Cause	Volume	0.7776V	
Volume	Cause	Bitcoin Trends	0.0276	*

Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '-'

The result of the Granger Causality test is in line with the results in previous sections. Where the traditional market variables don't impact the cryptocurrency market, but the variables from the cryptocurrency market impact the market itself. The only variable that is not in accord with the previous results is the variable Bitcoin Trends. This variable specifically doesn't Grager cause the cryptocurrency market, variable Volume.

To clarify this point I performed the Granger Causality test in contrary order, to verify if the cryptocurrency market Granger causes the investors' attention. The result of this test is in the last line of table 2, where is possible to see, that the cryptocurrency market granger causes the investors' attention. This indicates that cryptocurrency market growth attracts investors' attention and it is not the investor's attention that influences the cryptocurrency market.

WAVELET COHERENCE EMPIRICAL RESULTS

The movements between the Traded Currency Volume and the other variables are shown in figures 8 and 9 below.

The interpretation of the graph is not intuitive so to make it easy for the readers to understand the results of this analysis, I will give a brief explanation of how to read the graphs.

The interpretation of the graphs is done as follows: The interpretation of the graphs is done as follows: The intensity of the relationship is given by the scale of colors on the right side of each figure, how close the colors if to read the greater the local correlation in time, and the close to blue lower it will be. Regions with significant correlations are inside the white curve and

have a darker tone. The significance of the relationships is based on Monte Carlo simulations against an AR(1). The curve works as a significance level, where regions with estimates of greater significance and those of lesser significance are separated. The correlation is positive if the arrows point to the right, when the correlation is negative the arrows point to the left. If the first grade has a leading role in relation to the second grade, the arrow will point downwards. If this relationship is lagged, the arrow will point upwards.

Figure 8: Wavelet coherence
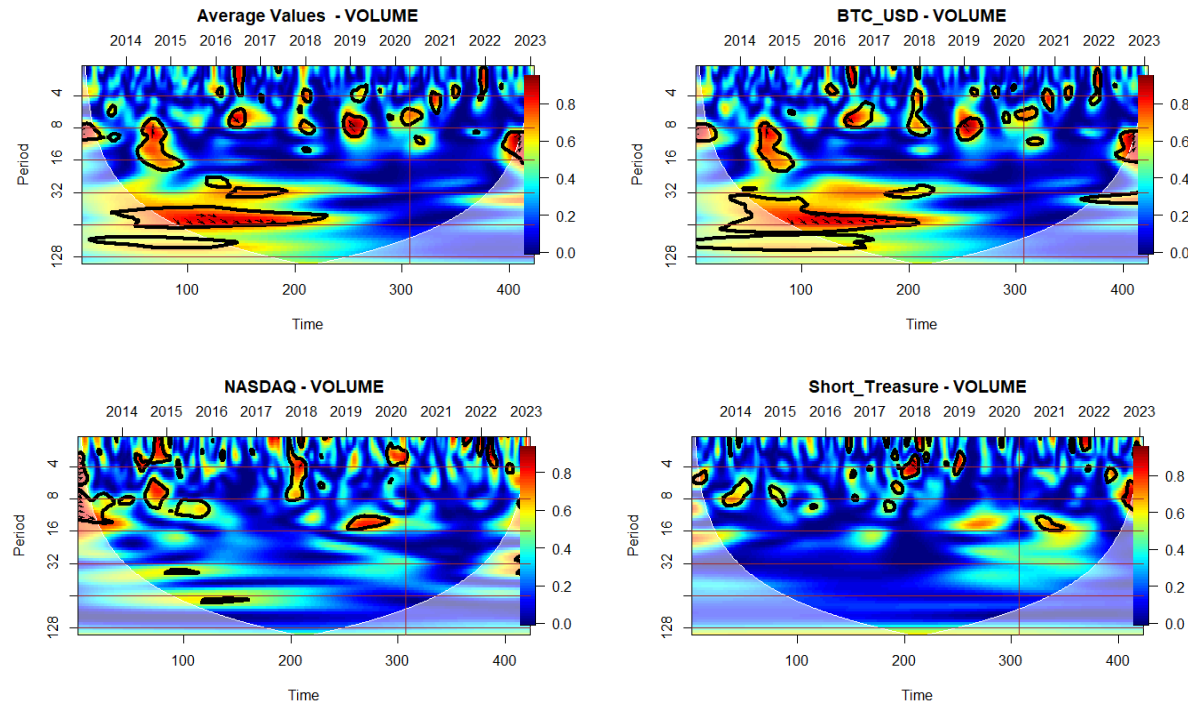
Now analyzing the graphs is possible to verify that for the variables, NASDAQ, Short Treasure, and Long Treasure that the wavelet coherence shows no relation with the cryptocurrency market, variable Volume. For the variable Dollar at some point of time during 2016 and 2017 there was a correlation with the Volume variable, where the Dollar was the leader in the relationship, however, this relationship does not hold after 2017. Some similar behavior appears for the variables Average Value

Figure 9: Wavelet coherence

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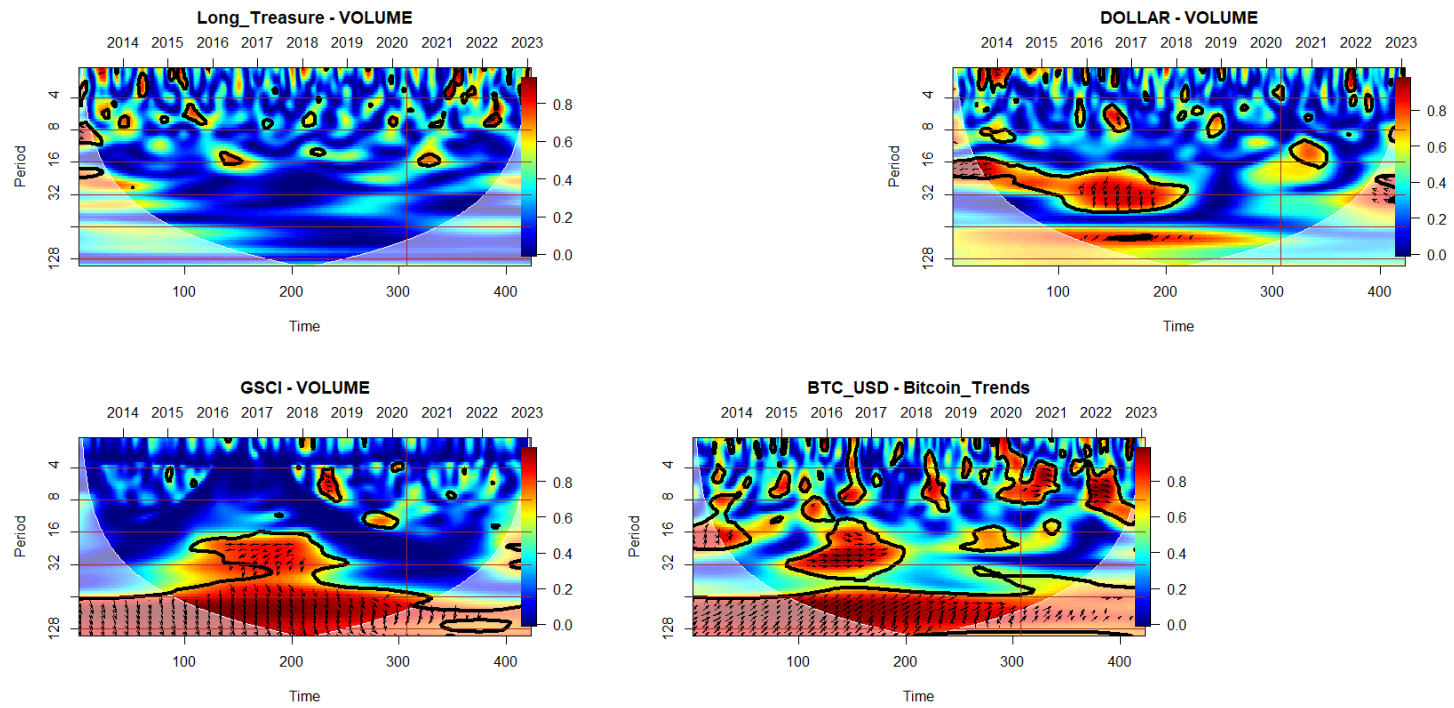
and BTC_USD.

Interestingly the variable GSCI, holds a more persistent relation, during all the periods of analysis where GSCI has the leading position, with some moments of lag leading from 2016 to 2018 in the period between 16 and 32 weeks. And the variable that has more relation with the Volume is the variable Bitcoin Trends. For the variable Bitcoin Trends, the variable Volume seems to be lagged. This result is in line with the Granger causality test where the Bitcoin Trends does not Grange Cause Volume but Volume Grange Cause Bitcoin Trends. About the traditional market, only the GSCI has a relation with the cryptocurrency market, but well ahead in periods of time, this is one of the reasons that the Granger Causality test didn't get this relation. This result corroborates with the literature where some relation between the cryptocurrency market and the commodities market is found. In addition to this here the wavelet coherence shows that this relation occurs in the long term.

Conclusion

The present study analyzed the main traditional markets, Commodities markets, Stock markets, Exchange markets, and Government Bonds in order to verify which of these markets have the greatest capacity to impact the cryptocurrency market. The hypothesis that the cryptocurrency market is more impacted form internal movements than external ones was also verified. The paper also tested the hypotheses of the impact of the investor's attention in the cryptocurrency market. To test this hypothesis, I used three approaches, a VAR model, the Granger causality test, and Wavelet Coherence. And to this, more than 6000 cryptocurrencies were considered. Making this one of the most complete studies in this field. First, a VAR(1) model was estimated to verify how the shocks of the traditional markets, the internal shocks, and the investor's attention shocks impact the cryptocurrency market. As a result, it was possible to verify that the traditional markets have no impact on the cryptocurrency market, on the other hand, the internal variables and investor's attention have a short and small impact on the market. The Granger causality test showed similar results, with one interesting additional result, the investor's attention is caused by the market growth and not the contrary. Wavelet Coherence also had similar results. The traditional markets have no impact on the cryptocurrency market. The exceptions stand for commodities, GSCI variable, where it was possible to verify a leading relation of the GSCI to the cryptocurrency market in the long term. The investor's attention, fowl the cryptocurrency market growth who bigger the market more is the investor's attention in it.

The study could conclude that the cryptocurrency market is not significantly impacted by traditional markets, being more influenced by its own dynamics in addition, it was possible to verify that investor attention is generated by market growth. This result reinforces the thesis of the independence of the digital currency market presented by other authors and brings new information that this is a market that is most influenced by its internal dynamics and has few impacts on investors.

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