Investigation of the Causal Relationship Between Crypto Currency Prices and The Gross Domestic Products of BRICS Countries: Bitcoin Example[1]

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Abstract

The aim of the study is to investigate the causal relationship between the most popular cryptocurrency, BITCOIN, and the annual Gross National Product (GNP) values of the BRICS countries (Brazil, Russia, India, China, and South Africa). In this context, the Granger Causality Model developed by C. W. J. Granger (1969) was used. Annual BITCOIN prices and annual GNP data of BRICS countries between 2010 and 2020 were included in the analysis and calculations were made. The striking result in the analysis was that when the relationship between China's GNP data and BITCOIN prices was calculated, they formed a bidirectional causality relationship. There was no significant relationship between GNP data of other BRICS countries and BITCOIN prices.

Keywords: Cripto Currencies, BRICS Countries, Gross Domestic Product, BİTCOIN.

1. Introduction

Thanks to developing technology, many transactions have now become faster and almost everything can be performed electronically. One of the innovations this has brought is cryptocurrencies. This market, which has become a phenomenon recently, is subject to buying and selling on many platforms with high transaction volumes. Cryptocurrencies are currencies that are secured on the basis of cryptology, whose encryption system is based on mathematical equations, and are available in digital form and available for use. Cryptocurrencies used via the internet, without a monitoring mechanism, emerged as an attempt to establish a digital cash system (Nair and Motwani, 2018, p.35).

Bitcoin, the most popular cryptocurrency, was published by a user or group under the pseudonym "Satoshi Nakamoto" in a study titled "Bitcoin: Peer-to-Peer Electronic Cash Payment System" to intermediary institutions, banks and central banks, and even governments. It was introduced to the world in 2008, when trust was decreasing and a global crisis was experienced (Nakamoto, 2009). The main idea of launching this cryptocurrency is to decentralize the financial system by freeing it from the hands of a certain number of decision makers. In other words, by creating a free market without external intervention in the system, the prices of the asset in question are determined only by the users. The total supply limit is 21 million units (Arıcan and Yücemüş, 2018, p. 8-11).

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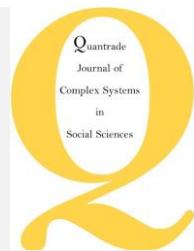
The technology used to create cryptocurrencies is called Blockchain technology. The working principle of this system is that encrypted data are connected to each other like a chain link, combining them in an internal access in the form of unchangeable blocks. The basis of this technology lies in cryptography. The concept of cryptography means encryption and decryption in a mathematical context. In this context, it refers to putting the information in a state where it cannot be known by anyone other than the recipients. In this structure, data that has not yet been encrypted is encrypted and hidden using a mathematical algorithm. Thus, ordinary unencrypted data takes on a complex structure when cryptography is involved. The purpose of blockchain technology in using cryptography is to secure the identity of those sending the data and to ensure that historical records are kept and cannot be changed (Atabaş, 2018, p. 11-25).

On May 22, 2010, a user with the pseudonym "Laszlo" purchased 2 pizzas by paying with Bitcoin. Another Bitcoin user purchased the pizza from Dominos on behalf of Laszlo, paying 10,000 Bitcoins and had it shipped to his address. May 22, 2010 went down in history as the day Bitcoin was used as a medium of exchange for the first time in history. This date is celebrated as Laszlo Pizza Day in many parts of the world (Çarkacıoğlu, 2016, p. 17).

Cryptocurrencies are examined in two separate forms, coins and tokens, considering the principle of their production. While crypto assets that have their own blockchain are referred to as coins, crypto assets that are traded on the blockchain that is currently in use belonging to a coin are called tokens. For example, crypto assets named Tether and Tron are tokens because they use the blockchain of the coin called Ethereum (Güven and Şahinöz, 2018, p. 85-86).

In recent years, various cryptocurrencies such as Litecoin, Etherium, Auroracoin and Dogecoin, which are described as altcoins after Bitcoin, have emerged, but Bitcoin has had the largest number of users since its establishment. With each passing day, the increase in the number of companies accepting Bitcoin has ensured that the assumed value of this cryptocurrency becomes real. The high volatility of Bitcoin prices has led financial experts and many others to assume that it is a speculative instrument (Bouoiyour et al., 2015).

As of January 2022, the amount of Bitcoin in circulation in the market is approximately 18.93 million. While Bitcoin was traded at $0.1 in the market in August 2010, it is traded at $41,815.2 as of January 20, 2022 (Investing.com).

Nowadays, cryptocurrencies have become a frequently followed market, especially in our country, and the number of users has gradually increased. Cryptocurrencies have now become investment instruments, and buying and selling activities have begun to occur very frequently. In the study, the causality relationship between Bitcoin and the Gross National Product values of BRICS countries was examined. This causality relationship was tested with Granger Causality Analysis. The results of this test were also interpreted and concluded in the study.

2. Literature

In their study, Koy et al. (2023) investigated the presence of US stock market index returns in the volatility structure of Bitcoin. In the study, daily data for the period 10.03.2016 – 11.06.2019 was used. In the study, GARCH, EGARCH and TARCH models, which are Generalized Autoregressive Conditional Heteroscedasticity models, were used. SP500, Nasdaq100 and Dow Jones Industrial were used as variance variables. Findings show that all three indices are significant in explaining the volatility of Bitcoin, the models developed with stock market indices, GARCH, EGARCH and TARCH models are all stronger than the similar basic model, and the EGARCH model developed with indices is the strongest model.

In his study, Sezal (2023) conducted an econometric investigation of the relationship between Bitcoin prices and the Dollar index. In the research, the data range covers the business day of 21.12.2021 and consists of daily data. Time series analysis was used as a method in the study. According to the Toda-Yamamoto test results, it has been determined that there is no causal relationship between Bitcoin prices and the Dollar index.

In his study, Andrean (2020) examined the determinant affecting Bitcoin prices and how bitcoin prices react to GDP (Gross Domestic Product), inflation, exchange rate, JCI (Jakarta Composite Index) shock. According to the results obtained from the study, (1) inflation has a negative significant effect on futures Bitcoin prices in the short term and long term, and the exchange rate has a positive significant effect on the Bitcoin price in the long term. In the short term and long term, GDP and JCI have no significant impact on Bitcoin prices. (2) According to the IRF results, while Bitcoin prices reacted negatively to GDP and exchange rate, Bitcoin prices reacted positively to the shock from inflation and JCI.

Dulupçu et al., (2017) discussed the functioning and importance of Bitcoin and examined the causality relationship between the popularity of Bitcoin and Bitcoin prices. As a measure of popularity, it was based on internet searches for Bitcoin. According to the analysis results, they detected a causal relationship from internet searches regarding Bitcoin to Bitcoin prices. Thus, they found that as Bitcoin's popularity increases, its prices will also increase.

Baek and Elbeck (2015) used Bitcoin and S&P 500 daily data and studied the question of whether Bitcoin can be considered an investment tool or a speculative instrument. The findings show that Bitcoin has greater volatility than the S&P500 index and that Bitcoin is not affected by fundamental macroeconomic variables. They also stated that Bitcoin is
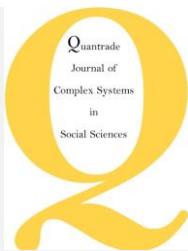
a speculative tool driven by sellers and buyers. However, if the use of Bitcoin increases, its volatility will be expected to decrease. Thus, there will be a more balanced economic impact representing the investment instrument.

Dyhrberg (2016) examined the hedging abilities of Bitcoin against gold and the dollar with volatility modeling using GARCH models. He addressed the ability to hedge financial risk through various macroeconomic variables measuring sensitivities to the price of gold and the dollar. The variables in question are the exchange rate of gold and the dollar, the dollar value of gold bullion, the FTSE Index, the gold cash rate and the gold futures rate. The asymmetric GARCH model has concluded that a negative news that may come to the market is an ideal way to manage risk for investors. In addition, Bitcoin and gold; They emphasized that they have similar characteristics in terms of their similar reactions to the variables in the GARCH model, their ability to hedge risks, and their asymmetrical reactions to good and bad news.

Koçoğlu et al., (2016), Bitfinex, Btce, Bitstamp, Mt., which can be traded in Bitcoin markets according to transaction volume and in currencies such as US Dollar, Euro, Sterling, Yen and Yuan. They analyzed the exchanges Gox, Kraken, Okcoin, Coinfloor, Anx and tested the existence of their relationship with Bitcoin. Although there is a cointegration relationship, no causality relationship was found. Bitcoin has been considered as an investment instrument and it has been stated that it is unreliable and can be used speculatively due to its extreme volatility.

Dirican and Canöz (2017) investigated the relationship between Bitcoin prices and the largest major stock market indices in the world. A cointegration relationship has been observed between Bitcoin prices and leading US and Chinese Stock Exchange indices. In this context, they concluded that Bitcoin prices can affect the long-term investment decisions of investors in these exchanges and that there is no relationship between Bitcoin and London FTSE100, Tokyo NIKKEI 225 and Istanbul BIST100.

In their study where they analyzed the causality relationship between the 10 cryptocurrencies with the highest market value, Karaağaç and Altınırmak (2018) conducted Johansen Cointegration and Granger Causality analysis to determine the relationship between the prices of cryptocurrencies, using the prices between 15.12.2017 and 17.01.2018. According to the findings obtained from this analysis, they concluded that the prices of cryptocurrencies, which have a causal relationship between them, affect each other in the short term.

In his study, Kasper (2017) compared the volatility of Bitcoin with the currencies of underdeveloped countries and other cryptocurrencies with the GARCH model. As a result of the study, it was concluded that Bitcoin volatility is significantly higher than the volatility in currencies according to the exchange rate and yield data of underdeveloped countries.

In their study, İçellioğlu and Öztürk (2017) determined the relationship between Bitcoin and some exchange rates using unit root tests, Engel-Granger Cointegration Test, Johansen Test and Granger Causality Test. In the study, the working days between 29.04.2013 and 22.09.2017 were taken into account and it was concluded that there was no long or short term relationship between Bitcoin and Dollar, Euro, Pound, Yen and Yuan.

Vockathaler (2015) investigated the long-term factors affecting the market price by examining the volatility of Bitcoin prices. According to the results, he stated that unexpected shocks increased the volatility of Bitcoin and the effects of these shocks could be modeled with the GARCH model. With the empirical findings obtained, it was concluded that unexpected shocks contributed the most to Bitcoin volatility.

In their study, Pichl and Kaizoji (2017) examined the effect of standard currencies and their volatility in the last five years on the price of Bitcoin. The volatility of Bitcoin exchange rates is modeled using daily logarithmic return distribution and realized volatility. As a result of the study, time series of Bitcoin prices are similar to the prices of EUR/USD exchange rates.

In his study examining the effect of Tether issuance on Bitcoin prices, Wei (2018) analyzed the Granger Causality relationship between Tether and Bitcoin prices by creating a VAR model. According to the analysis findings, it was concluded that the transaction volume of Bitcoin increased in the periods after the issuance of Tether, but there was no significant change in its price.

Göttfert (2019) in his study analyzing the cointegration relationship between Bitcoin and Etherium, Ripple, Bitcoin Cash, EOS and Litecoin, according to the Granger Causality test and Vector Error Correction Model results, Bitcoin is cointegrated with Bitcoin Cash, Ethereum, Litecoin and Ripple, With EOS, it was concluded that it was not, and it was also determined that the Bitcoin price had a statistically significant effect on the prices of Bitcoin Cash, Ethereum, Litecoin and Ripple in the long term.

In his study, Hacıoğlu (2019) examined the practical consequences of Blockchain and cryptocurrencies in terms of businesses and investments. He discussed decentralized consensus ledgers applied to cryptography and legal boundaries.

In their study, Ulusoy and Çelik (2019), following the second law of thermodynamics, started from the question of whether the amount of work given to the system in the cryptocurrency reserve can explain the possible transaction (stock market) prices. In the study, possible cash flows with the Carnot cycle were examined from a new perspective.

In his study, Uygun (2019) explained the blockchain system in a way that it can be applied to economic systems.
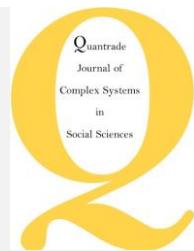
In their study, Kendirli and Şenol (2021) examined the impact analysis between major stock market volume and Bitcoin volume in the 11-month period between 2019-2020 within the framework of Chaos theory, and then the relationship between them and the world uncertainty index was examined.

In his study, Abed (2023) evaluated the positive impact of cryptocurrencies on the monetary policy represented by the financial and banking sector of the State of El Salvador. In addition, it sought to measure the level of trust and acceptance in adopting cryptocurrencies in the banking and finance field. Survey method was used in the study. According to the results of the study, a statistically significant impact relationship was found between the adoption of cryptocurrencies and the monetary policy of the banking sector by reducing the costs of banking services and increasing operational efficiency, developing and improving banking services.

3. Method

Granger causality test is a statistical hypothesis test of whether one time series is suitable for predicting another time series. Normally correlations "merely" reflect correlations, but Clive Granger (1969) has argued that a certain set of tests reveals something about causation. A time series . Let y and x be stationary time series. A step-by-step test of the basic hypothesis "x is not a Granger cause of y":

(1) Appropriate lag values (number of lags) of y in a univariate autorelation of y are found:

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \cdots . + a_m y_{t-m} + kalıntı_t$$

(2) The autorelation of y is expanded by adding the lagged values of x:

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \cdots . + a_m y_{t-m} + b_p x_{t-p} + \cdots + b_q x_{t-q} + kalıntı_t$$

According to the test, it is preserved if it adds strength to the explanatory power of the correlation (basic hypothesis in the F test: "x's together do not contribute to the explanatory power"). In the extended correlation representation above, the shortest lag length that makes the lagged value of x meaningful is p, and the longest lag length is q'. "x is not a Granger cause of y" is preserved. In the above context, no delay of x is preserved.

In the study, since Bitcoin will be tested bi-directionally for Granger causality with each variable, separate hypotheses have been determined for all of them. While the hypotheses are stated below, the x GDP value is symbolized as the GDP value of the country to be tested.

Bitcoin is the independent variable and x GDP is the dependent variable;

H0: Bitcoin does not Granger cause x GDP.
H1: Bitcoin is the Granger cause of x GDP.
Bitcoin is the dependent variable; x GDP is the independent variable;

H0: x GDP does not Granger Cause Bitcoin.
H1: x GDP is the Granger cause of Bitcoin.

4. Data Set, Analysis and Findings

Bitcoin annual prices and Gross National Product (GNP) data of BRICS countries (Brazil, Russia, India, China, South Africa) were obtained and included in the analysis. Bitcoin data was obtained from Investing, and GDP data of BRICS countries was obtained from the World Bank database. Table 1 is including the data sets.

Table-1: Dataset Table

Abbreviation	Explanation	Period	Time Range	Source
BTC	Bitcoin Prices	Per year	2010-2020	Investing.com
BRA	Brazil GDP	Per year	2010-2020	World Bank Database
RUS	Russia GDP	Per year	2010-2020	World Bank Database
IND	India GDP	Per year	2010-2020	World Bank Database
CHI	China GDP	Per year	2010-2020	World Bank Database
GAF	South Africa GDP	Per year	2010-2020	World Bank Database
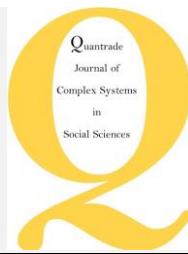
Country	Brazil	Russia	India	China	South Africa
2010	2,140,639,114,483.86	1,477,812,768,442.99	1,657,660,320,258.90	6,061,091,977,327.45	367,345,427,102.11
2011	2,548,973,132,352.94	1,985,526,208,275.05	1,807,018,710,051.40	7,481,123,496,788.67	405,768,835,686.05
2012	2,403,681,256,873.69	2,140,634,973,644.45	1,806,177,662,220.65	8,512,412,397,984.89	385,572,905,881.92
2013	2,438,446,843,189.09	2,212,868,846,622.34	1,833,601,556,952.89	9,492,579,024,339.07	357,214,254,626.85
2014	2,410,227,796,260.09	1,991,279,765,491.87	2,015,015,376,660.14	10,488,982,516,424.10	341,540,887,462.65
2015	1,768,302,238,329.98	1,325,732,263,446.11	2,079,182,325,743.56	11,019,763,021,469.30	309,749,111,813.47
2016	1,757,603,662,733.08	1,241,290,379,222.41	2,247,940,124,045.80	11,188,324,988,592.10	288,167,015,664.09
2017	2,024,930,461,457.34	1,532,146,087,071.58	2,622,799,774,506.27	12,300,721,956,915.40	339,070,750,925.79
2018	1,863,643,739,320.33	1,616,936,975,710.13	2,672,176,417,221.77	13,819,938,054,383.30	356,648,758,113.63
2019	1,827,512,816,466.85	1,633,927,975,465.61	2,843,265,469,943.79	14,246,120,664,698.00	341,523,075,219.40
2020	1,417,068,693,062.22	1,448,704,617,346.39	2,598,299,250,058.05	14,623,681,312,311.60	296,205,721,888.91

Table 2 includes Bitcoin annual data.

Table – 2: Bitcoin Annual Prices

As seen in the table, it started with $ 0.30 and reached $ 28,949.40 by the end of 2020. It has also been observed that this price has decreased from time to time in the interim periods. These data will be included in the Granger causality analysis and calculations will be made. Apart from these, there is also a table of GNP data of BRICS countries. These data can be seen in Table 3 below.

Table – 3: Gross National Product Values of BRICS Countries

Date	Price
2010	$ 0.30
2011	$ 4.70
2012	$ 13.50
2013	$ 805.90
2014	$ 318.20
2015	$ 430.00
2016	$ 963.40
2017	$ 13,850.40
2018	$ 3,709.40
2019	$ 7,196.40
2020	$ 28,949.40

As seen in the table, the volumes of these countries remained at billion Dollar analyzed one by one with relationship between each Table 4 below.

data of BRICS countries are included. While the GNP reach trillions of dollars; Only South African GNP values levels. Bitcoin annual price information was compared and the annual GNP of these countries, and the causality pair was tested. The results of these tests are shown in the

Table – 4: Causality Relationship Between Bitcoin and Brazilian GNP

The dependent variable: BRA

	Ki-Square	GU	Possibility
BTC	0.048563	1	0.8256

The dependent variable: BTC
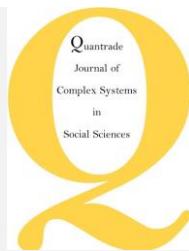
	Ki-Square	GU	Possibility
BRA	0.045576	1	0.8309

In Table - 4, Granger causality between Brazilian GNP and Bitcoin was examined, in this context, both Brazilian GNP and Bitcoin price were considered as separate dependent variables and causality was sought in both scenarios. In the table, BRA is coded as Brazil's GNP and BTC is coded as Bitcoin price. In the table, while Brazilian GNP is the dependent variable, the probability value for BTC is 0.8256, which corresponds to the null hypothesis "Bitcoin is not the Granger cause of Brazilian GNP." will require the hypothesis to be accepted. At the same time, since the probability value was 0.8309 when the dependent variable was BTC, the null hypothesis was accepted and a causal relationship between these two variables could not be determined.

Table – 5: Causal Relationship Between Bitcoin and Russian GNP

The dependent variable: BTC

	Ki- Square	GU	Possibility
RUS	0.108342	1	0.7420

The dependent variable: RUS

	Ki- Square	GU	Possibility
BTC	0.000172	1	0.9895

In the results in Table 5, Bitcoin is coded with BTC and Russian GNP data is coded with RUS. Again, since the probability values in both scenarios are well above 5%, the null hypothesis is accepted and it can be said that there is no causal relationship between them.

Table – 6: Causal Relationship Between Bitcoin and India GNP

The dependent variable: BTC

	Ki- Square	GU	Possibility
IND	1.035831	1	0.3088

The dependent variable: IND

	Ki- Square	GU	Possibility
BTC	0.754362	1	0.3851

In Table – 6, Indian GNP is coded with IND. In cases where both values are considered dependent variables, the probability values are above 5%, so it cannot be said that there is a causal relationship between these two variables.

Table – 7: Causal Relationship Between Bitcoin and China GNP

The dependent variable: BTC

	Ki- Square	GU	Possibility
CHN	9.154977	1	0.0025
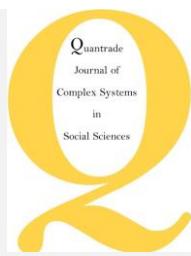
The dependent variable: CHN

	Ki- Square	GU	Possibility
BTC	4.530905	1	0.0333

In Table 7, Chinese GNP data is coded as CHN. Unlike the others in this table, the probability values are below 5% in both cases. In this case, H1: "China GDP is the Granger cause of Bitcoin." and "Bitcoin is the Granger cause of China GDP." The hypothesis has been realized. In other words, it can be said that there is a mutual causality relationship between China and Bitcoin. The point that draws attention here is; In 2021, the Chinese Government banned Bitcoin activities throughout the country. However, according to analysis until this year, there is a mutual causality relationship between GNP and Bitcoin prices.

Table – 8: Causal Relationship Between Bitcoin and South African GNP

The dependent variable: BTC

	Ki- Square	GU	Possibility
GAF	1.191375	1	0.2751

The dependent variable: GAF

	Ki- Square	GU	Possibility
BTC	0.261283	1	0.6092

In Table 8, South Africa's GNP data is coded as GAF. Since no mutual causality relationship is found in this table, the null hypothesis will be accepted. Thus, neither Bitcoin Granger-causes the South African GNP data nor South African GNP Granger-causes Bitcoin.

5. Conclusion

With the developing technology and rapid globalization, every transaction has started to be transferred to the electronic environment, and many transactions continue to be carried out in electronic environments. These developments are also open to generating new developments. Cryptocurrency was created at a time when trust in states, markets and governments was decreasing, and it gained a lot of value in a 10-year period and became extremely volatile.

In this study, a research was conducted on whether there is a causal relationship between crypto currencies and the GNP amounts of countries, based on Bitcoin, and BRICS countries were selected and included as samples in this research. With the Granger Causality Analysis, Bitcoin prices and GNP data of 5 countries were compared one by one, and the results were interpreted.

As a result of the analysis, no causal relationship was found between the GNP data of Brazil, Russia, India and South Africa and Bitcoin prices. However, a mutual causality relationship was observed between China's GNP and Bitcoin, and it was concluded that they were the cause of each other. On September 24, 2021, the Central Bank of China announced that the activities of Bitcoin and its derivatives are illegal and that sanctions will be imposed if they are detected (BBC). Since Bitcoin was free in China until September 2021, it showed a causal relationship between GNP and cryptocurrency in practice. This may lead to the following conclusion: If China's GNP affected Bitcoin prices as found in the study and was affected by it, it may have realized this and felt the need to intervene.

The results obtained from the study and the results obtained from Adrean's (2020) study are compatible with each other. The study confirmed Adrean's study and there is no interaction between countries' GNP and bitcoin prices.
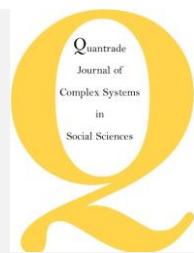
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