DIGITALIZATION IN BUSINESS AND ECONOMY

(Blockchain, Cryptocurrencies, Industry 4.0, Digital Transformation)

Editor
Dr. Ozan Gönüllü

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CHAPTER 13

CORRELATION ANALYSIS BETWEEN BITCOIN AND TOP CRYPTOCURRENCIES' RETURNS

*Muhammet Rıdvan İnce - Murat Emiköne*l

1. Introduction

Many factors affect economic understanding. One of the most important of these is technological innovations. With the introduction of technology into our lives, economic concepts are evolving in this direction. Although technology generally directs our economic life through real markets and production systems, it has also started to affect the money market through the banking system, especially since the 1980s. As a simple example, the entry of credit cards into our lives has revealed the necessity of abandoning and updating the classical views about the speed of Money circulation.

Recently, the effects of blockchain-supported technological developments on the money market have generally been towards a more effective and efficient structure of the existing system. However, blockchain technology, which is based on an older theory, has practically been in our lives for a little more than ten years. It appears as a technological innovation that ultimately questions the current monetary system with crypto asset markets. The most important feature of this new system is the acceptance of non-centralized currencies by economic units. In the traditional system, each state has separate currencies and these currencies get their power from the production power of the economy they belong to, while the assets in the cryptocurrency market get their power directly from their technological structures and supply-demand dynamics.

The inclusion of cryptocurrencies in economic dynamics is based on the article “Bitcoin: A Peer-to-Peer Electronic Cash System” published by Satoshi Nakamoto in 2008. The first example of cryptocurrencies is Bitcoin (BTC), which still

constitutes an integral part of the crypto asset market today. Comparing the value of this cryptocurrency when it was first released to the market and its current value explains the importance of crypto money markets in economic life in the most accurate way. According to the BTC / USD rate published by the New Liberty Standard stock exchange in October 2009, 1 $ = 1,309 BTC, while as of May 18, 2022, according to the average BTC / USD rate of 2022, it corresponds to 1 $ = 0.00000024 BTC. This shows that BTC has experienced a valuation of more than 5.5 trillion times against the USD in the past period.

BTC, which was only known by a very small group in the first days of its release, has started to be recognized by many segments, especially with the establishment of crypto money exchanges. The establishment of cryptocurrency exchanges and the launch of new cryptocurrencies along with BTC have attracted people's attention to this market. According to Coinmarketcap data, as of May 2022, there are 19,432 currencies and 526 exchanges in the crypto money market, and the market's total value is over 1.5 trillion dollars. In the light of these data, it would not be wrong to say that a significant part of the world's population trades on cryptocurrency exchanges and evaluates their savings in these markets. However, the fact that the money and finance authorities, which are influential on a global scale, follow these markets very closely and take positions according to the price movements in the markets is just one of the many factors that show the importance of crypto assets.

Like every asset with a value and monetary value, cryptocurrencies are also priced. These price movements take place depending on supply and demand conditions within the framework of micro and macro economic dynamics. However, compared to other exchanges, the crypto asset market stands out as a market with very high volatility compared to other markets. Such a high level of volatility is one of the major obstacles that may come in the way of crypto assets collecting investment. According to Coinmarketcap data dated May 2022, it is seen that the price movements of BTC, which constitutes approximately 45% of the total market value of the crypto asset market, are shaping the market. As a matter of fact, many academic studies on the subject and the evaluations of market analysts show that a significant part of the price movements in the market is parallel to the price movements of BTC, which is the flagship of the market. The price movements of BTC, on the other hand, are affected by the movements in other asset prices, commodity prices, global-scale decision mechanisms directing the market, and many other macroeconomic dynamics, especially the central banks, which are essential on a global scale.

In this direction, in the simplest sense, it is accepted by market participants that there is a solid and meaningful relationship between the price movements of BTC and cryptocurrencies other than BTC - these cryptocurrencies are called altcoins.

The main purpose of the study is to reveal the strength and direction of the relationship between price movements within the framework of intra-market dynamics, based on the existence of this relationship between cryptocurrencies. In this context, the strength and direction of the relationship between the price movements of the seven cryptocurrencies with the highest market share as of May 2022 were tried to be revealed by correlation analysis. For this purpose, the study is divided into four parts in the following sections. In the second part, the conceptual framework about the cryptocurrency market is presented. In the third part, information is given about the global markets and the movements in the crypto money markets of the epidemic period, which is the first and most significant development that can affect the economic data on a global scale after the emergence of the crypto money market. In the fourth part, the literature review of the published studies on the subject is included, and in the last part, the statistical model prepared within the framework of intra-market dynamics is presented.

2. Conceptual Framework

The term crypto is derived from the Greek word Kryptos, which means secrecy due to its etymological origin. Cryptocurrency, on the other hand, is a virtual money system that is not based on a central system using the science of cryptology, which expresses the science of privacy but can be used as a payment tool in the purchase of goods and services, with monetary value created with codes. The use of cryptographic (encryption) methods ensures that cryptocurrencies are unique (Farell, 2015: 4). The foundations of the concept of electronic currency were laid by David Chaum in 1983 in an article named “Blind signatures for untraceable payments”. Later, Wei Dai contributed in 1998 by proposing the creation of another database to find out how much money each user and each different nickname has. In 2008, the first successful decentralized cryptocurrency, Bitcoin, was introduced by the pseudonym Satoshi Nakamoto in the article “Bitcoin: A Peer-to-Peer Electronic Cash System” (Nakamoto, 2008: 1). Blockchain structure is used in Bitcoin transactions. The most basic principles of blockchain technology are a distributed database where each party can access the entire database and all its history, anonymity and transparency that everyone can follow, the possibility of transferring directly from user to user without the need for any intermediary institution, and the inability to recover the data records processed after processing

in the database (Tapscott and Tapscott 2017: 3). The Hashcash PoW mechanism, proposed by Adam Back in 1997, is used as the mechanism, and the SHA-256 hash function is used for nodes (Back, 1997; Nakamoto, 2008). When a node finds a solution to the problem, it is deemed to have met the PoW requirements and is added to the new blockchain and broadcast to all nodes. Since only one block can be verified at a time, the probability of a node decoding the correct hash increases with the amount of CPU power expended. The last briefing about the Bitcoin ecosystem was made on December 12, 2012, with the completion of its software. Until and after this process, no definite information about the developer could be obtained. However, due to its open-source structure, the continuous development of the system by the software developers continues to expand the Bitcoin ecosystem. Bitcoin transfers are realized by users, called miners, by solving algorithms in the system with processor power. As a result of this transfer, the system rewards the miners. The amount of the prize is halved every four years. As of the year it was released, the amount of reward given as 50 BTC decreased to 25 BTC on November 28, 2012, to 12.5 BTC on July 9, 2016, and to 6.25 BTC on May 11, 2020. As a result of this reward system, called halving, it is predicted that all BTCs will be released until 2140.

The popularity of BTC and its prominence as an asset valued by economic units has led to the emergence of many BTC-like cryptocurrencies. The most important of these is Ethereum, which was introduced as a new generation blockchain in 2013 by crypto money researcher and programmer Vitalik Buterin. Ethereum's currency is called Ether. Ether is second only to BTC in terms of market share.

3. General Economic Outlook and Crypto Asset Market During the Covid 19 Pandemic Period

In December 2019, the covid-19 virus emerged in Wuhan, China. The strict measures are taken by China in the early days of the virus and the fact that BTC entered the halving process in the same period prevented negative pressure on the market. Since the Covid-19 virus first appeared in China, China was the country whose financial markets were affected the earliest. February 3, 2020, has been recorded as the worst day for the markets in China since 2015. With the opening of the markets, which were closed due to New Year's Eve, after the holiday in the country, the CSI 300 index of the Shanghai Stock Exchange fell by 9.1%. This decrease caused a loss of approximately 420 billion dollars in the Chinese stock markets that day. China's central bank injected 1.2 trillion yuan of liquidity into the

market to disperse the panic atmosphere in the market. In addition, it reduced the 7-day reverse repo rate from 2.50% to 2.40% and the 14-day interest rate from 2.65% to 2.55% in this process. The People's Bank of China (PBOC) later reduced the reverse repo rate by 20 basis points from 2.40% to 2.20% on March 30, against the negative effects of the Covid-19 outbreak on the economy. In addition to these measures, the PBOC injected another 50 billion yuan into the banking system. The US Federal Reserve, which decided to cut the emergency interest rate last during the 2008 crisis, reduced the policy interest rate by 50 basis points to the range of 1-1,25% with an urgent decision on March 3, 2020. Following this decision, the US 10-year bond yields fell below 1% for the first time in its history, while the Dow Jones index depreciated by 2.94%, the S&P500 index by 2.81%, and the Nasdaq index by 2.99%. As the S&P500 index opened with a 7% depreciation on March 9 and 12, trading in the stock market was closed for a while. When evaluated worldwide, stock markets closed with an average of 10% decline in the USA, 12% in Canada, France, and Germany, 17% in Italy, and 14% in Spain on March 12, 2020. The decline continued in the following days, and on March 16, the New York stock market realized its lowest closing since 1987, depreciating 12.94%.

In the same period, significant losses were experienced in silver and gold prices. Silver prices fell to the lowest level in the last 11 years. Similar decreases were experienced in terms of energy and commodity prices. As of the end of March 2020, the price of a barrel of Brent oil dropped to 22.69 dollars, which is the lowest price in the last 18 years. On March 16, the Federal Reserve (FED) decided to cut the policy rate to 0-0.25 percent with a second rate cut decision. Beyond to interest rate cut, it provided the market with 700 billion dollars of liquidity. Despite this, sharp declines continued in the US stock markets. In addition to all these measures, the FED temporarily established swap lines with nine central banks on 19 March 2020 to combat the economic problems caused by the epidemic. The European Central Bank (ECB), on the other hand, decided to keep the policy rate of -0.5% constant at its meeting on 12 March 2020. Moreover, it announced a 120 billion Euro bond purchase program.

With the World Health Organization declaring a pandemic on March 11 and the situation worsening for other countries, the demand for money increased due to uncertainty in the financial markets, resulting in large sales. In the same period, when the situation of cryptocurrencies is examined, while the closing price of BTC was about $ 7,200 on December 31, 2019, it increased to about $ 10,500 on February 14 with the halving process. However, after the declaration of the

pandemic, there was a sharp decline in cryptocurrencies that while BTC was at the level of $ 8,100 on March 11, 2020, it fell to the level of $ 3,800 with a loss of approximately 53% in 2 days. Although it rose to $5,500 after this decline, it regressed to $4,500 on March 16. After this decline, it entered a 4-day upward trend again and rose to $ 6900 and kept its current level by fluctuating between March 20, 2020 - March 31, 2020.

Comparing the returns of financial assets as of the first periods of the pandemic provides important information about market dynamics. For example, as of January - March 2020, the highest value of the Dow Jones index was 29,551 points dated February 12. The lowest value in the same period was 18,531 points dated March 23. When the highest and lowest values are compared within the said period, there is a negative return of 37%. The closing value of the Dow Jones index on March 31, 2020, was 22,250 points, and it provided a positive return of 20% after a negative return of 37%. When silver price movements are analyzed, it is seen that the highest value is $18, and the lowest value is $11.5. The highest value was on February 24, and the lowest value was on March 19. Considering the highest and lowest prices for silver, there is a negative return of 35%. However, considering that the price of silver is $14 as of March 31, it is seen that it provides a 21% positive return compared to its lowest level. In the same period, when BTC's highest and lowest pricing levels are compared, there is a 53% negative return. When the lowest level is compared with the value at the end of March, it is seen that BTC provides a positive return of 32%. As a result, although there was a decrease in the demand for money due to uncertainty in the financial markets, recovery processes were experienced after the panic effect passed. However, BTC was the financial asset that responded most positively to this recovery process.

4. Literature Review

Yermack (2013) analyzed whether Bitcoin can be a currency or not. As a result of the analysis, he stated that Bitcoin will be a speculative investment rather than a currency, as the volatility in Bitcoin prices is higher than that of commonly used currencies. Glaser et al. (2014) investigated whether BTC was used as a transaction tool or as an investment tool. Similar to the results of Yermack, the authors determined that BTC was used as an investment tool for speculative purposes. On the other hand, Kristoufek (2015) analyzed the potential effects of BTC prices on the Chinese market, and Yermack (2013) and Glaser et al. (2014) concluded that BTC is an asset with both standard and speculative features.

Koçoğlu et al. (2016) analyzed BTC price, liquidity, volatility, and the effectiveness of eight selected cryptocurrency exchanges. As a result of the analysis, they determined that BTC is not related to other currencies, and in terms of liquidity, exchanges traded in dollars and yuan have more liquidity. In addition, they found that out of the eight selected exchanges, except for the Okcoin exchange, other exchanges act together in the long term.

Dulupcu et al. (2017) examined the relationship between the price and awareness of BTC using the Variance Decomposition and Granger Causality tests. As a result of the study, it was stated that the price of BTC increased as the awareness of BTC increased.

In their study, Dirican and Canöz (2017) examined the relationship between BTC price, trading volume and value, and important stock market indices using the ARDL bounds test approach. As a result of the analysis, they found long-term cointegration between BTC price and stock market indices.

Koutmos (2018) explored the relationship between 18 major cryptocurrencies in terms of returns and volatility. As a result of the analysis, it was determined that BTC affects the spread of return and volatility among the cryptocurrencies and that the spreads of returns and volatility increase over time.

Jang et al. (2019) examined the relationship between BTC prices and gold, stock market index, and USD with Granger causality and transfer entropy. As a result of the analysis, they found that BTC interacts with other asset markets and moves with other asset prices in the long run.

Salihoğlu and Han (2019) examined the relationship between four cryptocurrencies (BTC, Ethereum, Litecoin, Ripple) with Hacker Hatemi and Hatemi-J causality tests. As a result of the analysis, the authors determined that the four selected coins were generally affected by each other's shocks, with one-way causality from Ethereum to Bitcoin.

In his study investigating the relationship between Bitcoin and altcoin prices, Adedokun (2019) divided the daily data for the period of 8 August 2015-31 December 2018 into three separate sub-periods and applied the cointegration and VEC Granger Causality/Block Externality Test. As a result of the analysis, he determined that there was a pure price separation between altcoins and Bitcoin in 2015-2016.

Aksoy et al. (2020) investigated the causality relationship between the prices of cryptocurrencies (BTC, Bitcoin Cash, Ethereum, Litecoin, and Ripple) for the period 18.01.2018-24.12.2019 with the Toda-Yamamoto test. As a result of the

analysis, they determined that all cryptocurrencies in the study affect the price of Litecoin, while Ethereum affects all cryptocurrencies. They also stated that the five cryptocurrencies are in a causal relationship with at least two cryptocurrencies.

Kim et al. (2021) examined the causality relationship of the eight cryptocurrencies with the highest market value using daily data between 23.07.2017 and 28.11.2019. As a result of the analysis, they determined that there is a strong causality relationship in the returns of cryptocurrencies. However, they stated that BTC and Ethereum, which have the highest market value, have more robust causality than other cryptocurrencies.

Palazzi et al. (2020) investigated the dynamic relationships between BTC and Euro, Pound, Swiss Franc, Yuan, Yen, and Ruble by a multivariate GARCH model and nonlinear causality test. The analysis results show that BTC was affected by the Euro, and after the structural break in 2014, there was only a relationship between Yuan and BTC. In addition, the results show a non-linear relationship between the currency markets and BTC, and the historical values of exchange rates contribute to predicting BTC price movements.

Şak (2021) examined the relationship between thirteen selected cryptocurrencies in the context of periods with negative and positive returns using the Hatemi-J asymmetric causality test. As a result of the analysis, the author determined that investors minimize their risks by shifting their investments to cryptocurrencies that seem less risky compared to other cryptocurrencies in negative return periods. He determined that in positive return periods, investors can take more risks and diversify their investment tools among cryptocurrencies.

Elsayed et al. (2022) investigated the causality dynamics between Bitcoin, Litecoin, Ripple, and nine major foreign exchange markets using two methods. As a result of the analysis, they found a significant return spread effect between Bitcoin and Litecoin in the first three quarters of 2017. For Ripple, they found the return spread in the first three quarters of 2015 to be significant. Another finding in the analysis is that Bitcoin is only tied to the previous level of the Chinese Yuan, while Ripple is tied to the previous levels of Bitcoin and Litecoin. Litecoin, on the other hand, is tied to the previous Ripple level and then to the Chinese Yuan.

5. Statistical Model

In the study, the strength and direction of the relationship between the price movements of the seven cryptocurrencies, which have the largest share in the crypto money market, have been tried to be revealed with the help of correlation

analysis. Correlation analysis is a method used to test the relationship between two variables or the relationship of a variable with two or more variables and to measure the strength of any existing relationship. The purpose of correlation analysis is to see in which direction the other variable will change when the value of one variable changes. It is basically divided into two parts, parametric and non-parametric correlation analysis. While Pearson correlation analysis is used to test the parametric relationship, Spearman correlation analysis is used to test the non-parametric relationship. On the other hand, Kendall Tau b analysis is used to determine non-parametric association. The most important requirement for the application of Pearson correlation analysis is that the data must have a normal distribution. In Spearman correlation analysis, however, this condition is not required to be met. In other words, Spearman correlation analysis can be applied for data that do not have a normal distribution. Correlation significances in both analyzes are determined using the t-test.

In the study, the cryptocurrencies whose price movements are examined are, respectively, according to their market share sizes; They are Bitcoin (BTC), Ethereum (ETH), BNB, XRP, Cardano (ADA), Dogecoin (DOGE), and TRON (TRX). The working period covers the dates between 01.01.2015 and 15.05.2022, and daily opening data is used. Each data set consists of 1596 observations. Time path graphs of normalized values of cryptocurrencies examined within the scope of the model are shown in Figure 1. When Figure 1 is examined, the degree of volatility in the crypto money market can be seen. However, the market can also be manipulated from time to time by major market actors known as whales. The endpoints and fluctuations observed separately in each data show this situation.

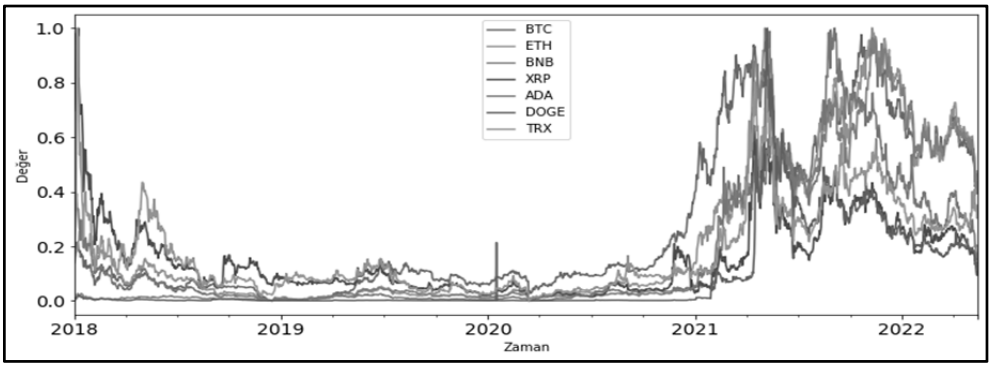

Figure 1: Cryptocurrencies Time Path Charts for the Period 01.01.2015 - 15.15.2022 (Data Normalized)

Source: investing.com

The decision on which correlation analysis to use in examining the relationship between the data was made according to whether the data distributions were in accordance with the normal distribution. Four different tests (Shapiro-Wilk, D'Agostino's K-squared, Chi-Square, Lilliefors) were applied for the normal distribution, and it was determined that all data were not suitable for normal distribution in all tests. Normality tests were applied over the daily return values for all series. Therefore, it was decided to perform a Spearman correlation analysis.

The return graphs of the cryptocurrencies included in the analysis are shown in Figure 2. Figure 2 shows that the yield graphs of all cryptocurrencies move parallel to each other. When the data for the study period is examined, there was no excessive volatility in returns from mid-2018 to the end of 2020. Still, the volatility in price returns reached remarkable levels, especially in 2021.

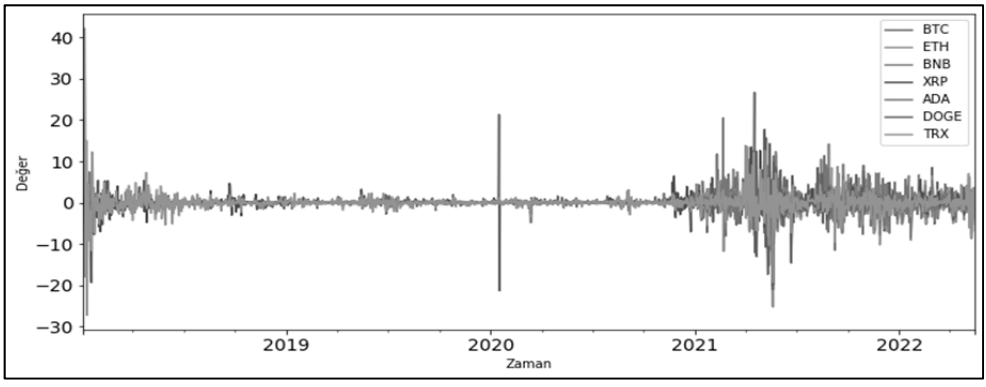

Figure 2. Cryptocurrencies Daily Return Data for the Period 01.01.2015 - 15.05.2022 Time Path Charts

Source: % changes calculated using data from Figure 1

The results of the Spearman correlation analysis of the cryptocurrencies are presented in Figure 3. In Figure 3, the diagonal matrix takes the value 1 because it shows the correlation of each cryptocurrency with itself.

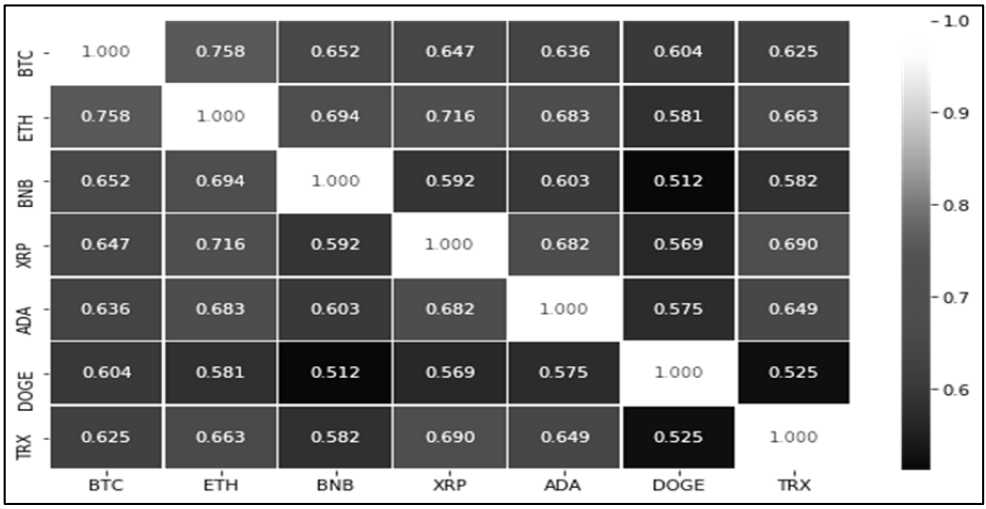

Figure 3. Spearman Correlation Analysis Results

The statistical interpretations of the correlation coefficients between cryptocurrencies (correlation strength between cryptocurrencies) are shown in Table 1.

Table 1. Correlation Analysis Results

	BTC	**ETH**	**BNB**	**XRP**	**ADA**	**DOGE**	**TRX**
BTC	-	-	-	-	-	-	-
ETH	High	-	-	-	-	-	-
BNB	Moderate	Moderate	-	-	-	-	-
XRP	Moderate	High	Moderate	-	-	-	-
ADA	Moderate	Moderate	Moderate	Moderate	-	-	-
DOGE	Moderate	Moderate	Moderate	Moderate	Moderate	-	-
TRX	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	-

As a result of the correlation analysis made for the seven cryptocurrencies with the largest market share in the crypto money market, a statistically strong relationship was found only between ETH and BTC and ETH and XRP. In all other combinations, correlation analysis results show that the strength of the relationship between cryptocurrencies is moderate. On the other hand, the correlation coefficient of the DOGE and other cryptocurrencies is low. Another point to consider is that ETH's Correlation coefficients are high compared to other

correlation coefficients. Figure 4 shows the scatter plots showing the relationship of each of the cryptocurrencies subject to the analysis with each other.

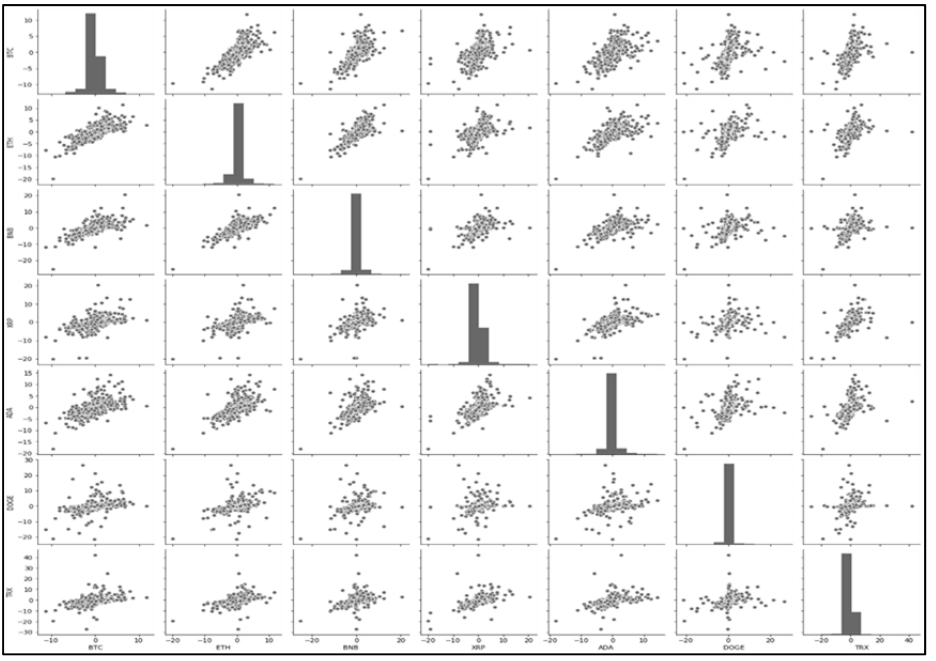

Figure 4. Relationship Scatterplots between Cryptocurrencies

At the same time, the diagonal matrix consists of graphs showing the distribution of the cryptocurrency in the relevant row or column. When the diagonal matrices are examined, it can be seen that the return data of all cryptocurrencies are not distributed in accordance with the normal distribution. On the other hand, when the scatterplots are examined, it is understood that the relationship between all cryptocurrencies is positive. The graphical representations confirm the analysis results.

6. Conclusion

After the industrial revolution, we entered a period in which technological innovations changed and improved the economic structure. The effects of technological innovations on the economic structure are generally through the production structures over the real sectors. However, especially in the last half-century, technological innovations have significantly affected the economic structure both in the real and financial sectors.

When the impact of today's technological developments is evaluated, it is seen that the influence of technology has reached higher levels than ever before. That is, previous technological developments and innovations made the functioning of the established economic structure more efficient, today's changes have a powerful effect that can completely change the current economic system. The newest and most important of these technological developments is undoubtedly cryptocurrencies. The most critical aspect of cryptocurrencies is questioning the existing monetary system in the world. Cryptocurrency has two important aspects. First is its technological infrastructure, and the other is its economic value.

In this study, the pricing structure, which is one of the economic aspects of cryptocurrencies, is emphasized. Although cryptocurrencies are a technology that has emerged to change the existing monetary system, the markets where these currencies change hands act in accordance with the generally accepted economic theories in terms of market dynamics. For this reason, based on the assumption that the values of cryptocurrencies are related to each other, the relationship between the returns of the largest cryptocurrencies in terms of market share was analyzed with the spearman correlation test. As a result, a positive correlation was found between the returns of all cryptocurrencies. When evaluated in terms of the degree of the relationship, a strong relationship was detected between ETH - BTC and ETH XRP, while all other relationships were found to be moderate within the 0.50 - 0.69 correlation coefficient. On the other hand, the size of the correlation coefficients between cryptocurrencies should be paid attention to. For example, while the correlation coefficients of the DOGE are relatively low, the correlation coefficients of ETH are relatively high.

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