

THE IMPACT OF CRYPTOCURRENCIES ON TRADITIONAL FINANCIAL MARKETS

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Abstract: *The paper examines the impact of cryptocurrencies on financial markets. The analysis is based on monthly data for the period 2019-2023. Kendall's and Spearman's correlation analysis methods were applied to investigate the relationship between cryptocurrency prices and traditional financial instruments. The variables used in the analysis include the prices of Bitcoin, Ethereum, and BNB, gold, crude oil, and the MSCI World Index. The correlation analysis, employing Kendall's and Spearman's correlation coefficients, decisively refutes the null hypothesis of the absence of a statistically significant relationship between cryptocurrency prices and those of traditional financial instruments. Notably, the findings underscore significant and positive correlations between Bitcoin, Ethereum, and BNB prices, and those of crude oil, gold, and the MSCI World Index. According to the results of the VAR analysis and Granger Causality test, a causal relationship can be confirmed in one direction from Bitcoin to crude oil, but not vice versa. Additionally, there is a one-way causal relationship from the MSCI World Index to the price of Ethereum. Furthermore, there are bidirectional causal relationships in most interactions among the selected cryptocurrencies.*

Keywords: *Bitcoin 1, Ethereum 2, BNB 3, GOLD 4, OIL 5, MSCI World Index 6.*

JEL classification: *C10, C32, C50, G10*

1. INTRODUCTION

Over the past few years, the cryptocurrency market has undergone significant changes. These changes have had an impact on the dynamics of traditional financial markets, leading to a growing

interest in exploring the relationships and trends between them. This research aims to investigate how cryptocurrencies are affecting traditional financial markets by analyzing the correlation between cryptocurrency prices and the prices of traditional financial instruments. By using Kendall's and Spearman's correlation analysis and comparing the volatility of each variable, we hope to gain a better understanding of how cryptocurrency markets and traditional financial markets interact.

The paper is segmented into three parts. The first part discusses the theoretical framework based on previous research on the implications of cryptocurrencies on traditional financial markets. The second section provides a detailed description of the variables used in the study along with descriptive statistics. The fourth section presents the results of the data normality tests and correlation analysis. The fifth part of the paper encompasses the results obtained through VAR analysis and the Granger Causality Test. Finally, the last section of the paper includes concluding remarks and potential directions for future research.

2. THEORETICAL FRAMEWORK

With the advancement of technology, the cryptocurrency market has developed, but cryptocurrencies are still not widely accepted as legal tender and cannot threaten the stability of some major international currencies (USD, EURO). However, further technological development could lead to an increase in the popularity and use of cryptocurrencies, potentially resulting in their concurrent use with other official currencies in the market. This poses risks to the monetary policies of central banks (Claeys,

Demertzis, & Efstathiou, 2018). The emergence of cryptocurrencies and the growth of their popularity have raised questions about their potential impact on traditional financial markets. There are conflicting opinions about whether these markets are interconnected (Wang, Zhang, Li, & Shen, 2019).

Supply and demand factors have a significant impact on Bitcoin, with demand factors being crucial. However, the research findings of Jakub (2015) do not support previous findings regarding the impact of certain global and financial factors and investor speculation on the price of Bitcoin. Although cryptocurrencies are attractive for investment, they have several differences compared to fiat money and financial instruments. The main drawback is the high market volatility, which makes it difficult to predict its exchange rate. Therefore, compared to official legal currency, cryptocurrency cannot serve as a means of savings or payment (Mikhaylov, 2020).

The interaction between cryptocurrency prices and the prices of gold and crude oil was analyzed by Asena Deniz & Teker (2020). Daily data from April 3, 2018, to December 31, 2020, was utilized. The results of this analysis showed that the prices of gold and crude oil do not have a strong influence on cryptocurrency prices. In the study by Erdas & Caglar (2018), an asymmetric causal relationship between Bitcoin and gold, crude oil, the US dollar, the S&P 500, and BIST 1000 indexes was analyzed using weekly data from 2013 to 2018. The results indicated that the only causal relationship exists was one-way for Bitcoin prices towards the S&P 500 Index. However, the authors failed to prove a causal relationship between Bitcoin and the other included variables. From January 2020 to October 2022, Wątorrek, Kwapien & Drożdż (2023) analyzed the correlation between the cryptocurrency market (Bitcoin and Ethereum) and traditional financial markets (such as stock indexes, Forex, and commodities). The results of the study indicate that since the onset of the COVID-19 crisis in March 2020, the dynamics of Bitcoin and Ethereum prices have become dependent on prices in traditional financial markets, and cryptocurrency prices also react to inflation similarly to traditional financial instruments. The influence of fundamental economic indicators on the virtual financial asset market and the possibility of using cryptocurrencies as assets were examined by Baranovskyi, Kuzheliev, Zherlitsyn, Serdyukov, & Sokyрко (2021). The analysis was based on US fundamental economic indicators data from 2014 to 2021. Through correlation and multiple regression analysis, the results indicate that cryptocurrencies can be an effective investment

tool, offering high returns and high variability. Additionally, there is a significant impact of stock and financial market prices on cryptocurrency prices. Bitcoin can become a new global currency and influence the future movements of some world currencies, such as the US dollar, euro, or Chinese yuan. However, in its current form, it cannot have significant implications for the US dollar. The main reason is that the regulation of Bitcoin is a major obstacle, as is its limited supply of 21 million units. The authors employed SEM technique for simultaneously testing and estimating causal relationships among multiple independent and dependent constructs. For uncovering the underlying structure of five key variables in the initial set of 30 respondents, they used EFA with ADANCO 1.1.1. Later, they applied CFA for 193 respondents (Seetharaman, Saravanan, Patwa, & Mehta, 2017).

Nam (2023) investigated the impact of cryptocurrencies on financial markets using a multiple linear regression model. The analysis included variables such as exchange rates, gold prices, crude oil prices, and stock indices. Over the period from 2014 to 2021, the results of this analysis indicate that cryptocurrencies have an impact on the financial market, with an inverse effect of currency pairs on cryptocurrencies and interaction among different cryptocurrencies. According to Trabelsi (2018), there are no significant spillover effects between cryptocurrency markets and traditional financial markets. The results of his research also indicate that cryptocurrencies are weakly integrated into the global financial market. The findings of Kim (2022) suggest that the cryptocurrency market is connected to the traditional financial market through reserve-backed stablecoins. Using the Pearson correlation coefficient, Ariya, Chanaim, & Dawod (2023) examined the impact of the COVID-19 pandemic on the relationship between the market prices of some traditional financial instruments and cryptocurrency prices. The results of the study indicate a direct impact on the movement of cryptocurrency prices as well as on the traditional financial market in Thailand from 2019 to 2022. Moreover, correlations have a stronger connection in the case of digital assets compared to traditional ones.

3. METHODOLOGICAL FRAMEWORK

The research covers the period from 2019 to 2023 and uses monthly data on the prices of three key cryptocurrencies: Bitcoin, Ethereum, and BNB. The data were collected from the leading website, CoinMarketCap (2024). Regarding traditional financial markets, data on the prices of crude oil, gold, and the MSCI World Index were used,

collected from the website Macrotrends (2024). The MSCI World Index provides a measure of the profitability of large and medium-sized companies worldwide, providing insight into global trends in financial markets.

First, a descriptive analysis of the selected variables was conducted, as shown in Table 1. Based on the results of descriptive statistics, it can be concluded that the maximum price of bitcoin during the analyzed period from 2019 to 2023 was \$60,352 in October 2021. According to the calculated standard deviation, the highest volatility was present in Bitcoin prices as well as in the price of gold. The maximum price of gold was \$65,477.41 in July 2020. The lowest volatility among the variables analyzed was observed in the price of oil throughout the analysis period.

Through the Kolmogorov-Smirnov and Shapiro-Wilk tests, an assessment of data normality was

conducted. According to the results shown in Table 1, based on the Kolmogorov-Smirnov test for the variables Bitcoin, Ethereum, BNB, and GOLD, the null hypothesis can be rejected, confirming that the data is not normally distributed, as the p-value is less than the accepted significance level of 0.05.

For the variable MSCI IDX, the null hypothesis can also be rejected. Similar results were obtained through the Shapiro-Wilk test, indicating that the p-value is lower than the accepted significance level for the variables Bitcoin, Ethereum, BNB, GOLD, and MSCI IDX, while for the variable OIL, the p-value is higher than the accepted significance level, standing at 0.905, indicating that according to this test, only in the case of the OIL and MSCI IDX variables are the data normally distributed.

Table 1. Descriptive Statistics

	Min.	Max.	Sum.	Mean.	Stand. dev.
BIT	3604.69	60352.00	1464881.55	24414.6925	15444.99148
ETH	108.90	4132.17	82786.14	1379.7690	1115.63154
BNB	6.17	591.20	11919.85	198.6642	167.44907
GOLD	41492.95	65477.41	3382875.93	56381.2655	6602.98886
OIL	18.84	114.09	4026.66	67.1110	20.73892
MSCI	1852.73	3370.00	157432.83	2623.8805	410.05016

Source: Author's calculation

Table 2. Test of Normality

Variables	Kolmogorov-Smirnov test		Shapiro-Wilk test	
	Statistic	Sig.	Statistic	Sig.
Bitcoin	0,135	0,008	0,934	0,003
Ethereum	0,175	0,000	0,898	0,000
BNB	0,238	0,000	0,872	0,000
Gold	0,131	0,012	0,909	0,000
Oil	0,055	0,200	0,990	0,905
MSCI IDX	0,110	0,069	0,952	0,020

Source: Author's calculation.

After checking the normality of the data distribution using the Shapiro-Wilk test, it was concluded that the data did not adhere to the assumption of a normal distribution. Given this characteristic of the dataset, it was decided to use Kendall's and Spearman's correlation coefficients to assess the relationship between cryptocurrency prices and selected traditional financial instruments. These coefficients are a suitable choice because they do not require assumptions about the normality of the data distribution, ensuring their applicability in situations where the data deviates from a normal distribution.

4. CORRELATION ANALYSIS

Based on the obtained results of the normality tests using Kendall's and Spearman's correlation coefficients, a detailed analysis of the relationship between the prices of cryptocurrencies Bitcoin, Ethereum, and BNB, and the prices of traditional financial instruments such as crude oil, gold, and the MSCI World Index was conducted. These coefficients will provide insight into the degree of correlation between these variables, contributing to a deeper understanding of the interactions between cryptocurrencies and traditional financial markets during the analyzed period. The hypotheses outlined in the study are as follows:

H0: There is no statistically significant relationship between the prices of cryptocurrencies (Bitcoin, Ethereum, BNB) and the prices of crude oil, gold, and the MSCI World Index.

H1: There is a statistically significant relationship between the prices of the mentioned cryptocurrencies and the prices of the mentioned traditional financial instruments.

According to the presented results of the correlation analysis using Kendall's coefficient, the alternative hypothesis can be confirmed, meaning that there is a statistically significant relationship between the prices of Bitcoin, Ethereum, and BNB with the prices of gold, crude oil, and the MSCI World Index. It is important to note that the relationship between the prices of selected

cryptocurrencies and the prices of traditional financial instruments is a positive correlation, as all obtained coefficients are in a positive sign (Table 3). Additionally, the obtained p-value is at the level of statistical significance of 0.01. According to Spearman's coefficient (Rho), the correlation matrix indicates that the null hypothesis can be rejected, and there is a statistically significant relationship between the prices of cryptocurrencies and the prices of gold, crude oil, and the MSCI World Index. The correlation relationship is even stronger according to Spearman's coefficient compared to Kendall's (Table 4).

Table 3. Correlation analysis - Kendall

Variables		BIT	ETH	BNB	GOLD	MSCI	OIL
BIT	Coeff.	1,000	0,820**	0,707**	0,350**	0,693**	0,323**
	Sig.		0,000	0,000	0,000	0,000	0,000
ETH	Coeff.	0,820**	1,000	0,779**	0,410**	0,738**	0,396**
	Sig.	0,000		0,000	0,000	0,000	0,000
BNB	Coeff.	0,707**	0,779**	1,000	0,297**	0,604**	0,468**
	Sig.	0,000	0,000		0,001	0,000	0,000
GOLD	Coeff.	0,350**	0,410**	0,297**	1,000	0,490**	0,213*
	Sig.	0,000	0,000	0,001		0,000	0,016
MSCI	Coeff.	0,693**	0,783**	0,604**	0,490**	1,000	0,280**
	Sig.	0,000	0,000	0,000	0,000		0,002
OIL	Coeff.	0,323**	0,396**	0,468**	0,213*	0,280**	1,000
	Sig.	0,000	0,000	0,000	0,016	0,002	

** Correlation is significant at the 0,01 level (2-tailed).

* Correlation is significant at the 0,05 level (2-tailed).

Source: Author's calculation.

Table 4. Correlation analysis - Spearman

Variables		BIT	ETH	BNB	GOLD	MSCI	OIL
BIT	Coeff.	1,000	0,940**	0,867**	0,534**	0,875**	0,551**
	Sig.		0,000	0,000	0,000	0,000	0,000
ETH	Coeff.	0,940*	1,000	0,927**	0,602**	0,890**	0,647**
	Sig.	0,000		0,000	0,000	0,000	0,000
BNB	Coeff.	0,867**	0,927**	1,000	0,468**	0,789**	0,707**
	Sig.	0,000	0,000		0,000	0,000	0,000
GOLD	Coeff.	0,534**	0,602**	0,468**	1,000	0,689**	0,316*
	Sig.	0,000	0,000	0,001		0,000	0,014
MSCI	Coeff.	0,875**	0,890**	0,789**	0,689**	1,000	0,475**
	Sig.	0,000	0,000	0,000	0,000		0,002
OIL	Coeff.	0,551**	0,647**	0,707**	0,316*	0,475**	1,000
	Sig.	0,000	0,000	0,000	0,014	0,000	

** Correlation is significant at the 0,01 level (2-tailed).

* Correlation is significant at the 0,05 level (2-tailed).

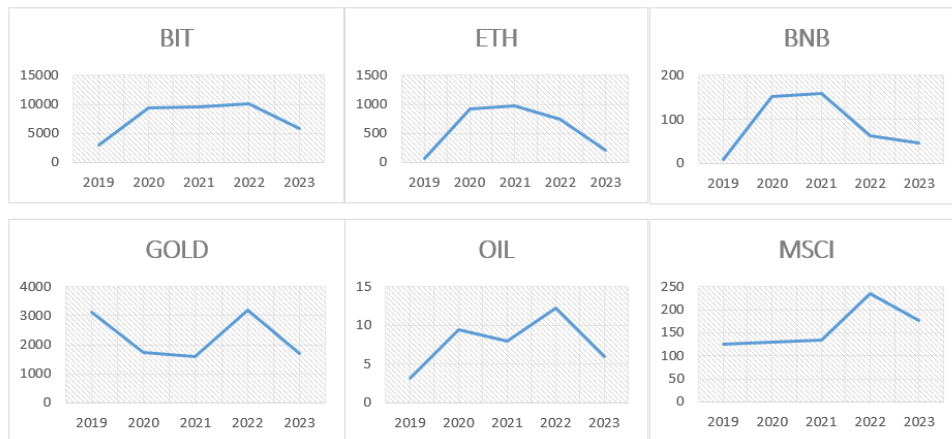
Source: Author's calculation.

The volatility of cryptocurrency prices and the prices of traditional financial instruments is calculated using the standard deviation. Based on Graph 1, it can be observed that there is a decrease in volatility for all analyzed variables. In the case of Bitcoin, a decrease in volatility is observed from the year 2022. For Ethereum, it is noted that the volatility of prices shows a gradual decrease from the year 2021, followed by a more intense decline from the year 2022. The price of BNB records a drastic decrease in volatility from the year 2021, followed by a milder decline from the year 2022. An interesting fact about the volatility of gold prices is that from the year 2021 to 2022, there is a drastic increase in volatility followed by a steep decline from the year 2022 to 2023.

The price of crude oil records a significant decrease in volatility from the year 2022. The MSCI World Index shows an increase in volatility from 2021 to 2022, followed by a milder decline in the last year of 2023. Therefore, although there has been a decrease in volatility in the prices of cryptocurrencies and traditional financial instruments, there is a difference in whether this occurred in 2021 or 2022. What is evident is that in the last year of 2023, there was a decrease in volatility for all analyzed variables.

However, although there is an evident decrease in volatility across all observed variables, it is important to highlight which variables had the highest volatility each year.

Graph 1. The volatility of the cryptocurrency market and traditional financial market



Source: Author's calculation.

Table 5. Volatility 2019-2023

	Bitcoin	Ethereum	BNB	Gold	Oil	MSCI IDX
2019	2917.75	60.72321	9.33681	3111.08	3.11407	125.40261
2020	9375.56325	926.28815	151.18313	1745.03514	9.4442	129.68762
2021	9482.60759	967.33633	157.81005	1602.74592	8.03186	135.31917
2022	10101.57449	743.57724	62.75407	3184.282	12.29753	235.37136
2023	5849.04533	218.1647	46.05434	1712.99851	5.95665	175.83301

Source: Author's calculation.

Based on Table 5, it can be concluded that in the analyzed period from 2019 to 2023, both in the cryptocurrency market and traditional financial markets, the lowest volatility was observed in 2019. When comparing variables from the cryptocurrency market and traditional markets, it is evident that there is higher volatility in the former. Within the cryptocurrency market, the highest volatility is observed in the case of Bitcoin, specifically in 2022. However, the prices of

Ethereum and BNB cryptocurrencies recorded their highest volatility in 2021. In the case of traditional financial markets, the highest volatility is observed in the price of gold, while the lowest is observed in the price of crude oil. Additionally, it is noted that the highest volatility in this market was in 2022, similar to Bitcoin. The generalized conclusion is that in the last year of the analysis, 2023, volatility decreased in both observed

markets, but it remained higher compared to the

initial analyzed year (2019).

5. VAR ANALYSIS

To conduct a time series analysis, it is crucial to first perform a stationarity test. Stationarity represents a fundamental assumption necessary for reliable interpretation of results and accurate forecasting of future values. If time series data is non-stationary, it can lead to unreliable analyses and inaccurate conclusions. In our research, the stationarity of all relevant variables, including the

prices of Bitcoin, Ethereum, BNB, gold, crude oil, and MSCI_IDX, was examined using the Dickey-Fuller test (Dickey-Fuller, 1979). The results indicated that the time series were non-stationary at level, prompting us to apply differencing to achieve stationarity. The results of the Dickey-Fuller stationarity test are comprehensively presented in the attached Table 6.

Table 6. Dickey-Fuller test for unit root

	T-statistic	P-value
DBIT	-6,136	0,000*
DETH	-7,599	0,000*
DBNB	-8,487	0,000*
DGOLD	-8,961	0,000*
DOIL	-6,795	0,000*
DMSCI_IDX	-5,745	0,000*

**1% significance level*

Source: Author's

Based on the results presented in the table, we can conclude that all variables are stationary after applying first differencing. Additionally, the negative t-statistic values for all variables indicate the presence of negative correlation between the variables and their lagged values. The very low p-value obtained for all variables (0.000) suggests that the null hypothesis of the presence of a unit root in the time series is rejected with a high degree of confidence. In other words, the time series of the variables under consideration do not exhibit non-stationarity characteristics. To investigate the relationships and interactions among multiple variables over time, the use of a VAR (Vector Autoregression) model was chosen. Building a VAR model requires that all variables included in the analysis are stationary, which has been confirmed through the application of the Dickey-Fuller test. Stationarity is a key prerequisite for reliable time series analysis, enabling precise modeling of interdependencies and forecasting of future variable movements. We constructed a VAR model using Bitcoin, Ethereum, BNB, gold, crude oil, and MSCI_IDX as variables.

In order to estimate the VAR model, we investigated the optimal lag length using the Akaike, Schwarz, and Hannan-Quinn criteria, as well as the prediction error criterion. Based on these criteria, two periods seemed to be the optimal lag length. These findings served as the basis for specifying the VAR model, enabling us to effectively model the relationships among variables over time. Specifically, we examined

stationary conditions after estimating the VAR model. This step holds significant importance for ensuring the reliability of our findings. In essence, when the inverse roots of the characteristic AR polynomial have a modulus of less than one and fall within the unit circle, the stability of the VAR model estimation is affirmed, and conversely. Upon examining the results concerning the Eigenvalue stability condition, we ascertain the stability of the VAR model, as all eigenvalues reside within the unit circle. These results serve to bolster the credibility of our statistical analyses and empower us to interpret the outcomes of our model with confidence. Subsequently, we checked for autocorrelation among the residuals. The Lagrange Multiplier test was then conducted to investigate whether there is autocorrelation at the selected lag. According to the results of this test, the null hypothesis cannot be rejected, confirming that there is no autocorrelation in the model at the selected lag of two periods. After conducting the tests, the Granger Causality Test was examined (Table 7). This test investigates whether lagged values of one variable help predict other variables in the model.

H0: X does not Granger Cause Y

H1: X Granger Causes Y

Rule of decision: if p-value is:

<0,05 = "X" Granger causes "Y" at the 5% significance level.

>0,05 = "X" does not Granger cause "Y" at the 5% significance level.

Table 7. Granger Causality Wald test

	chi2	df	prob>chi2
BIT→OIL	5,761	2	0,050**
OIL→BIT	0,591	2	0,744
BIT→GOLD	0,136	2	0,934
GOLD→BIT	0,557	2	0,757
BIT→MSCI_IDX	3,493	2	0,174
MSCI_IDX→BIT	3,272	2	0,195
ETH→OIL	1,293	2	0,524
OIL→ETH	0,614	2	0,736
ETH→GOLD	0,953	2	0,621
GOLD→ETH	0,518	2	0,772
ETH→MSCI_IDX	1,115	2	0,561
MSCI_IDX→ETH	7,180	2	0,028**
BNB→OIL	5,211	2	0,074
OIL→BNB	1,238	2	0,538
BNB→GOLD	2,042	2	0,360
GOLD→BNB	3,215	2	0,200
BNB→MSCI_IDX	2,127	2	0,345
MSCI_IDX→BNB	2,843	2	0,241
BIT→ETH	12,237	2	0,002*
ETH→BIT	3,262	2	0,196
BIT→BNB	26,453	2	0,000*
BNB→BIT	40,131	2	0,000*
ETH→BNB	7,529	2	0,023**
BNB→ETH	1,402	2	0,496

*1% significance level

**5% significance level

Source: Author's calculation.

Based on the results of the Granger Causality test, we observe that only a few variables exhibit mutual interactions. For instance, the price of Bitcoin, with a p-value of 0.05 at a significance level of 5%, can be useful in predicting future movements in the price of crude oil. Similarly, the movement of MSCI_IDX, with a statistical significance of 5%, can predict future movements in the price of Ethereum. We notice that there are more causal relationships in the cryptocurrency market, especially among the selected three cryptocurrencies. For example, at a significance

CONCLUSION

The correlation analysis, conducted using Kendall's and Spearman's correlation coefficients, clearly rejects the null hypothesis of no statistically significant relationship between cryptocurrency prices and prices of traditional financial instruments. Specifically, the results highlight statistically significant and positive correlations between the prices of Bitcoin, Ethereum, and BNB, and the prices of crude oil, gold, and the MSCI World Index. Despite the high volatility of the cryptocurrency market, this

level of 1%, the price of Bitcoin can predict future movements in the price of Ethereum, but not vice versa. In the case of variables Bitcoin and BNB, there is a causal relationship in both directions, with statistical significance of 1% (BIT→BNB) and 5% (BIT→BNB). Additionally, the price of Ethereum can be useful in predicting future prices of BNB, with a statistical significance of 5%. So, only in these interactions and causal relationships can we reject the null hypothesis, while in most others, we must accept the alternative hypothesis.

suggests its integration with traditional financial markets, which may be of interest to investors for portfolio diversification and risk management purposes. Finding a significant interaction between these diverse asset classes implies that macroeconomic factors could simultaneously affect both sectors, warranting further research to better understand the causes and mechanisms of these connections. At the 1% significance level, the price of Bitcoin predicts movements in the price of Ethereum, but not vice versa.

Additionally, there is a causal relationship between the prices of Bitcoin and BNB in both directions, with statistical significance at 1% and 5%. The price of Ethereum can predict the price of BNB with 5% statistical significance. This study has contributed to understanding the relationship between major cryptocurrencies and selected traditional financial instruments, stocks,

and indexes, as well as comparing their dynamics during the period from 2019 to 2023. Future research should include more variables from both mentioned markets and attempt to construct an adequate model to further investigate the dynamics in these markets, their connectivity, and mutual influence.

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