E-ISSN:2757-6140
Bilim-Teknoloji-Yenilik Ekosistemi Dergisi
Journal of Science-Technology-Innovation Ecosystem
Cilt/Volume: 3, Sayı/No: 2, Yıl/Year: 2022, 95-107

- RESEARCH ARTICLE –

Causality Analysis for Developing Country Stock Exchanges and Cryptocurrency Bitcoin

Ayşegül Berrak KÖTEN[a]

Abstract

Bitcoin, which has blockchain technology behind it, has an important place in the development of awareness on cryptocurrencies at a global level. Currently, Bitcoin and other cryptocurrencies create a deep enough market and can generate high returns, but they are also seen as a tool for speculation due to their high volatility. Cryptocurrencies are used both as a transfer and investment tool because of the very low transaction costs and the ability to perform transactions very quickly. Its use as an investment tool raises the question of how it relates to other investment instruments such as stock market, gold, foreign currency, interest, and bonds. The aim of this study is to examine the causality relationships between the developing country stock markets BIST100 (XU100), Bovespa (BVSP), MOEX Russia (IMOEX) and BSE Sensex 30 (BSESN) and Bitcoin, by Hackers and Hatemi-J (2006) Bootstrap causality analysis for monthly data from January 2010 to February 2021. As a result of the analysis, one-way causality from Bitcoin to developing country stock markets has been obtained.

Key Words: Bitcoin, Stock Exchange, Causality Analysis, Hacker and Hatemi-J (2006) Test.
Jel Kodes: G11, G19, G32, C59.

Başvuru: 10.10.2022 **Kabul:** 13.12.2022

Gelişmekte Olan Ülke Borsaları ve Kripto Para Bitcoin için Nedensellik Analizi

Özet

Kripto paralar konusunda küresel düzeyde bir farkındalık gelişmesinde, arkasında blockchain teknolojisi bulunan Bitcoin'in önemli bir yeri vardır. Günümüzde, Bitcoin ve diğer kripto para birimleri yeterince derin bir piyasa oluşturmakta ve yüksek getiri sağlayabilmekte, fakat volatilitelerinin yüksek olması nedeniyle spekülasyon aracı olarak da görülmektedir. Kripto paralar, işlem maliyetlerinin çok düşük olması ve işlemlerin oldukça hızlı gerçekleştirilebilmesine imkân sağlaması sebebiyle hem transfer hem de yatırım aracı olarak kullanılmaktadır. Yatırım aracı olarak kullanılması borsa, altın, döviz, faiz, tahvil gibi başka yatırım araçları ile ilişkisinin nasıl olduğu sorusunu gündeme getirmektedir. Bu çalışmanın amacı, gelişmekte olan ülke borsaları BIST100 (XU100), Bovespa (BVSP), MOEX Russia (IMOEX) ve BSE Sensex 30 (BSESN) ile Bitcoin arasındaki nedensellik ilişkilerini 2010 Ocak – 2021 Şubat arası aylık verileri için Hacker ve Hatemi-J (2006) Bootstrap nedensellik analizi ile ortaya koymaktır. Analiz sonucunda Bitcoin'den gelişmekte olan ülke borsalarına doğru tek yönlü nedensellik elde edilmiştir.

Anahtar Kelimeler: Bitcoin, Borsa, Nedensellik Analizi, Hacker ve Hatemi-J (2006) Testi.
Jel Kodları: G11, G19, G32, C59.

[a] Dr. Ayşegül Berrak Köten, Investor Relations Manager, DESA Deri Sanayi ve Ticaret A. Ş., a.berrak@gmail.com, ORCID: 0000-0002-5680-9920.

INTRODUCTION

The global financial crisis caused many changes in the world financial system in 2008, the stock markets of countries collapsed, credit rating agencies lost credibility, financial institutions and companies came to the edge of bankruptcy, and large banks went bankrupt. However, most importantly, the opinions of people regarding the financial sector changed and their trust in banks was damaged seriously. Bitcoin, which emerged after the collapse of the financial markets, was presented as an alternative model to the failure of the financial system and strong reserve currencies (i.e. Dollar and Euro) (Bouri et al., 2018:5937).

There have been significant developments, especially in recent years regarding cryptocurrencies. Bitcoin has come to the fore among these currencies with its market size, the number of users, and acceptance as a payment tool by some companies. Bitcoin, whose value has increased in terms of transaction volume and market capitulation since it first emerged, has become a phenomenon of the period (Matkovskyy and Jalan, 2019:94). However, Bitcoin, which increased its value more than twenty-fold in 2017, approached the level of 20 thousand dollars towards the end of the year. What made Bitcoin different was that it changed hands directly between the buyer and the seller in the digital sphere without the need for a third-party/authority (e.g. a state or central bank).

While the interest in Bitcoin and altcoins has been increasing in individual and institutional terms in recent years, some cryptocurrencies have been accepted as legal assets and have started to be traded on large stock exchanges. In this respect, the optimistic atmosphere brought by Bitcoin transactions has found a wide place on the agenda with the use of cryptocurrencies in both investment and money transfer transactions (Hung et al., 2020:5; Gil-Alana et al., 2020:3).

The tempting performance of Bitcoin also triggered many people to direct their investments toward cryptocurrencies. As a result of the trend towards cryptocurrencies, the demand for Bitcoin also increased, and the market volume and price increased rapidly. However, the rapid appreciation of Bitcoin caused it to be considered a speculative investment tool with its excessive fluctuation while exceeding its emergence purpose (Hung, 2019:25). As an alternative to traditional investment vehicles, Bitcoin brought with it a lot of debates. In the present study, the purpose was to determine the relationship between Bitcoin price and developing country stock market indices. The relationships between Bitcoin and different investment instruments are important in terms of being a guide for investors.

1. CRYPTOCURRENCY: BITCOIN AND OTHERS

After the global crisis, the cryptocurrency Bitcoin first came to the forefront in 2009 with the article "Bitcoin: A Peer-to-Peer Electronic Cash System" written by a person or group named Satoshi Nakamoto. In this article, which was also the white paper of Bitcoin, the cryptocurrency, Bitcoin, was defined as an electronic payment system that was established on cryptographic proof and in which two parties were directly linked to each other. The article described the peer-to-peer payment system that used electronic cash (cryptocurrencies) that could be sent directly from someone. An innovation was proposed after the use of "blockchain" technology, which was like a shared "ledger" in a peer-to-peer network where all transactions were verified by the network to ensure that they were not fraudulent (Nakamoto, 2009:11).

Bitcoin works by using peer-to-peer technology without a central authority or bank. The management of the transactions and the distribution of Bitcoins are collectively handled by the network. Bitcoin is open-source, which means its design is public, no one owns or controls Bitcoin and anyone can participate. With its many unique characteristics, Bitcoin can handle many different payments which cannot be made with other payment methods (Bitcoin.org). In the article of Nakamoto (2009), intermediary services that were offered by banks were criticized and it was emphasized that banks were not required for the realization of trade in the framework of the rising trend of electronic commerce. The main message of the study, in which a new peer-to-peer electronic money system was defined without a reliable third party, was to try to acquire a new concept of how to solve the trust problem after the global crisis with technology.

In our present day, there are many types of cryptocurrencies available and are divided into Bitcoin and others in the literature. Because other cryptocurrencies released after Bitcoin, which was the first crypto money, were developed based on Bitcoin and were described as alternative crypto money and were called altcoins. Although many currencies are produced with blockchain encryption technology, Bitcoin came to the forefront with its feature of being the first and prevalent. Aside from Bitcoin, thousands of different cryptocurrencies are being

traded under different names such as Ethereum, Tether, BNB, USD Coin, XRP, Solana, Ripple, Avax, Bitcoin Cash, Cardano, Litecoin, Nem, Neo, Stellar, IOTA, EOS, Monero, and the numbers are changing with each passing day. As reported by the studies of Charfeddine et al. (2020), there are hundreds of altcoins, especially Ethereum, and Ripple, and their number is increasing day by day. Ethereum is a platform, which allows different applications to be created, and is similar to the Bitcoin structure in terms of privacy. In Ethereum, block rewards are fixed and there is no supply limit. According to the study by Zeng, Yang, and Shen (2020), it aims at the highly secure, fast, and free global money transfer of Ripple because it is limited in terms of supply. Ripple uses an interactive consensus process corresponding to Bitcoin's mining process and provides faster money transfer than Bitcoin.

After Bitcoin came to the agenda in 2008, when it first entered the market in 2010, its value was announced as $ 0.07. Bitcoin, which was traded in the market with a maximum of 1 dollar until the beginning of 2011, saw 13 dollars in 2012, continued its rise with 266 dollars in 2013, and closed in 2016 at 960 dollars. Bitcoin, which entered 2017 with $ 960, showed an incredible performance throughout the year and reached $ 20.000. The serious appreciation of Bitcoin in such a short time found a wide place on the world agenda and was referred to as "the digital/virtual gold". The increase in Bitcoin supply, which has had a constant level of 21 million, is now gradually decreasing. The purpose of keeping the Bitcoin supply limited is to ensure that it is treated as money for gold (Dilek, 2018: 15).

Bitcoin started to be used as an investment tool after the increase in its prices. Not only individuals but also institutional investors started to use Bitcoin as an investment tool. The most important of them were several companies such as Pantera Capital, Falcon Global Capital, and Global Advisors Bitcoin Investment Fund (Paule-Vianez et al., 2020:349). However, the number of companies, which accept payments with Bitcoin, is increasing rapidly. Major companies such as Microsoft, Intuit, PayPal, and Virgin Galactic are among those who trade with Bitcoin. The changing discourses of institutions regarding Bitcoin and the increased demand for Bitcoin have played an important role in the rise of Bitcoin prices in recent times. One of these developments was in October 2020, when PayPal, which is the online payment system, added Bitcoin to its payment tools. After this announcement of PayPal, which had 346 million users worldwide, the price of Bitcoin increased by 20% in October 2020, exceeding 13 thousand dollars. China Construction Bank, which is the second-largest bank in the world according to its total assets, announced that it would export bonds worth 3 billion dollars for transactions with Bitcoin and other cryptocurrencies. Announcing that important companies such as MicroStrategy and Square invested in Bitcoin, and JPMorgan's article announcing that Bitcoin competed with gold as an alternative investment tool can be listed among the factors playing roles in the rise of Bitcoin prices.

The most important reasons why cryptocurrencies can be used as investment tools are the related low transaction costs and lack of government control. However, the low acceptability of crypto money, low trust in the system, and excessively volatile prices still affect the use of Bitcoin as an investment tool. Bitcoin is a speculative investment tool that has high volatility and high returns. It is difficult to predict the future value and use of Bitcoin; however, if the demand increases steadily, the prices will continue to rise (Chuen et al., 2017:19; Dastgir et al., 2019:162; Demir et al., 2018:147; Gozgor et al., 2019:78).

However, Bitcoin is in demand by investors with a high-risk appetite in Turkey, and, institutions such as the BRSA and CMB are warning investors and anyone who has the potential to be interested in Bitcoin.

As is the case in the entire world, Bitcoin is traded among people in Turkey, which is called "over the counter" on trading platforms. Bitcoin is often bought and sold to obtain increased value. Platforms, where cryptocurrencies can easily be used for shopping, will become widespread in the future. With Bitcoin, any balance can be transferred very quickly and cheaply from wallet to wallet and it does not matter from where in the world this transfer is made to which other location.

Previous studies show that many people in the Middle East are turning to cryptocurrency to protect their savings against currency devaluation, which is a trend seen in other developing markets such as Africa and Latin America. According to the 2021 Global DeFi Adoption Index that was released in October 2021 as a report of Chainalysis, which is a blockchain data analysis company, Turkey ranked 13th among the top 20 countries. Despite that increase, Middle Eastern countries show relatively low grassroots adoption. Afghanistan is the highest-ranked in the region on Global Crypto Adoption Index at 20, followed by Turkey at 26. However, Turkey has by far the highest transaction volume in the region at $132.4 billion during the period studied. The analysis with the title "Estimated International Share of All Cryptocurrency Sent by Sending Country" also drew attention in the same report. An estimated 86% of all cryptocurrency sent from Russia-based addresses and

87% of cryptocurrency sent from Ukraine-based addresses transfers to addresses based in another country. Turkey is the only country that sends a bigger share of its cryptocurrency abroad (Chainalysis, 2021). According to the report of Chainalysis, economic uncertainties in the region and volatility in the Turkish Lira played a role in Turkey's rapid adaptation to cryptocurrencies.

2. LITERATURE REVIEW

There are many academic studies conducted in the world and Turkey on Bitcoin, which is the first among cryptocurrencies and always ahead in terms of popularity. Studies were generally conducted about Bitcoin's market value, and transaction volume, examining its Blockchain technology and evaluating it as an investment alternative.

Traditional CAPM shows the importance that stock price changes are related closely to the system risks of domestic markets (Sharpe, 1964; Lintner, 1965; Black, 1972; Liu and Gao, 2019). The Arbitrage Pricing Theory, on the other hand, emphasizes the ability of macroeconomic variables to predict stock prices (Ross, 1976; Fama & French, 1993). However, there are some discussions in the relevant literature showing that both models lack the factors that the digital economy age represents.

Chow, Liu, and Niu (2011) reported in their study that was conducted on the integration and co-movement of stock markets in the world that most of the Asian stock markets were affected by the US market.

Hileman (2016) reported that financial stocks can be affected not only by the composite stock price indices of their own countries but also by the spread in Bitcoin value, especially in regions where virtual currency transactions are active because the Bitcoin index is compiled in the US market.

Yermack (2013) examined the data between 19.07.2010 and 29.11.2013 by using the correlation analysis method to show whether Bitcoin had basic functions such as value storage and unit of account in the currencies that were used in current transactions. In his study, it was reported that there was a very low correlation between Bitcoin and gold prices and Bitcoin with Dollar, Sterling, Euro, and Yen exchange rates.

The New York Stock Exchange released the Bitcoin Index (NYXBT) in 2015, and the NASDAQ Stock Exchange compiled the Financial Technology Index in 2016 to track the changes in the Fin-Tech companies. The study of the effects of virtual currencies and information technology on stock prices in the real world was pushed into another area (Bohume, Christin, Edelman, & Moore, 2015; Gkillas & Katsiampa, 2018; Ren & Culpan, 2017).

Baek and Elbeck (2015) investigated whether Bitcoin is an investment tool by using the daily data of Bitcoin and the Standard and Poor's 500 (S&P500) Index from July 2010 to February 2014. In their study, it was reported that Bitcoin has 26-fold more volatility than the S&P500 Index. According to the results of the regression analysis, it was found that there were no relations between Bitcoin and the S&P500 Index.

Chu, Nadarajah, and Chan (2015) examined 7 different exchange rates between Bitcoin and the currencies of major industrial countries such as Bitcoin-USD and reported that their statistical characteristics approached a hyperbolic distribution and there were no serial correlations and variance in these exchange rate quotations.

Atik et al. (2015) analyzed the working principle of Bitcoin and its effects on traditional foreign exchange markets by using the daily exchange rates of Bitcoin and the currency-US dollar parity of 6 countries by using cointegration and causality tests. It was found that there is a one-sided causality relation between the Japanese Yen and Bitcoin prices from Japanese Yen to Bitcoin.

Cheung et al. (2015) reported that the rapid rise in price and volatility of Bitcoin when it first came out strengthened the arguments that Bitcoin was a bubble ready to burst. The daily Bitcoin price movements in US Dollars between July 2010 and 18 February 2014 were analyzed in the analysis by using the GSDAF Test of Philips. As a result of the analysis, although it was seen that there were short-term bubbles between 2010-and 2014, it was found that there were 3 big bubbles lasting between 66-106 days between 2011-2013.

Dyhrberg (2015) investigated the relationship between stocks, Bitcoin, and Dollar in FTSE100 between 19.07.2010 - 22.05.2015 by using the daily data. The analysis was made by using the Asymmetric GARCH Method. As a result of the study, it was found that Bitcoin can be used as a hedging tool against the stocks in the FTSE100 Index. It was also determined that it can be used as a hedging tool with gold and against the US Dollar in the short term.

Kristoufek (2015) investigated the factors that affected Bitcoin prices and the potential effects of Bitcoin on the Chinese market. In his study, Wavelet Coherence Analysis was made by using variables such as Bitcoin price index, exchange rate, gold prices, and financial pressure index between 14.09.2011 - 28.02.2014. In general, this study showed that Bitcoin is a tool with financial and speculative characteristics.

Ciaian et al. (2016) reported in their study that macro-financial development (as measured by Dow Jones Index, exchange rate, and crude oil price) played important roles in guiding Bitcoin prices in the short run, and this role was not significant in the long run.

Kocoglu et al., (2016) analyzed the efficiency, liquidity, and volatility of Bitcoin exchanges by evaluating the functioning of the Bitcoin exchange and the formation of Bitcoin prices and included 8 exchanges in their analysis (Bitfinex (USD), Bitstamp (USD), Mt.Gox (USD), BTC (USD), Okcoin (CNY), Kraken (EUR), Anx (JPY), Coinfloor (GBP)). The relation of Bitcoin with other currencies and gold was measured by calculating daily changes between 02.06.2014 and 02.06.2015 by using the Augmented Dickey-Fuller (ADF) and Johansen Cointegration Analysis to measure the efficiency of the markets. It was concluded that Bitcoin was not a reliable tool as an investment tool, its volatility was very high and it was open to speculative use.

Many studies in the literature (Bouri et al., 2017; Baur et al., 2018; Corbet et al., 2018; Guesmi et al., 2018; Ji et al., 2018) examined the direct correlation between Bitcoin and traditional assets such as stocks, commodities, and bonds and report evidence of a very weak correlation.

Baur et al. (2017) examined whether Bitcoin was a speculative investment tool. As a result of the analysis they made by using the daily data between July 2010 and June 2015, they reported that Bitcoin had a weak relation with traditional assets such as stocks. It then became clear that Bitcoin could be used as a speculative investment tool.

Dirican and Canoz (2017) analyzed the relation between Bitcoin in London, FTSE100, Tokyo NIKKEI225, USA Dow30, NASDAQ, and BIST100 by using the ARDL Test and weekly data between 24.05.2013 and 05.11.2017. As a result, a cointegration relation was found between the US and Chinese stock market indices, but no cointegration relation was detected between London FTSE100, Tokyo NIKKEI, and BIST100 stock market indices. This relation showed that the Bitcoin prices of investors trading in the US and Chinese stock markets affected investment decisions in the long run.

Ciaian, Rajcaniova, and Kancs (2018) showed that general economic indicators affected the prices of virtual currencies. They also reported that the overall economy had a causal relation with virtual currencies.

Kılıc and Cutcu (2018) analyzed the relations between Bitcoin prices and the BIST100 Index using Engle-Granger and Gregory Hensen Cointegration, and Toda Yamoto and Hacker Hatemi-j causality tests. The daily data between 02.02.2012 and 06.03.2018 were used for the analysis. As a result, it was found that there was no cointegration relation between Bitcoin prices and the BIST stock market index in the medium and long term, and according to the causality test, there was a one-way causality relation from BIST to Bitcoin.

Salisu et al. (2018) examined the role of Bitcoin prices in the predictability of stock returns for G7 countries in their article. The main purpose of their study was to leverage the inherent information in Bitcoin prices to improve the predictability of the stock returns of the G7 countries. For this reason, they added to the existing literature by expanding the factors underlying stock returns (country-specific and common factors) to include the Bitcoin price (BTC). The country-specific factors that were considered were inflation, exchange rate, and interest rate (short-term and long-term interest rates), and the common factors were oil and commodity prices. In one of the analysis results, they reported that the stock returns of the G7 countries were better predicted by the BTC-based model than the combination of the relevant macroeconomic variables, excluding Japan regarding the combination of predictions. In summary, the predictive power of Bitcoin can be used to model stock returns, especially during periods coinciding with the high-volume Bitcoin transactions globally.

In the study that was conducted by Kanat and Öget (2018), the short and long-term relations between Bitcoin price and stock market indices of G7 countries and Turkey were examined with the Unit Root and Cointegration Tests by using the daily data between 01.01.2013-26.01.2018. To investigate whether the relation between the variables was in equilibrium in the long run, VECM and short-term relationships were examined by using the Granger Causality and Wald tests. As a result of the analysis, although no long-term relations were detected between Bitcoin and other country stock markets, it was found that the British Stock Market (FTSE) was the

cause of Bitcoin in the short term. Also, Bitcoin was seen to be the cause of the S&P500 and the Canadian stock market (STSX).

Montesdeoca and Niranjan (2019) tried to explain the changes in the residual signal after they established a simple linear time series model using macroeconomic and currency change variables. They showed that the variables that affected cryptocurrencies on both analyzed timescales (daily and monthly values) were very different from stock indices (S&P 500).

Umar et al. (2020) investigated the relationship between cryptocurrencies (Bitcoin, Ethereum, Ripple, Bitcoin Cash, and Ethereum Operating System), and major stock markets (NYSE composite index, NASDAQ composite index, Shanghai Stock Exchange, Nikkei 225, and Euronext NV). Using the asymmetric dynamic conditional correlation (ADCC) and wavelet coherence approaches, they determined a significant time-varying conditional correlation between the majority of the cryptocurrencies and stock market indices and that the negative shocks play a more prominent role than the positive shocks of the same magnitude.

Wang et al. (2020) drew attention to the relation between the stock market and Bitcoin and identified and established a structural vector autoregressive model for Bitcoin, S&P 500, NASDAQ, and Dow Jones variables. In their article, based on impulse response analysis, they summarized that Bitcoin's impact on the stock market was weaker than the stock market impact on Bitcoin, and S&P 500 stock growth had a relatively strong effect on Bitcoin.

Ghorbel and Jeribi (2021) analyzed the relations between the volatilities of five cryptocurrencies, American indices (S&P500, NASDAQ, and VIX), oil, and gold. The results of the BEKK-GARCH model showed evidence of a higher volatility spillover between cryptocurrencies and lower volatility spillover between cryptocurrencies and financial assets. The results of the DCC-GARCH model identify an important effect of the launch of Bitcoin futures.

In their study, Szetela et al. (2021) aimed at verifying the existence of short- and long-term relations between the strength of a trend and the volume in bullish and bearish cryptocurrency markets. They applied the vector error correction model to Bitcoin daily data from 14.01.2015 to 22.12.2019. The results of their study showed that there was no long-term relationship between the strength of a trend and volume in both bearish and bullish markets. For this reason, a trend does not react to changes in the volume. However, there is a long-term relationship between volume and trend, but bearish by only an 88% adjustment rate. In the short term, the strength of a trend and the price in both bullish and bearish markets are independent of volume changes. However, volume is sensitive to price changes, especially for an uptrend. The relation in question is unidirectional, which means positive information from the cryptocurrency market encourages investors to make a stronger entry into the market causing bubbles and increasing price spikes.

3. ECONOMETRIC ANALYSIS

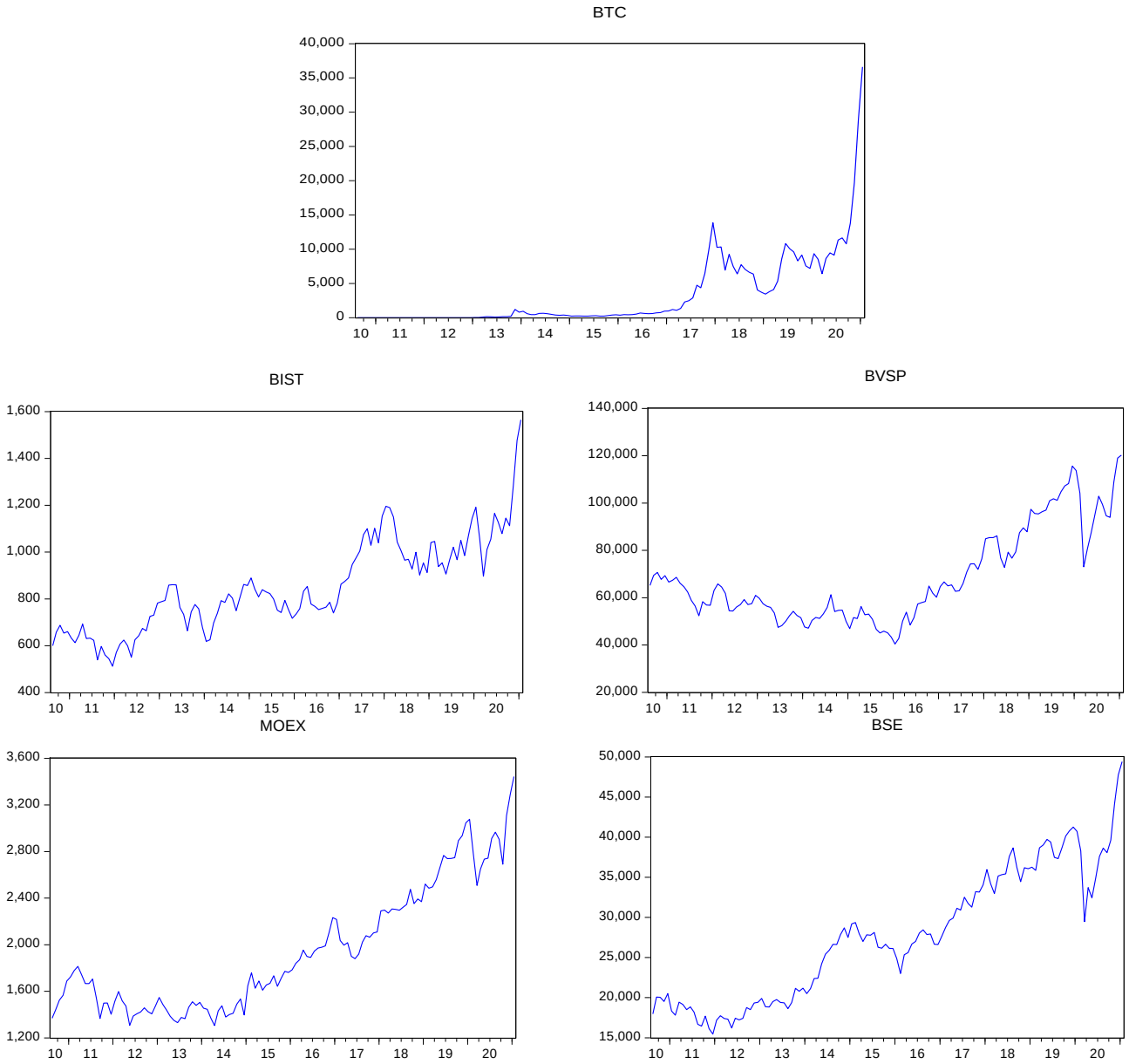
3.1. Description of the Data

The causality relations between Bitcoin and developing country stock markets for the monthly data including the period [2010.01-2021.09] were discussed in the analysis of the study. The data were received from the Thomson Reuters database. The analyses were made with the help of Eviews 10.0 and R codes. The variables that were included in the model are given in Table 1.

Table 1. The description of the Variables Used in the Analysis

Variable	Notation	Description
Bitcoin ($)	BTC	Cryptocurrency
BIST 100 (XU100)	BIST	Stock Exchange of Developing Countries – Turkey
Bovespa (BVSP)	BVSP	Stock Exchange of Developing Countries – Brazil
MOEX Russia (IMOEX)	MOEX	Stock Exchange of Developing Countries – Russia
BSE Sensex 30 (BSESN)	BSE	Stock Exchange of Developing Countries – India

The charts regarding the course of the variables over time are shown below:



The descriptive information of the data is given in Table 2.

Table 2. Descriptive Information of the Data

Statistics	BTC	BIST	BVSP	MOEX	BSE
Mean	4671.712	912.485	71362.15	2134.283	28463.10
Median	915..400	811.257	66312.37	1935.104	28050.02
Maximum	36593.40	1565.010	129315.86	3945.217	51276.43
Minimum	0.100000	494.241	45.987.00	1423.608	19643.21
Std. Dev.	6823.389	213.375	21356.09	645.813	8975.109
Asymmetry	2.952	0.973	0.955	0.885	0.604
Kurtosis	9.226	3.462	2.921	2.714	2.237

3.2. Econometric Method

The Augmented Dickey-Fuller (ADF) (1981) and Phillips-Perron (PP) (1988) tests were employed for stability tests. In the literature, there are criteria frequently used to determine the common lag length for the variables in the equation system (Final Prediction Error (FPE), Hannan-Quinn (HQ), Schwarz (SW), Likelihood Ratio (LR), and Akaike Information Criteria (AIC)). The lag length was determined according to these criteria. Also, Hacker and Hatemi's (2006) Bootstrap Causality analysis was made to investigate the causality relationship.

3.3. Findings and Evaluation

3.3.1. Stability Test Results

In the first step, the stationarity tests were analyzed for the data. The "constant" and "constant+trend" options were used for each test. The Census X12 filter that is included in Eviews 10.0 version was applied to the variables to eliminate seasonality.

Table 3. The ADF and PP Test Results of the Variables

Variables	ADF		PP	
	Constant	Constant+Trend	Constant	Constant+Trend
BTC	-1.321(0.122)	-1.398(0.134)	-1.403(0.138)	-1.516(0.147)
BIST	-1.436(0.156)	-1.487(0.183)	-1.582(0.192)	-1.603(0.203)
BVSP	-2.099(0.227)	-2.105(0.244)	-2.118(0.314)	-2.254(0.341)
MOEX	-1.839(0.141)	-1.974(0.167)	-1.937(0.174)	-2.067(0.180)
BSE	-0.977 (0.310)	-1.086(0.328)	-1.113(0.366)	-1.369(0.372)
∆BTC	-7.943(0.002)*	-8.125(0.004)*	-8.012(0.000)*	-8.204(0.009)*
ΔBIST	-8.593(0.011)*	-8.916(0.000)*	-8.755(0.000)*	-9.214(0.003)*
ΔBVSP	-9.265(0.000)*	-9.521(0.000)*	-9.616(0.013)*	-9.306(0.002)*
ΔMOEX	-8.505(0.000)*	-9.103(0.009)*	-9.338(0.000)*	-9.871(0.000)*
ΔBSE	-9.389(0.009)*	-9.716(0.012)*	-9.711(0.007)*	-10.033(0.000)*

**Stationary variable for 0.05. The values in parentheses are (p) values and the Δ notation show the first-order difference.*

According to the results given in Table 3, all variables have unit-roots. The variables are stationary for the first-order difference, there is stationarity at the I(1) level.

3.3.2. Hacker and Hatemi (2006) Bootstrap Causality Analysis

Hacker-Hatemi's (2006) causality test has the form of the bootstrap simulation of the table critical value when compared with the test statistic calculated in the Toda-Yamamoto (TY) (1995) causality test. Also, Hacker-Hatemi (2006), Toda-Yamamoto (1995), and Dolado-Lütkepohl (1996) argued that the optimal lag length in the estimation of VAR models could best be determined with the HQ and SIC information criteria, and as the two criteria showed different lag lengths in some cases, they used two information criteria. Hatemi-J (2003) (HJC), who analyzed them together, said that the optimal lag length must be determined with the information criterion. The formulation of the HJC information criterion is given in Equation (1).

$$HJC = ln\left(\left|\widehat{\Omega}\right| + j\left(\frac{n^2\, lnT + 2n^2 \ln(lnT)}{2T}\right)\right) \quad (1)$$

$\left|\widehat{\Omega}\right|$, denotes the variance-covariance matrix of the error terms of the VAR model estimated with j lag length, n denotes the number of equations in the model, and T denotes the number of observations. After determining the optimal lag length, if the TY-VAR analysis (j+dmax) equation to be performed for the analysis of the null hypothesis is expressed as Y=DZ+δ;

Y= (y_1, y_2, y_3,… y_T) (nxT) matrisi, $\widehat{D}$ = ($\widehat{\alpha}$, $\widehat{A_1}$, $\widehat{A_2}$, $\widehat{A_j}$,… …,A_{j+dmax}) (nx(1+n(j+d_{max})) matrisi

$$Z_t = \begin{bmatrix} 1 \\ y_t \\ y_{t-1} \\ \vdots \\ y_{t-j-d_{max+1}} \end{bmatrix} ((1+n(j+ dmax)) \text{ matrisi, } t=1,\ldots, T \quad (2)$$

Unreserved regression error terms (nxT) $\widehat{\delta_U}$ matrix is estimated as

$S_U = \frac{\widehat{\delta_U'}\widehat{\delta_U}}{T}.\beta = vec(\alpha, A_1, \ldots, A_j, O_{nxndmax})$, $\beta = vec(D)$ vec denotes column-accumulation operator. $O_{nxndmax}$, n($dmax$) denotes column null matrix. Toda-Yamamoto's modified MWald test is given in equation (3).

$$\text{MWald} = (C\widehat{\beta})'[C\,((Z'Z)^{-1} \otimes S_U)C']^{-1}\,(C\hat{\beta}) \quad (3)$$

⊗ the symbol denotes the Kronecker product and the indicator function matrix of size jxn(1+n(j+dmax) that includes constraints on C. C's each j row is related to the constraint whether or not the coefficient β is equal to zero. The null hypothesis of investigating the Granger causality in TY-VAR analysis is tested as H_0= Cβ = 0. The fact that Hacker-Hatemi (2006) obtained TY Granger causality analysis of the table critical values more effectively with bootstrap simulation and testing whether there was an ARCH effect in the model was determined by the autoregressive conditional variance developed by Engle (1982). Testing with the ARCH) test ensures that causality findings are more effective.

3.3.3. Hacker and Hatemi (2006) Bootstrap Causality Results

The causality test that was developed by Hacker and Hatemi (2006) was employed to determine the causal relations between the variables. In this respect, 1 lag was added to the VAR model, whose appropriate lag length was set by the HJC (Hatemi-J Criterion) criterion, which was determined as 2 in all methods. Also, 10.000 bootstrap simulations were performed to reach the appropriate critical values.

Table 4. Hacker and Hatemi (2006) Bootstrap Causality Test Results for Stock Exchange of Developing Countries

Null Hypothesis	MWALD Statistics	Bootstrap Critical Values			Lag Length
		%1	%5	%10	
BIST ⇏ BTC	0.08736	7.842	4.516	2.314	2
BTC ⇏ BIST	16.7254***	7.755	4.724	2.483	2
BVSP⇏ BTC	3.07205	8.461	4.489	2.497	2
BTC ⇏ BVSP	9.75619**	8.224	4.623	2.538	2
MOEX ⇏ BTC	1.79327	7.698	4.387	2.715	2
BTC ⇏ MOEX	10.2766*	8.325	4.558	2.813	2
BSE ⇏ BTC	1.44690	7.672	4.812	2.774	2
BTC ⇏ BSE	5.52965**	8.335	4.546	2.618	2

***, **, and * denote 1%, 5%, and 10% significance, respectively.

The optimal lag length was set by the HJC (Hatemi-J Criterion) criterion.

When the developing countries were considered, there was no causal relationship from BIST to BTC, but there was causality from BTC to BIST. In this regard, one-way causality was obtained (BTC→BIST).

There was no causality from BVSP to BTC, there was causality from BTC to BVSP. In this regard, one-way causality was obtained (BTC→BVSP).

There was no causality from MOEX to BTC, there was causality from BTC to MOEX. In this regard, one-way causality was obtained (BTC→MOEX).

There was no causality from BSE to BTC, there was causality from BTC to BSE. In this regard, one-way causality was obtained (BTC→BSE).

As can be seen, developing stock markets are the cause of BTC, and their historical values are effective on BIST, BVSP, MOEX, and BSE.

4. CONCLUSION

The investment alternatives of the savers are also increasing with the technological developments. As the costs of accessing information decrease, investment tools become diversified. Means of payment are changing Not only in investment but also in trade. With the widespread use of mobile applications on smartphones after the development of computer software and the development of electronic devices easy to carry, transactions have become both faster and easier.

The purpose of this study was to analyze and reveal the Bitcoin causality relations with developing market stock markets BIST100 (XU100), Bovespa (BVSP), MOEX Russia (IMOEX), and BSE Sensex 30 (BSESN) for 2010 January-2021 September monthly data with Hacker and Hatemi-J (2006) Bootstrap causality analysis. As a result of the analysis, one-way causality was obtained from Bitcoin to the stock markets of developing countries. In other words, the past values of Bitcoin affect the current values of these exchanges. However, the historical values of these exchanges did not have significant effects on Bitcoin. Bitcoin phenomenon structure has shown

itself here. The capital markets of developing countries are open to speculation since the financial system has not been deepened. When Bitcoin became popular among investment tools, it started to affect developing stock markets. Since the capital markets of developing countries are not fully settled, they are not effective on Bitcoin. In the scope of this relationship, it was concluded that Bitcoin prices can affect the short-term investment decisions of investors in these exchanges. According to the findings, Bitcoin investors must predict the change in the stock markets accurately and constantly update their investments according to this change. In this respect, investors who will invest in Bitcoin have different country stock market returns as well as gold and foreign exchange prices, etc. different investment instruments, and for this reason, international markets must be followed closely. Otherwise, changes that are not expected, which might occur in other investment instruments, might affect Bitcoin prices and cause the profit margins of the investors to change. In future studies, different cryptocurrencies and exchanges of other countries should be included, and analyses to cover and compare different periods will contribute to the literature data.

REFERENCES

Antonakakis, N., Chatziantoniou, I. and Gabauer, D. (2019), "Cryptocurrency market contagion: market uncertainty, market complexity, and dynamic portfolios", Journal of International Financial Markets, Institutions and Money, 61(1), 37-51.

Atik, M., Kose, Y., Yılmaz, B., ve Saglam, F. (2015). Kripto Para: Bitcoin ve Döviz Kurları Üzerine Etkileri. Bartın Üniversitesi İ.İ.B.F. Dergisi, 6(11), 247-261.

Baek, C. and Elbeck, M. (2015) Bitcoins as an Investment or Speculative Vehicle? A First Look. Applied Economics Letters, 22(1), 30-34.

Baur, D.G., Lucey, B.M. (2010). Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold. The Financial Review, 45(2), 217-229.

Baur, D. G., Hong, K. ve Lee, A. D. (2017). "Bitcoin: Medium of Exchange or Speculative Assets?", Journal Of International Financial Markets, Institutions and Money, 54(1), 177-189.

Black, F. (1972). Capital market equilibrium with restricted borrowing. The Journal of Business, 45(3), 444–455. doi:10.1086/295472

Bohme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. Journal of Economic Perspectives, 29(2), 213–238. doi:10.1257/jep.29.2.213

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., Hagfors, L.I., (2017). On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? Finance Research Letters, 20, 192-198.

Bouri, E., Das, M., Gupta, R. and Roubaud, D. (2018). "Spillovers between Bitcoin and other assets during bear and bull markets", Applied Economics, 50(55), 5935-5949.

Brauneis, A. & Mestel, R. (2018). "Price discovery of cryptocurrencies: bitcoin and beyond", Economics Letters, 165(1), 58-61.

Charfeddine, L., Benlagha, N., Maouchi, Y. (2020). Investigating the dynamic relationship between cryptocurrencies and conventional assets: Implications for financial investors, Economic Modelling, 1(1), 1-21.

Cheung, A., Eduardo Roca, E. ve Su J.J. (2015), "Crypto-Currency Bubbles: An Application of The Phillips–Shi–Yu (2013) Methodology On Mt. Gox Bitcoin Prices", Applied Economics, 47(23), 2348-2358

Chi M. H. (2020). Does virtual currency development harm financial stocks' value? Comparing Taiwan and China markets, Economic Research-Ekonomska Istraživanja, 33:1, 361-378, DOI: 10.1080/1331677X.2019.1702076

Chow, G. C., Liu, C., & Niu, L. (2011). Co-movements of Shanghai and New York stock prices by time-varying regressions. Journal of Comparative Economics, 39(4), 577–583. doi:10.1016/j.jce.2011.06.001

Chuen, D. L. K., Guo, L., & Wang, Y. (2017). Cryptocurrency: A new investment opportunity? The Journal of Alternative Investments, 20(3), 16-40.

Chu, J., Nadarajah, S., & Chan, S. (2015). Satistical analysis of the exchange rate of Bitcoin. PloS One, 10(7), e0133678–27. doi:10.1371/journal.pone.0133678

Ciaian, P., Rajcaniova, M., Kancs, D. A., 2016. The economics of Bitcoin price formation, Applied Economics, 48(19), 1799–1815.

Ciaian, P., Rajcaniova, M., & Kancs, D. (2018). Virtual relationships: Short- and long-run evidence from BitCoin and altcoin markets. Journal of International Financial Markets Institutions & Money, 52, 173-195. doi:10.1016/j.intfin.2017.11.001

Corbet, S., Meegan, A., Larkin, C., Lucey, B., Yarovaya, L., 2018. Exploring the dynamic relationships between cryptocurrencies and other financial assets. Economics Letters, 165, 28-34.

Dastgir, S., Demir, E., Downing, G., Gozgor, G., (2019). The causal relationship between Bitcoin attention and Bitcoin returns: Evidence from the Copula-based Granger causality test, Finance Research Letters, 28(1), 160-164.

Demir, E., Gozgor, G., Lau, C. K. M., & Vigne, S. A. (2018). Does economic policy uncertainty predict the Bitcoin returns? An empirical investigation. Finance Research Letters, 26(1), 145- 149.

Dickey, D. A. & Fuller, W. A. (1981). "Distribution of the estimators for autoregressive time series with a unit root", Econometrica, 49(1), 1057-1072.

Dilek, S. (2018). Blockchain Teknolojisi ve Bitcoin. Turkuvaz Haberleşme ve Yayıncılık A.Ş., İstanbul, Analiz, Şubat 2018, Sayı: 231. https://setav.org/assets/uploads/2018/02/231.-Bitcoin.pdf

Dirican, C. & Canoz, I.(2017), "Bitcoin Fiyatları ile Dünyadaki Başlıca Borsa Endeksleri Arasındaki Eşbütünleşme İlişkisi: ARDL Modeli Yaklaşımı ile Analiz", Journal of Economics, Finance and Accounting, 4(4), 377-392.

Dolado, J. L. ve H. Lütkepohl (1996), "Making Wald Tests Work for Cointegrated VAR Systems", Econometric Reviews, 15(1), 369-386.

Dyhrberg, A. H. (2015), "Hedging Capabilities Of Bitcoin. Is İt The Virtual Gold?", *Finance Research Letters*, 16 (2), 1-6.

Engle, R. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. Econometrica, 50(1), 987-1007.

Eswara, M. (2017), "Cryptocurrency Gyration and Bitcoin Volatility", International Journal of Business and Administration Research Review, 3(18), 187-195.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33(1), 3–56. doi:10.1016/0304-405X(93)90023-5

Ghorbel, A., Jeribi, A. (2021). Investigating The Relationship Between Volatilities of Cryptocurrencies and Other Financial Assets, Decisions in Economics and Finance, 1(1), 1-27.

Gil-Alana, L., Abakah, E. J. A., & Rojo, M. F. (2020). Cryptocurrencies and stock markets indices. Are they related? Research in International Business and Finance, 51(1), 1-23.

Gkillas, K., & Katsiampa, P. (2018). An application of extreme value theory to cryptocurrencies. Economics Letters, 164, 109–111. doi:10.1016/j.econlet.2018.01.020

Gozgor, G., Tiwari, A. K., Demir, E., & Akron, S. (2019). The relationship between Bitcoin returns and trade policy uncertainty. Finance Research Letters, 29(1), 75-82.

Guesmi, K., Saadi, S., Abid, I., Ftiti, Z., 2018. Portfolio diversification with virtual currency: Evidence from bitcoin. International Review of Financial Analysis. https://doi.org/10.1016/j.irfa.2018.03.004

Hacker, R. S. ve Hatemi-J, A. (2006), "Tests for Causality between Integrated Variables Using Asymptotic and Bootstrap Distributions: Theory and Application", Applied Economics, 38(1), 1489-1500.

Hatemi-J, A. (2003) "A New Method to Choose Optimal Lag Order in Stable and Unstable VAR Models" Applied Economics Letters, 10(3),135-137.

Hileman, G. (2016, January 28). State of Bitcoin and Blockchain. New York, NY: Coin Desk. Retrieved from https://www.coindesk.com/state-of-bitcoinblockchain-2016/

Hung, N.T. (2019). "An analysis of CEE equity market integration and their volatility spillover effects", European Journal of Management and Business Economics, 29(1), 23-40.

Hung, J., Liub, H., Yangc, J. (2020). Improving the realized GARCH's volatility forecast for Bitcoin with jump-robust estimators. The North American Journal of Economics and Finance, 52(1), 1-22.

Icellioglu, C. Ş. ve Öztürk, M. B. E. (2018), "Bitcoin İle SeIili Döviz Kurları Arasındaki İlişkinin Araştırılması: 2013-2017 Dönemi için Johansen Testi ve Granger Nedensellik Testi*",* Maliye Finans Yazıları, 109(1), 51-70.

Ji, Q., Bouri, E., Lau, C. K. M., & Roubaud, D. (2019). Dynamic connectedness and integration in cryptocurrency markets. International Review of Financial Analysis, 63(2), 257-272.

Ji, Q., Bouri, E., Gupta, R., Roubaud, D. 2018. Network Causality Structures among Bitcoin and other Financial Assets: A Directed Acyclic Graph Approach. The Quarterly Review of Economics and Finance, https://doi.org/10.1016/j.qref.2018.05.016

Kang, S.H., Yoon, S.M., Bekiros, S. and Uddin, G.S. (2019b), "Bitcoin as hedge or safe haven: evidence from stock, currency, bond and derivatives markets", Computational Economics, 56(2), 1-17.

Kanat, E. ve Oget, E. (2018), "Bıtcoin ile Türkiye ve G7 Ülke Borsaları Arasındaki Uzun Ve Kısa Dönemli İlişkilerin İncelenmesi", Finans Ekonomi ve Sosyal Araştırmalar Dergisi, 3(3), 601-614.

Kilic, Y. ve Cutcu, I. (2018). "Bitcoin Fiyatları İle Borsa İstanbul Endeksi Arasındaki Eşbütünleşme ve Nedensellik İlişkisi", Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, 13(3), 235-250.

Kocoglu, S., Cevik, Y. E. ve Tanrıoven, C. (2016), "Bitcoin Piyasalarının Etkinliği, Likiditesi ve Oynaklığı", İşletme Araştırmaları Dergisi, 8(2),77-97.

Kristoufek, L. (2015), "What are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis", *Plos One*, 10(4),1-15.

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. The Review of Economics and Statistics, 47(1), 13–37. doi:10.2307/1924119

Liu, H., & Gao, Y.-C. (2019). The impact of corporate lifecycle on Fama–French three-factor model. Physica A: Statistical Mechanics and Its Applications, 513(1), 390–398. doi.org/10.1016/j.physa.2018.09.037. doi:10.1016/j.physa.2018.09.037

Matkovskyy, R., & Jalan, A. (2019). From financial markets to Bitcoin markets: A fresh look at the contagion effect. Finance Research Letters, 31(1), 93-97.

McIver, R.P. and Kang, S.H. (2020), "Financial crises and the dynamics of the spillovers between the US and BRICS stock markets", Research in International Business and Finance, 54(1), 1-20.

Montesdeoca, L. and Niranjan, M. (2020). On Comparing the Influences of Exogenous Information on Bitcoin Prices and Stock Index Values. Mathematıcal Research for Blockchain Economy, pp.93-100. 10.1007/978-3-030-37110-4_7

Nakamoto, S. (2009). Bitcoin: A Peer-to-Peer Electronic Cash System, Bitcoin. https://bitcoin.org/bitcoin.pdf

Omane-Adjepong, M., Alagidede, P., & Akosah, N. K. (2019). Wavelet time-scale persistence analysis of cryptocurrency market returns and volatility. Physica A: Statistical Mechanics and its Applications, 514(1), 105-120.

Ong, B., Lee, T. M., Li, G., & Chuen, D. L. K. (2015). Evaluating the potential of alternative cryptocurrencies. In Handbook of digital currency (pp. 81-135). Academic Press.

Paule-Vianez, J., Prado-Rom_an, C. and G_omez-Mart_ınez, R. (2020), "Economic policy uncertainty and Bitcoin. Is Bitcoin a safe-haven asset?", European Journal of Management and Business Economics, 29(3), 347-363.

Peng, Y., Albuquerque, P. H. M., de Sá, J. M. C., Padula, A. J. A., & Montenegro, M. R. (2018). The best of two worlds: Forecasting high frequency volatility for cryptocurrencies and traditional currencies with Support Vector Regression. Expert Systems with Applications, 97(1), 177-192.

Phillips, P.C. B ve Perron, P. (1988), "Testing for a Unit Root in Time Series Regression", Biometrika, 75(2), 335-346.

Ren, S., & Culpan, T. (2017). Ethereum's wild ride needs to slow. Bloomberg Businessweek, July 13.

Ross, S. A. (1976). The arbitrage theory of capital asset pricing. Journal of Economic Theory, 13(3), 341–360. doi:10.1016/0022-0531(76)90046-6

Salisu, Afees A.; Isah, Kazeem; Akanni, Lateef O. (2018). Improving the predictability of stock returns with Bitcoin prices. The North American Journal of Economics and Finance, 48 (2019), *857-867*. https://doi.org/10.1016/j.najef.2018.08.010

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, 19(3), 425–442. Retrieved from http://www.jstor.org/stable/2977928 doi:10.2307/2977928

Szetela, B., Mentel, G., Bilan, Y., Mentel, U. (2021). The relationship between trend and volume on the bitcoin market, Eurasian Economic Review,11(1), 25-42.

The 2021 Geography of Cryptocurrency Report; Analysis of Geographic Trends in Cryptocurrency Adoption and Usage (October 2021) https://go.chainalysis.com/rs/503-FAP-074/images/Geography-of-Cryptocurrency-2021.pdf

Toda, H.Y. & Yamamoto, T. (1995). "Statistical Inference in Vector Auto regressions with Possibly Integrated Process", Journal of Econometrics, 66(1-2), 225-250.

Umar, M., Hung, N.T., Chen, S., Iqbal, A., Jebran, K. (2020). Are stock markets and cryptocurrencies connected, The Singapore Economic Review, 1(1), 1-20. https://doi.org/10.1142/S0217590820470050

Wang, X., Chen, X., Zhao, P. (2020). The Relationship Between Bitcoin and Stock Market, International Journal of Operations Research and Information Systems, 11(2), 22-35.

Wang, Xin; Chen, Xi; Zhao, Peng (2020). The Relationship Between Bitcoin and Stock Market. International Journal of Operations Research and Information Systems, 11(2), 22–35. doi:10.4018/IJORIS.2020040102

Wei, W.C. (2018), "Liquidity and market efficiency in cryptocurrencies", Economics Letters, 168(1), 21-24.

Yi, S., Xu, Z., & Wang, G. J. (2018). Volatility connectedness in the cryptocurrency market: Is Bitcoin a dominant cryptocurrency?. International Review of Financial Analysis, 60 (1), 98-114.

Yermack, D. (2013). Is Bitcoin a real currency? An economic appraisal. In Handbook of digital currency (pp. 31–43). Cambridge, U.S.: National Bureau of Economic Research,

Zeng, I., Yang, M., Shen, Y. (2020). Fancy Bitcoin and conventional financial assets: Measuring market integration based on connectedness networks, Economic Modelling, 90(1), 209-220.

Zhang, Y.J., Bouri, E., Gupta, R. and Ma, S.J. (2021), "Risk spillover between Bitcoin and conventional financial markets: an expectile-based approach", The North American Journal of Economics and Finance, 55(1), 1-19.