Üçüncü Sektör Sosyal Ekonomi Dergisi
Third Sector Social Economic Review
57(1) 2022, 442-457
doi: 10.15659/3.sektor-sosyal-ekonomi.22.02.1772

Research Article

Teknolojik İnovasyon ve Kripto Para Piyasaları: Momentum ve Zıtlık Anomalilerinin Test Edilmesi

Technological Innovation and Cryptocurrency Markets: Testing Momentum and Contrarian Anomalies

Eyyüp Ensari ŞAHİN	Ceyda AKTAN
Assoc. Prof. Dr., Hitit University Faculty of Economics and Administrative Sciences	Asst. Prof. Dr., University of Turkish Aeronautical Association Faculty of Business Administration
eyupensarisahin@hitit.edu.tr	caktan@thk.edu.tr
https://orcid.org/0000-0003-2110-7571	https://orcid.org/0000-0001-7040-4711

Makale Geliş Tarihi	Makale Kabul Tarihi
12.01.2022	25.02.2022

Öz

Bu çalışma, kripto para piyasasında var olabilecek hem momentum hem de zıtlık anomalilerini (stratejilerini) Bitcoin odağında incelemeyi amaçlamaktadır. 02.02.2012 ile 27.02.2020 tarihleri arasındaki Bitcoin fiyatları günlük olarak alınmıştır ve Kim (2009) tarafından önerilen wild bootstrap automatic variance ratio (WBAVR) testinde kullanılmıştır. Bu test, finansal zaman serilerinin temel özellikleri olan normal olmayan ve koşullu değişen varyanslılığa karşı güçlüdür, bu nedenle momentum ve zıt etkileri ölçmek için geçerli bir testtir. Çalışmada elde edilen sonuçlara göre: (1) Bitcoin fiyat hareketlerinde hem momentum hem de zıt anomalilerin varlığı görülmektedir; (2) Bitcoin fiyatları genellikle geçmiş fiyat hareketleriyle tahmin edilmektedir; (3) Anormal getirilerin, momentum stratejisine kıyasla zıt strateji kullanılarak elde edilmesi daha olasıdır. Bu çalışma, geçmiş fiyat hareketleri ile bir yatırım stratejisi izleyen tasarruf sahiplerine, portföy yöneticilerine ve kurumsal yatırımcılara Bitcoin fiyat hareketleri hakkında önemli bilgiler vermektedir.
Anahtar Kelimeler: Bitcoin, Blokzinciri, Momentum Anomalisi, Zıtlık Anomalisi, Kriptoparalar
JEL Kodları: C01, G14, G40.

Abstract

This study aims to investigate both the momentum and contrarian anomalies (strategies) that may exist in the cryptocurrency market, focusing especially on Bitcoin. Daily Bitcoin prices were taken from a period starting 02.02.2012 and ending 27.02.2020 and used in the wild bootstrap automatic variance ratio (WBAVR) test proposed by Kim (2009). This test is robust to non-normality and conditional heteroscedasticity which are the main characteristics of financial time series, therefore, making it a valid test to be used to measure the momentum and contrarian effects. Results of the study demonstrate that: (1) There are both momentum and contrarian anomalies in Bitcoin price movements; (2) Bitcoin prices are generally predicted with the past price movements; (3) Abnormal returns are more likely to be obtained by employing contrarian strategy compared to momentum strategy. This study gives important information about the Bitcoin price movements to savings owners, portfolio managers and institutional investors who follow an investment strategy with past price movements.
Keywords: Bitcoin, Blockchain, Momentum Anomaly, Contrarian Anomaly, Cryptocurrency.
JEL Codes: C01, G14, G40.

Önerilen Atıf /Suggested Citation
Şahin, E.E., Aktan,C., 2022 Teknolojik İnovasyon ve Kripto Para Piyasaları: Momentum ve Zıtlık Anomalilerinin Test Edilmesi, *Üçüncü Sektör Sosyal Ekonomi Dergisi,* 57(1), 442-457.

1. Introduction

The heavy, widespread use of technology has affected many different areas, such as manufacturing, logistics, health, and many more. In last couple of decades its impact on financial markets were also seen to increase dramatically. It has improved the quality of life, and brought with it efficiency and effectiveness. In the long run this change in technology has lead to a significant alteration in the socio-economics of financial markets creating strict regulations and frameworks for financial institutions to work with. Technological advancements are also seen to become home to many start-up and sandbox applications, especially in the banking and its affiliated sectors. The advantages it brings is great and diverse such as the speed, quality, and cost-reducing effects to the services provided. However, this cost-reducing effect has been criticized in many studies due to the fact it makes it harder, and sometimes impossible, for central institutions to track movement of funds. Adopted new technologies are also criticized for not being transparent and for limiting full financial participation. To overcome this problem, one of the most recent, popular, introduction to the financial markets, in terms of technology, is the Blockchain system.

The Blockchain system was introduced by the person(s) under the pseudonym Satoshi Nakamoto in 2008 with the claim that it can address the criticism directed towards technological systems. This is a decentralized system where a digital ledger is used to keep track of transactions. Together with the introduction of the Blockchain system, cryptocurrencies such as Bitcoin started to gain attention as this system allowed for the storage and distribution of information but work to prevent it from being edited (Nakamoto, 2008, 1-2). However, following the popularity of Bitcoin, being encrypted as well as decentralized, alternative cryptocurrencies soon appeared in the market. First of these was the Altcoin which offered higher speed and anonymity advantage when compared to the Bitcoin, which then was followed by currencies such as Namecoin and Litecoin (Mason, Halgamuge and Aiyar 2021, p. 133).

The increase in interest on blockchain and cryprocurrencies continues especially with new cryptocurrencies still being introduced to the market almost every month. As much as the opportunities it brings into the picture there are still many ethical and legal dilemmas relating to their use. Without a surprise the anonymity of the users has made the currency attractive for its use in criminal activities. The ease with which it can be moved from one place to another, when compared with other currencies, is seen as a disadvantage for regulatory bodies but have been favored by criminals (Srokosz and Kopciaski 2015, p. 620-621). Many countries around the World have banned their use as to its possible use to transfer funds in the blackmarket and in other illegal activities such as terrorism or money laundering (Fraser and Bouridane 2017, p. 54; Kshetri and Voas 2017, p. 11-12). However, it is incorrect to say that there is absolute anonymity within the blockchain system. Transactions on blockchains that include cryptocurrencies are first made public. Here, the cryptocurrency addresses serve as a pseudonym and hence, makes it identifiable to all the parties involved. If this link between the individual and the address is identified then the anonymity will disappear (Houben and Snyers 2018, p. 80). Therefore, the challenge of Blockchain and cryptocurrencies lies in factors such as the difficulty it presents in law enforcement, preventing governments from exerting pressures, lowering inflation risk, or lowering transaction costs (Oh and Nguyen 2018, p. 33-34; Fauzi, Paiman and Othman 2020, p. 695-696; Marthinsen and Gordon 2020, p. 1-2).

Besides finance, the recently introduced blockchain technology has been utilized in many other areas such as; the supply chain, automotive, insurance, healthcare, telecommunication, media, and so on (Alvarado and Halgamuge 2019, p. 2; Shrestha, Halgamuge and Treiblmaier 2020, p. 289-290). Just a couple of years after its introduction many big companies, including Microsoft and Expedia, began to accept the use of Bitcoin as one of their payment options to their customers. Therefore, Bitcoin started being referred to as a currency, a monetary instrument (Mason et al., 2021). This has led to a debate among researchers as to whether this definition for cryptocurrencies is actually correct or not. Although it is expressed as a monetary instrument in its definition, an evaluation needs to be performed within the framework of references to the definition of money in literature in order to call it as such. Mittal (2012), and Wolla (2018), have all supported the view that Bitcoin also carries these function whereas research conducted by Yermack (2015) have made counter arguments against the issue. However, it is seen that majority of previous academic studies on the topic focuses on both the technical and the legal side of these new instruments and generally neglects their potential as a new asset class (Grinberg, 2011, p.

160-161; Crosby, Pattanayak, Verma and Kalyanaraman 2016, p. 7). This presents as an interesting case as still being new and unexplored it is also seen as highly vulnerable to market changes.

The characteristics of the cryptocurrency market increases uncertainty making it a highly volatile market when compared with the foreign exchange or commodity markets (Caporale and Plastun 2020, p. 252). Volatility of the market can be translated as a measure on asset price variability over time and therefore an increase in it makes the market very unstable and risky (Woebbeking, 2021, p. 273-276). This characteristic of the market makes it an important for the use of cyptocurrencies as as a hedging instrument in the short term (Dyhrberg, 2016a, p. 85; Dyhrberg, 2016b, p. 139-140). However, the picture changes in the long term. Recent figures in cyrptocurrency, especially in Bitcoin, supports the research and points out to the price volatility in the market. Although Bitcoin prices started to increase in the beginning of 2021, reaching its highest in April 2021, it experienced a sharp drop in May 2021 and held its position. As one of the most important technological innovations of the last century, the reasons for this volatility in the cryptocurrency market is attributed to it still being an emerging market surrounded by speculation and fragile investors. The media also contribributes to the changing prices in cryptocurrencies as they report speculative bubbles surrounding these currencies and that it is a matter of time before they burst (Cheah and Fry 2015, p. 33).

There are many studies that try to understand the factors behind the movement in cryptocurrency prices. Interactions between supply and demand, attractiveness of cryptocurrencies for investors, and the financial and macroeconomic developments taking place globally were pointed out as some of the major factors causing these fluctuations in prices (Buchholz, Delaney, Warren and Parker 2012, p. 2-4; Kristoufek, 2013, p. 1-4; van Wijk, 2013, p. 14-15) and hence making the crypocurrency market highly volatile. As much as it is used in hedging to offset the risk in the short term (Dyhrberg, 2016a; Dyhrberg, 2016b), high volatility in cryptocurrency prices raise concerns regarding the efficiency of the market. If all the events surrounding the market, in other words all information, are instantaneously reflected in the prices causing them to move up or down, then the market can be referred to as informationally efficient (Urquhart, 2016, p. 80). According to the Efficient Market Hypothesis (EMH) no arbitrage opportunities exist and no investor can gain above normal returns if one market is found to be fully informationally efficient. When markets are efficient, future prices of currencies cannot be predicted and everyone will have access to same information at the same time (Kang, Lee and Park 2021, p. 2-3). An important issue regarding the Efficient Market Hypothesis is that, it is said to hold if all the actors within that market are rational. Therefore as new information arrives in the market it is reflected in the prices of stocks (Aktan, İren and Omay 2019, p. 979). However, it is found that markets not always follow the characteristics of the EMH. A recent argument proposed by behavioral finance is that investors are not at all rational and are guided by many different emotions when making decisions. When this happens and markets deviate from the rules of EMH it is referred to as an anomaly. These anomalies can take place only once or they can occur repeatedly. One way to group them is under three main headings: calendar, technical, and fundamental anomalies (Latif, Arshad, Fatima and Farooq 2011, p. 1). Another way to look at different anomalies that are present in young and volitile markets is through identifying the momentum and the contrarian effects. Momentum effect or anomaly takes place when securities hold their past performances. In other words, if the value of a security has decreased in the past, it is said to continue decreasing in the future (Tzouvanas, Kizys and Tsend-Ayush 2020, p. 1-2). Under the contrarian anomaly, a security thats value has been decreasing in the past is believed to increase in the future and cause rates of return to increase with it. In time these anomalies have provided grounds for investors to build their investment strategies. Whether selling poorly performing stock to purchase better performing ones, such as in the momentum strategy, or selling highly priced securities to purchase poorly priced ones which is reffered to as the contrarian strategy. The relationships within the movements in stock prices can be used for evaluating both the momentum and contrarian strategies (Doan, Alexeev and Vrooks 2016, p. 1-4; Özkan and Çakar 2021, p. 201-202).

Studies on the stock price momentum and contrarian anomalies or strategies can be found extensively in past literature. However, majority of these existing studies are seen to focus on the major world stock indices and neglect the cryptocurrency market. For this reason, with the purpose of investigating the existence of momentum and contrarian anomalies within the cryptocurrency market, focusing on Bitcoin, this study is believed to contribute greatly to existing literature. Daily Bitcoin prices are taken from a period starting 02.02.2012 and ending 27.02.2020 making 2931 observations in total. Data is then used in the wild bootstrap automatic variance ratio (WBAVR) test proposed by Kim (2009) because

it is seen to be used widely in literature to detect momentum and contrarian anomalies. It is robust to non-normality and conditional heteroscedasticity which are the features of financial time series.
The study will be presented in the following order. In Section 2 relevant literature will be reviewed followed by the explanation of the study's data and methodology in Section 3. Results will be given and explained in section 4 and the study concludes in section 5.

2. Literature Review

Although the focus on the Blockchain and the cryptocurrency market is quite recent, due to the markets attractiveness there have been an extensive number of studies conducted on it since. Analyzing past literature is an important step in market efficiency studies as the results of past literature is seen to vary according to many factors such as; the time period used, the tests applied or the frequency of the data taken. A collective look will be helpful in understanding the Dynamics behind the market and point to the important contribution this study will have to existing literature. For the purpose of this study, existing studies are grouped under two sections as firstly an analysis will be done on the efficiency of the cryptocurrency market, followed by a focus on studies measuring anomalies that may exist within this market.

One of the earliest studies on the efficiency of the cryptocurrency market was conducted by Urquhart (2016) where tests were applied on different samples of data. Daily data was taken from 1st August 2010 until 31st July 2016 which was the full sample of the study which was found to be inefficient after conducting the tests. Then two different subsamples (01.08.2010-31.07.2013 and 01.08.2014-31.07.2016) were used to observe how the efficiency had changed in time and was found that the second period the market had become weak form efficient. Therefore, the resulting argument was that in time these cryptocurrency markets were becoming more efficient which was later supported by Vidal-Tomas and Ibanez (2018), Khuntia and Pattanayak (2018), and Sensoy (2019). However, Nadarajah and Chu (2017) have revisited Urquhart (2016)'s study by taking the same data set and samples but made a simple power transformation to Bitcoin returns and found that the market was actually weak form efficient to begin with. In his study Bartos (2015) investigated whether the efficient market hypothesis is valid for Bitcoin. As a result of the study, it was found that the Bitcoin price responded immediately to the information disclosed to the public, in particular, the supply-demand and speculative investor effect was observed.

A recent study by Ozkan and Sahin (2020) compared 4 different cryptocurrencies (Bitcoin, Ripple, Litecoin, and Ethereum) in order to understand the differences in their efficiencies. Data was taken daily from 24.08.2016 to 28.02.2020 and used in the automatic portmanteau test proposed by Escanciano and Lobato (2009). The results showed that efficiency of these markets have changed over time which, once again, supported previous studies on the market. Yagmur and Mangir (2020) have specifically investigated the random walk behavior of Bitcoin between 2015 and 2019 and found supporting evidence for its existence. This result supported the findings of previous studyby Zeren and Esen (2018) where the existence of bubbles in Bitcoin prices were identified and found that the prices exhibited a random walk.

However, literature and analyses indicate that there are also situations where the Efficient Market Hypothesis does not hold. These deviations are referred to as anomalies. While their existence is widely investigated these anomalies indicate the possibility of abnormal returns for investors. The reasons behind abnormal returns can vary depending on the situation. Literature points to herding behavior, noise traders, behavioral patterns, and macroeconomic announcements as some of the main reasons behind the possible abnormal returns (Caporale and Plastun, 2020). Wang and Wei (2018) used the daily closing values of Bitcoin between 2013-2018 in their study. In the study, they measured the sensitivity of the stock returns to Bitcoin returns. In addition, the study compared 24 different anomalies for Bitcoin and stocks. As a result, they concluded that the Bitcoin anomaly provides more returns. In their study, Caporale, Gil-Alana and Plastun (2018) investigated overreactions in the cryptocurrency market and found price patterns following overreactions. As a result of the study, they concluded that the next day there were overreactions in prices. Again, Caporale and Plastun (2019a) examined the existence of day-of-the-week effects regarding the Bitcoin, LiteCoin, Ripple and Dash traded in the

cryptocurrency market with the Student T-test, ANOVA, and Kruskal-Wallis test. They claimed that there were anomalies and certain profit opportunities for Bitcoin on Mondays. They concluded that the day-of-the-week effect is not in play for other cryptocurrencies. In their study, Ma and Tanizaki (2019) examined day-of-the-week effects for both return and volatility in the cryptocurrency market. As a result of the study, they found significantly high fluctuations on Monday and Thursday.

Although the momentum and contrarian effects of asset prices are studied greatly for the stock market, this statement is not true for the case of the cryptocurrency market. Grobys and Sapkota (2019) have created a dataset from 143 cryptocurrencies that were traded in the market between 2014-2018. In the study, using the portfolio approach of Fama and French (2008), all cryptocurrencies are divided into groups according to their cumulative backgrounds. They were divided into two equally weighted groups as in gains and losses. They found no evidence of momentum anomaly in the study. As opposed to the findings of Grobys and Sapkota (2019), studies conducted by Yang (2018) and Caporale and Plastun (2019b) have both found evidence for the existence of strong momentum movements in the cryptocurrency market. Yang (2018) showed that if behavioral bias is explaining the anomaly in asset prices, it was statistically proven that strong momentum movements in the cryptocurrency market existed. While the market size and price momentum are statistically significant, the fall in prices and risk-based anomalies show a statistically weak effect. On the other hand, Caporale and Plastun (2019b) used the daily closing prices of Bitcoin, Ethereum and LiteCoin between 2017-2019 in their study. In the study, three important hypotheses were established and they investigated whether there was a momentum effect following abnormal returns at a daily value. In the study, the presence of returns in overreaction days, the presence of momentum between the overreaction days and the presence of momentum in one-day abnormal returns were investigated in hourly intraday price behavior. As a result of the study, they found positive (presence of momentum) in hourly returns for Bitcoin and negative (contrarian) overreaction for Ethereum. Study by Chevapatrakul and Mascia (2019) looked at the investor overreactions to Bitcoin prices. Through the quantile autoregressive model they have concluded that when there are periods where the returns of Bitcoin are negative, the following period will also generate negative returns and vice versa. Strong momentum effects were also supported by Cheng, Liu and Zhu (2019), Tzouvanas et al. (2020), and Liu and Tsyvinski (2021).

3. Data and Methodology

In this study, the wild bootstrap automatic variance ratio (WBAVR) test developed by Kim (2009) was employed to determine if a momentum and/or contrarian anomaly (strategy) in Bitcoin prices exists. Kim (2006) developed the wild bootstrap variance ratio test to overcome the shortcomings of Lo and MacKinlay's (1988) variance ratio test by using small samples, especially under conditional heteroscedasticity, which is a typical feature of the financial time series. Kim (2009) developed the WBAVR test in which the holding period can be determined automatically in a data-dependent manner to eliminate the problems that arise due to the subjective determination of the holding period of the method in question. Charles, Darne and Kim (2011) stated that the WBAVR test gives more successful results when compared to alternative tests in their study which was performed using the Monte Carlo simulation.

The statistical form of the original variance ratio test is shown in Equation (1).

$$\widehat{VR}(k) = 1 + 2\sum_{i=1}^{k-1}\left(1 - \frac{i}{k}\right)\hat{p}(i) \qquad (1)$$

Where, k refers to the holding period.

Because the original variance ratio test required subjective choices in the holding period, Choi (1999) developed the automatic variance ratio test using the method given by Andrews (1991), where the holding period was chosen optimally based on the data. Kim (2009) developed the WBAVR test using Mammen's (1993) wild bootstrap method to overcome the shortcomings of Choi's (1999) test in series which have conditional heteroscedasticity. The WBAVR test is carried out using the following three steps:

1) Forming a bootstrap sample of size T where $Y_t^* = \eta_t Y_t (t = 1, \dots, T)$, η_t denotes a random variable with a zero mean and a unit variance.

2) Calculating $AVR^*(k^*)$, using the $AVR(k^*)$ statistic which is calculated using $\{Y_t^*\}_{t=1}^{T}$.

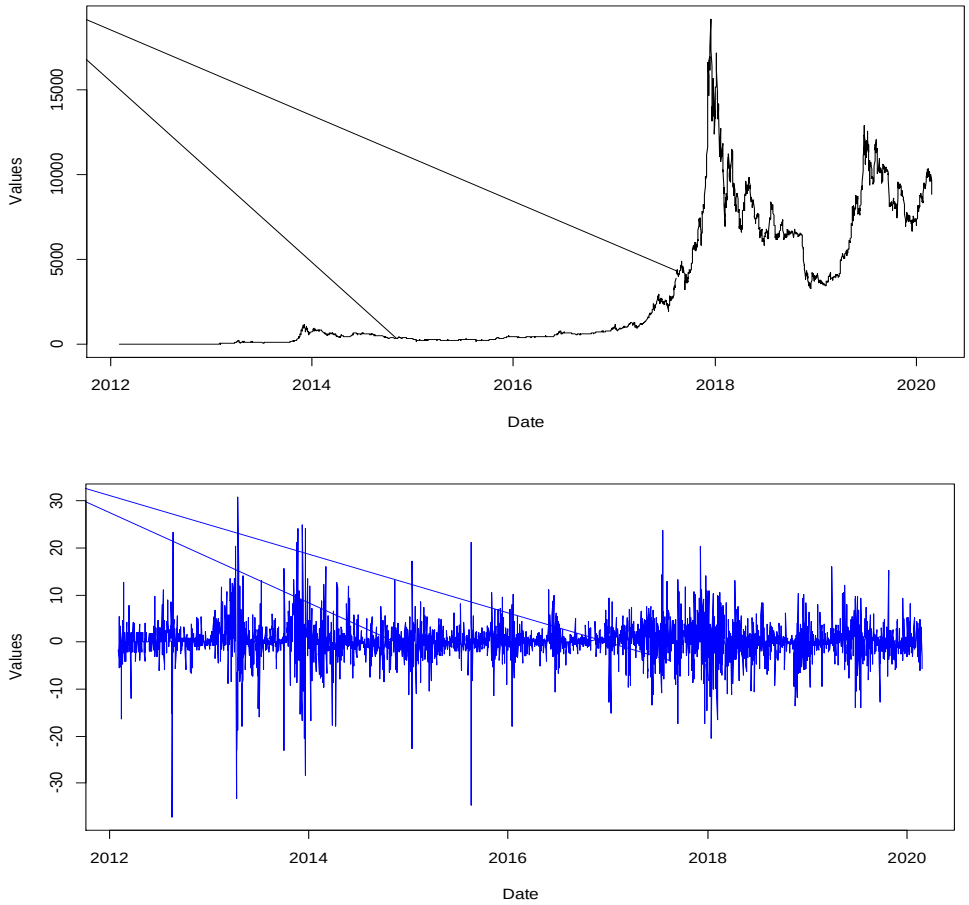
3) Repeating steps 1 and 2 bootstrap size (B) times to generate the bootstrap distribution of the AVR statistics $\{AVR(k^*; j)\}_{j=1}^{B}$.

If the statistical values obtained as a result of the WBAVR test exceed the critical values at the determined significance level or if the obtained p values are below the determined significance level then it can be stated that there is a significant relationship among the variables. In this study, bootstrap size is set to 500 which is same as in the study carried out by Charles, Darne and Kim (2015).

3.1. Data

In this study, Bitcoin data of 2931 days between 02.02.2012-27.02.2020 were used to observe the momentum and contrarian anomalies within the series. The related data were obtained from the website named Bitfinex (Access Date: 28.02.2020). The natural logarithmic first differences of Bitcoin prices were first multiplied by 100 and then the daily return rates were calculated. Bitcoin's daily prices and return rates are given in Figure 1 below.

Figure 1: Daily Prices and Return Rates of Bitcoin



When the graphs in Figure 1 are analyzed, it can be understood that the daily prices of Bitcoin are not stationary while the daily rates of return are stationary. Since the WBAVR test requires the datasets to be stationary, the stationarity of the series were tested using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results of both the ADF and the PP unit root tests are given in Table 1 below.

Table 1: ADF and PP Unit Root Test Results

Daily Prices ADF Test Results		Daily Prices PP Test Results	
Intercept	Trend and Intercept	Intercept	Trend and Intercept
-1.386366 (0.5905)	-2.788069 (0.2018)	-1.347203 (0.6095)	-2.734415 (0.2226)
Daily Return Rates ADF Test Outputs		Daily Return Rates PP Test Outputs	
Intercept	Trend and Intercept	Intercept	Trend and Intercept
-54.50728*** (0.0001)	-54.53440*** (0.0000)	-54.55651*** (0.0001)	-54.56543*** (0.0000)

Note: **** Indicates the the significance levels of 1% and the values in parentheses express the probabilities.*

When the outputs in Table 1 are analyzed, it is understood that the daily prices of Bitcoin were not found to be stationary. However, the daily return rates were found to be stationary according to both ADF and PP unit root test results. Descriptive statistical information on daily Bitcoin return rates that ensure the stationarity is given in Table 2.

Table 2: Descriptive Statistics

Number of Observations	2930
Mean	0.248514
Median	0.127301
Maximum	30.83014
Minimum	-37.15636
Standard Deviation	4.461935
Skewness	-0.523243
Kurtosis	12.89888
Jarque-Bera (JB)	12096.37***

Note: **** expresses significance level of 1%.*

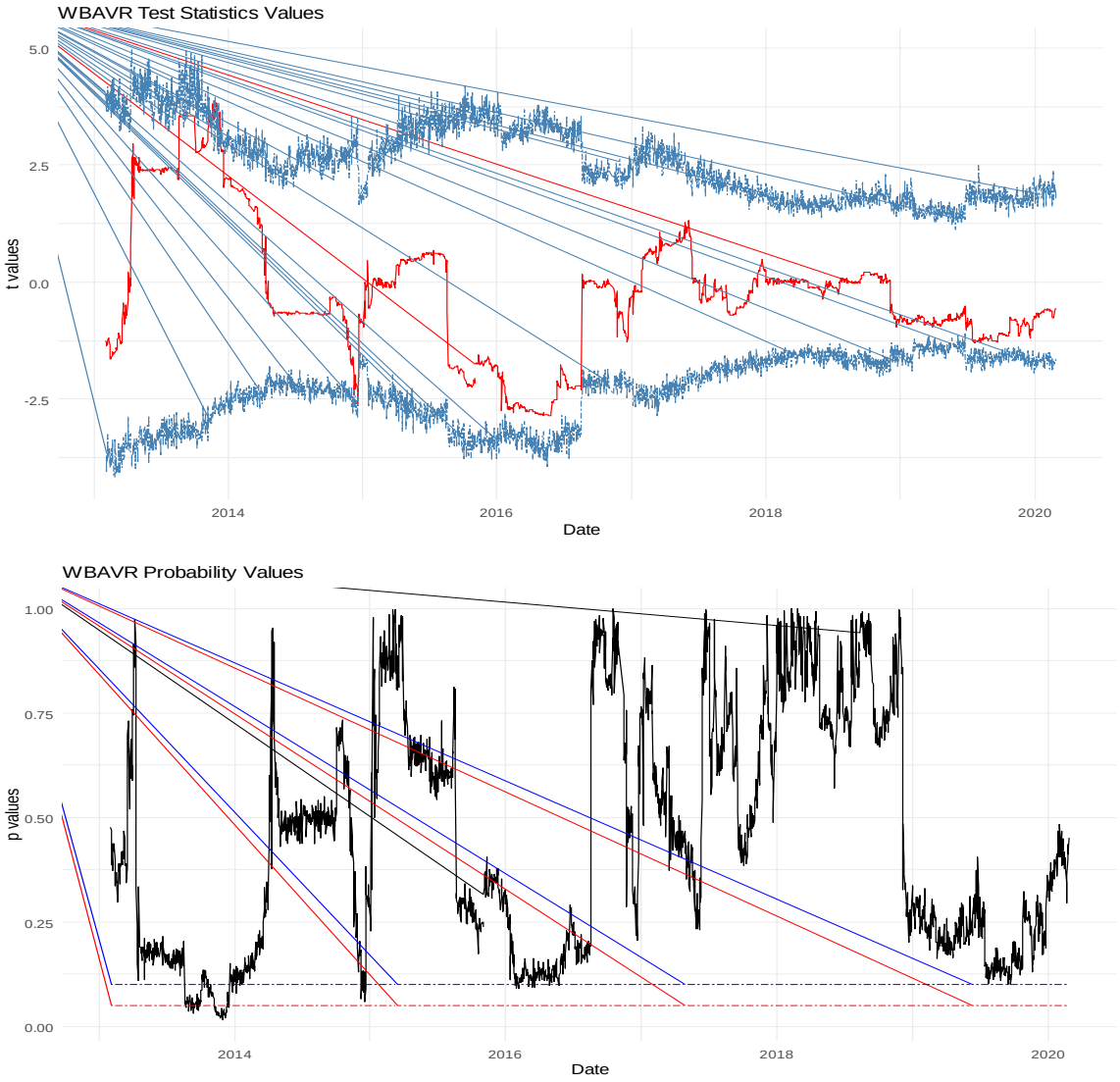
According to the information in Table 2, Bitcoin's average daily return rate was 0.25% whereas its standard deviation was 4.46. The skewness value indicates that the distribution of the Bitcoin daily return rates is skewed to the left compared to normal distribution. The kurtosis value from the table indicates that the distribution in question is rather steep and fat-tailed compared to the normal distribution, and thus is not distributed normally. JB test results developed by Jarque and Bera (1980), which are also carried out for normality, also indicate that Bitcoin's daily return rates are not distributed normally. The WBAVR test used in the study displays very successful results in non-normal distributed datasets such as Bitcoin daily return rates which supports previous literature (Charles, Darne and Kim 2012, p. 1607).

4. Empirical Findings

In the study, 1 year (365 days) fixed-length rolling sub-sampling windows were used. The reason for preferring the use of the rolling sub-sampling windows in this study was because these automatically bring structural breaks forward (Lazar, Todea and Filip 2012, p. 338) and can detect both momentum and contrarian anomalies at the same time. The first sub-sampling window contains daily return rates between 03.02.2012-01.02.2013. After the WBAVR test was performed on the first sub-sampling

window, the window was moved 1 day forward and a new sub-sampling window was created. With this method, a total of 2566 sub-sampling windows were created and the WBAVR test was applied to each sub-sampling window. The statistics and p values obtained as a result of the WBAVR test analysis performed to determine the presence of momentum and/or contrarian anomaly in Bitcoin prices are given below in Figure 2.

Figure 2. WBAVR Test Outputs



The first graph in Figure 2 displays the test statistics values and the second graph displays the probability (p) values. In the first graph, red lines represent the statistical values, blue lines represent the critical values of 5% significance level. The wavy black lines in the second graph represent p values, horizontal lines represent significance levels of 5% and 10%. The fact that the statistical values are greater than zero indicates that there is a positive relationship between the return rates and therefore refers to a momentum anomaly. Likewise, the fact that the statistical values are less than zero indicates that there is a negative relationship between the return rates and therefore refers to a contrarian anomaly. The statistical values exceeding the blue lines representing the critical values or the p values falling below their significance levels indicate that there is a statistically significant relationship in the rates of returns. When the graphics in Figure 2 are further analyzed, the findings and the inferences relating to this test is as follows:

Finding 1: There is a positive relationship between past returns from mid-2013 to 2014 and return rates within the same time period. In other periods, there are no positive relationships between return rates on any significance levels.

Inference 1: There is a presence of momentum anomaly for Bitcoin from mid-2013 to early 2014. Abnormal returns were gained with the momentum strategy on the relevant dates. Although positive relationships were observed between rates of return on other periods, these relationships could not be proven statistically.

Finding 2: In late 2014, in the first five months of 2016 and between the sixth and eighth months of 2019, there was a negative relationship between past rates of return and return rates in those periods.

Inference 2: The contrarian anomaly is present for Bitcoin in late 2014, in the first five months of 2016, and between the sixth and eighth months of 2019, and therefore abnormal returns were achieved using the contrarian strategy in the relevant periods. The validity of the contrarian anomaly (strategy) has changed periodically.

Finding 3: The number of days with negative relationship between return rates is 1630 and the number of days with positive relationship is 936.

Inference 3: The contrarian anomaly for Bitcoin is more common than the momentum anomaly. People or institutions that make Bitcoin investments using the contrarian anomaly are more likely to obtain abnormal returns than those who make Bitcoin investments using the momentum anomaly.

The findings and inferences above indicate that there are both momentum and contrarian anomalies in the Bitcoin price movement, and the chance of predicting Bitcoin prices using the contrarian strategy, and thus obtaining abnormal returns, is higher than the momentum strategy. For savings owners, portfolio managers and institutional investors who follow an investment strategy with past price movements, the contrarian strategy can be an opportunity for maximizing returns from their Bitcoin investments.

5. Discussion and Conclusion

Bitcoin is one of the financial tools conceived by the changes brought by technology and the technological transformation of finance. Bitcoin, due to its inherent structure as the first cryptocurrency based on proof of work (PoW) and Blockchain technology, has attracted the attention of many investors and researchers. Characteristics such as; transaction transparency, transaction security, and its untraceable nature caused Bitcoin prices to take a sharp rise to $19.056 by the end of December 2017. However, although this rise was followed by a rapid collapse its popularity continued. These events have become the focus point for many studies, especially on the direction Bitcoin prices are now heading and the fluctuations being experienced. For this purpose, in literature Bitcoin and many other cryptocurrencies have been investigated on issues of price volatility, price estimates, etc. In this context, in this study, an analysis was carried out with the wild bootstrap automatic variance ratio test developed by Kim (2009) to detect the momentum and/or contrarian anomaly (strategy) in Bitcoin prices. Daily Bitcoin prices were taken from a period starting 02.02.2012 and ending 27.02.2020.

The overall results of the study show that both momentum and contrarian anomalies exist in Bitcoin price movements and that these prices are likely to be predicted. In other words, the results indicate an opportunity to obtain abnormal returns by employing contrarian strategy compared to momentum strategy in case of Bitcoin investments. However, this cyptocurrency market is not yet mature and can still be referred to as unstable. Also, the market needs large institutional investors to enter and start trading in it to develop but yet again the uncertainty in regulations and security of the investments causes a barrier to entry for the market, and deter these investors. These factors can be the rational justification of the obtained results. Research on cryptocurrency markets is still in its infancy and there are still many elements of it to be tested in order to get a better piture of its efficiency and these price fluctuations. Like majority of the studies, the weak form inefficiency of the market provides grounds for investors to observe past prices and be able to make predictions and hence, earn above normal returns using contrarian strategies.

Competing Interests

The authors declare that they have no competing interests.

Funding

No specific financial support was received to carry out the study.

Authors'contributions

All authors contributed to the study equally. All authors have read and approved the final manuscript.

Acknowledgements

Not applicable.

References

Aktan, C., Iren, P., & Omay T. (2019). Market Development and Market Efficiency: Evidence Based on Nonlinear Panel Unit Root Tests. *The European Journal Of Finance*, 25(11), 979-993.

Alvarado, J., & Halgamuge, M. N. (2019). New Era in the Supply Chain Management with Blockchain: A Survey. In *Industry 4.0 And Hyper-Customized Smart Manufacturing Supply Chains* (pp 1-37). IGI Global.

Andrews, D. (1991). Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation. *Econometrica*, 59(3), 817–858.

Bartos, J. (2015). Does Bitcoin Follow the Hypothesis of Efficient Market?. *International Journal of Economic Sciences*, 4(2), 10-23.

Buchholz, M., Delaney, J., Warren, J., & Parker, J. (2012). Bits and Bets, Information, Price Volatility, and Demand for Bitcoin. *Economics*, 312, 2-48.

Caporale, G. M., Gil-Alana, L., & Plastun, A. (2018). Persistence in the Cryptocurrency Market. *Research In International Business and Finance,* 46, 141-148.

Caporale, G. M., & Plastun, A. (2018). The Day of the Week Effect in the Cryptocurrency Market. *Finance Research Letters*, 130(31), 258-269.

Caporale, G. M., & Plastun, A. (2019). Price Overreactions in the Cryptocurrency Market. *Journal of Economic Studies*, 46(5), 1137-1155.

Caporale G. M., & Plastun, A. (2019). On Stock Price Overreactions: Frequency, Seasonality and Information Content. *Journal of Applied Economics,* 22(1), 602-621.

Caporale, G. M., & Plastun, A. (2020). Momentum Effects in the Cryptocurrency Market After One-Day Abnormal Returns. *Financial Markets And Portfolio Management,* 34(3), 251-266.

Charles, A., Darné, O., & Kim, J. H. (2011). Small Sample Properties of Alternative Tests For Martingale Difference Hypothesis. *Economics Letters,* 110, 151-154.

Charles, A., Darné, O., & Kim, J. H. (2012). Exchange-Rate Return Predictability and the Adaptive Markets Hypothesis: Evidence From Major Foreign Exchange Rates. *Journal of International Money and Finance*, 31(6), 1607-1626.

Charles, A,, Darné, O., & Kim, J. H. (2015). Will Precious Metals Shine? A Market Efficiency Perspective. *International Review of Financial Analysis*, 41, 284-291. DOI: 10.1016/j.irfa.2015.01.018

Cheah, E. T., & Fry, J. (2015). Speculative Bubbles in Bitcoin Markets? An Empirical Investigation into the Fundamental Value of Bitcoin. *Economics Letters*, 130, 32-36.

Cheng, Q., Liu, X., & Zhu, X. (2019). Cryptocurrency Momentum Effect: DFA and MF-DFA Analysis. *Physica A: Statistical Mechanics and its Applications*, 526(03), 1-29.

Chevapatrakul, T., & Mascia, D. V. (2019). Detecting Overreaction in the Bitcoin Market: A Quantile Autoregression Approach. *Finance Research Letters*, 30, 371-377.

Choi, I. (1999). Testing the Random Walk Hypothesis For Real Exchange Rates. *Journal of Applied Econometrics*, 14(3), 293–308.

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation*, *2*(6-10), 5-19.

Doan, M. P., Alexeev, V., & Brooks, R. (2016). Concurrent Momentum and Contrarian Strategies in the Australian Stock Market. *Australian Journal of Management*, 41(1), 77-106.

Dyhrberg, A. H. (2016a). Bitcoin, Gold And The Dollar–A GARCH Volatility Analysis. *Finance Research Letters*, 16, 85-92.

Dyhrberg, A. H. (2016b). Hedging Capabilities of Bitcoin. Is it the Virtual Gold?. *Finance Research Letters*, 16, 139-144.

Escanciano, J. C., & Lobato, I. N. (2009). An Automatic Portmanteau Test for Serial Correlation. *Journal of Econometrics*, 151(2), 140-149.

Fama, E. F., & French, K. R. (2008). Dissecting Anomalies. *The Journal of Finance*, 63(4), 1653-1678.

Fauzi, M. A., Paiman, N., & Othman, Z. (2020). Bitcoin and Cryptocurrency: Challenges, Opportunities and Future Works. *The Journal of Asian Finance, Economics, and Business*, 7(8), 695-704.

Fraser, J. G., & Bouridane, A. (2017, September). *Have the Security Flaws Surrounding BITCOIN Effected the Currency's Value?*. Seventh International Conference on Emerging Security Technologies (EST) (Pp. 50-55). IEEE.

Grinberg, R. (2011). Bitcoin: An Innovative Alternative Digital Currency. *Hastings Science & Technology Law Journal*, 4(1), 160-207.

Grobys, K., & Sapkota, N. (2019). Cryptocurrencies and Momentum. *Economics Letters*, 180, 6-10.

Houben, R., & Snyers, A. (2018). Cryptocurrencies and Blockchain: Legal Context and Implications for Financial Crime, Money Laundering and Tax Evasion. Policy Department for Economic, Scientific, and Quality of Life Policies, European Parliament.

Jarque, C., & Bera, A. K. (1980). Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals. *Economics Letters*, 6(3), 255-259.

Kang, H. J., Lee, S. G., & Park, S. Y. (2021). Information Efficiency in the Cryptocurrency Market: The Efficient - Market Hypothesis. *Journal of Computer Information Systems*. Advance Online Publication. https://doi.org/10.1080/08874417.2021.1872046

Khuntia, S., & Pattanayak, J. K. (2018). Adaptive Market Hypothesis and Evolving Predictability of Bitcoin. *Economics Letters*, 167, 26-28.

Kim, J. H. (2006). Wild Bootstrapping Variance Ratio Tests. *Economics Letters*, 92, 38-43.

Kim, J. H. (2009). Automatic Variance Ratio Test Under Conditional Heteroskedasticity. *Finance Research Letters* 3, 179-185.

Kristoufek, L. (2013). Bitcoin Meets Google Trends and Wikipedia: Quantifying the Relationship Between Phenomena of the Internet Era. *Scientific Reports*, 3(1), 1-7.

Kshetri, N., & Voas, J. (2017). Do Crypto-Currencies Fuel Ransomware. *IT Professional*, 19(5), 11-15.

Latif, M., Arshad, S., Fatima, M., & Farooq, S. (2011). Market Efficiency, Market Anomalies, Causes, Evidences, And Some Behavioral Aspects of Market Anomalies. *Research Journal of Finance and Accounting*, 2(9), 1-13.

Lazar, D., Todea, A., & Filip, D. (2012). Martingale Difference Hypothesis and Financial Crisis: Empirical Evidence from European Emerging Foreign Exchange Markets. *Economic Systems*, 36, 338-350.

Liu, Y., & Tsyvinski, A. (2021). Risks and Returns of Cryptocurrency. *The Review of Financial Studies*, 34(6), 2689-2727.

Lo. A., & Mackinlay, A. (1988). Stock Market Prices Do Not Follow Random Walk: Evidence From A Simple Specification Test. *The Review of Financial Studies*, 1, 41-66.

Ma, D., & Tanizaki, H. (2019). The Day-Of-The-Week Effect on Bitcoin Return and Volatility. *Research In International Business and Finance*, 49, 127-136.

Mammen, E. (1993). Bootstrap and Wild Bootstrap for High Dimensional Linear Models. *The Annals of Statistics*, 21, 255-285.

Marthinsen, J. E., & Gordon, S. R. (2020). Hyperinflation, Optimal Currency Scopes, and a Cryptocurrency Alternative to Dollarization. *The Quarterly Review of Economics and Finance*. Advance Online Publication. https://doi.org/10.1016/j.qref.2020.12.007

Mason, N., Halgamuge, M. N., & Aiyar, K. (2021). Blockchain and Cryptocurrencies: Legal and Ethical Considerations. *In Industry Use Cases on Blockchain Technology Applications in Iot and the Financial Sector* (pp. 132-159). IGI Global.

Mittal, S. (2012). Is Bitcoin Money? Bitcoin and Alternate Theories of Money, Accessed http://cryptochainuni.com/wp-content/uploads/Is-Bitcoin-money-Bitcoin-and-Alternate-Theories-of-Money.pdf

Nadarajah, S., & Chu, J. (2017). On The Inefficiency Of Bitcoin. *Economics Letters*, 150, 6-9.

Nakamoto, S. (2008). Bitcoin: A Peer-To-Peer Electronic Cash System. *Decentralized Business Review*, 21260, 1-9. Accessed: https: // Bitcoin. Org / Bitcoin.Pdf.

Oh, J. H., & Nguyen, K. (2018). The Growing Role of Cryptocurrency: What Does it Mean for Central Banks and Governments. *International Telecommunications Policy Review*, 251, 33-55.

Özkan, O., & Çakar, R. (2021). Momentum and Contrarian Anomalies in Islamic Equity Markets: Evidence from Qismut Countries. *In Research & Reviews in Social, Human and Administrative Sciences* (pp. 199-214). Ankara: Gece Publishing.

Özkan O., & Şahin, E. E. (2020). Etkin Piyasalar Hipotezi Kapsamında Kripto Paraların Zayıf Form Bilgisel Etkinliklerinin Karşılaştırılması. *Turkish Studies - Economics, Finance, Politics*, 15(4), 2393-2406.

Phillips, P., & Perron, P. (1988). Testing For a Unit Root in Time Series Regression. *Biometrika*, 75(2), 335-346.

Said, S., & Dickey, D. A. (1984). Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order. *Biometrika*, 71(3), 599-607.

Sefa, M., Koy, A., & Ersoy, H. (2019). Kriptoparalarda Fiyat Balonu İncelemesi. *BDDK Bankacılık Ve Finansal Piyasalar Dergisi*, 13(1), 105-120.

Sensoy, A. (2019). The Inefficiency of Bitcoin Revisited: A High-Frequency Analysis With Alternative Currencies. *Finance Research Letters*, 28, 68-73.

Shrestha, B., Halgamuge, M. N., & Treiblmaier, H. (2020). Using Blockchain for Online Multimedia Management: Characteristics of Existing Platforms. *In Blockchain and Distributed Ledger Technology Use Cases*. Study Paper: 289-303.

Srokosz, W., & Kopciaski, T. (2015). Legal and Economic Analysis of The Cryptocurrencies Impact on The Financial System Stability. *Journal of Teaching and Education*, 4(2), 619-627.

Tzouvanas, P., Kizys, R., & Tsend-Ayush, B. (2020). Momentum Trading in Cryptocurrencies: Short-Term Returns and Diversification Benefits. *Economics Letters*, 191, 108728. Advance Online Publication. https://doi.org/10.1016/j.econlet.2019.108728

Urquhart, A. (2016). The Inefficiency of Bitcoin. *Economics Letters*, 148, 80-82.

Van Wijk, D. (2013). *What Can Be Expected from the Bitcoin*(Dissertation, Erasmus University, Rotterdam). Retrieved from https://thesis.eur.nl/pub/14100/Final-version-Thesis-Dennis-van-Wijk.pdf

Vidal-Tomás, D., & Ibañez, A. (2018). Semi-Strong Efficiency of Bitcoin. *Finance Research Letters*, 27, 259-265.

Wang, Y., & Wei, K. J. (2018). Virtual Digital Currencies And Stock Returns: The Bitcoin Anomaly Qingjie Du.

Woebbeking, F. (2021). Cryptocurrency Volatility Markets. *Digital Finance*, 3(3), 273-298.

Wolla, S. A. (2018). Bitcoin: Money or Financial Investment. Page One Economics.

Yağmur, A., & Mangır, F. (2020). Bitcoin Piyasasında Rassal Yürüyüş Hipotezi. *Yönetim ve Ekonomi Araştırmaları Dergisi*, 18(2), 161-175

Yang, H. (2018). Behavioral Anomalies in Cryptocurrency Markets. Available At SSRN 3174421.

Yermack, D. (2015). Is Bitcoin a Real Currency? An Economic Appraisal. *In Handbook Of Digital Currency* (pp. 31-43). Academic Press.

Zeren, F., & Sinan, E. (2018). Geleceğin Para Birimi Ya Da Sadece Bir Balon: Bitcoin. *Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 21(39), 433-448.

Https://Www.Bitfinex.Co (Access Date: 28.02.2021).

Araştırma Makalesi

Teknolojik İnovasyon ve Kripto Para Piyasaları: Momentum ve Zıtlık Anomalilerinin Test Edilmesi

Technological Innovation and Cryptocurrency Markets: Testing Momentum and Contrarian Anomalies

Eyyüp Ensari ŞAHİN	Ceyda AKTAN
Assoc. Prof. Dr., Hitit University	Asst. Prof. Dr., University of Turkish Aeronautical Association
Faculty of Economics and Administrative Sciences	Faculty of Business Administration
eyupensarisahin@hitit.edu.tr	caktan@thk.edu.tr
https://orcid.org/0000-0003-2110-7571	https://orcid.org/0000-0001-7040-4711

Genişletilmiş Özet

Uzun vadede teknolojideki değişim, finansal kurumların birlikte çalışması için katı düzenlemeler ve çerçeveler oluşturarak finansal piyasaların sosyo-ekonomisinde önemli bir değişikliğe yol açmıştır. Teknolojik gelişmelerin, özellikle bankacılık ve bağlı sektörlerde birçok start-up ve sandbox uygulamasına da ev sahipliği yaptığı görülmektedir. Getirdiği avantajlar, sağlanan hizmetlere hız, kalite ve maliyet düşürücü etkiler gibi büyük ve çeşitlidir. Ancak bu maliyet düşürücü etki, merkezi kurumların fon hareketlerini takip etmesini zorlaştırması ve bazen imkânsız hale getirmesi nedeniyle birçok çalışmada kritize edilmiştir. Benimsenen yeni teknolojiler de şeffaf olmadıkları ve tam finansal katılımı sınırladıkları için de aynı zamanda eleştiriler almaktadır. Bu sorunun üstesinden gelmek için, finansal piyasalara teknoloji açısından en yeni, popüler girişlerden biri Blockchain sistemidir.

Blockchain sisteminin tanıtılmasıyla birlikte, bu sistemin bilginin depolanmasına ve dağıtılmasına izin verdiği için Bitcoin gibi kripto para birimleri dikkat çekmeye başlamıştır (Nakamoto, 2008, s. 1-2). Bununla birlikte, Bitcoin'in popülaritesini takiben, şifreli olmasının yanı sıra merkezi olmayan, alternatif kripto para birimleri de piyasada görülmektedir. Hatta piyasaya sunulmasından sadece birkaç yıl sonra, Microsoft ve Expedia gibi birçok büyük şirket, müşterilerine ödeme seçeneklerinden biri olarak Bitcoin kullanımını kabul etmeye başlamıştır. Bu nedenle de Bitcoin, artık bir para birimi, parasal bir araç olarak değerlendirilmektedir (Mason, Halgamuge ve Aiyar 2021, s. 133). Ancak bu durum, kripto para birimleri için bu tanımın gerçekten doğru olup olmadığı konusunda araştırmacılar arasında bir tartışmaya yol açmıştır.

Kripto para piyasasının özellikleri belirsizliği artırarak onu döviz veya emtia piyasalarıyla karşılaştırıldığında oldukça oynak bir piyasa haline getirmektedir (Caporale ve Plastun 2020, s. 252). Kripto para fiyatlarındaki hareketin arkasındaki faktörleri anlamaya çalışmak için birçok çalışma yapılmış olup; arz ve talep arasındaki etkileşimler, kripto para birimlerinin yatırımcılar için çekiciliği ve küresel olarak meydana gelen finansal ve makroekonomik gelişmeler kripto para piyasasını oldukça değişken hale getiren başlıca faktörler olarak gösterilmektedir (Buchholz, Delaney, Warren ve Parker 2012, s. 2-4; Kristoufek, 2013, s. 1-4; van Wijk, 2013, s. 14-15).

Kısa vadede riski dengelemek için riskten korunma amacıyla kullanılsa da (Dyhrberg, 2016a, s. 85; Dyhrberg, 2016b, s. 139-140), kripto para fiyatlarındaki yüksek oynaklık piyasanın etkinliğine ilişkin endişeleri de aynı zamanda arttırmaktadır. Piyasayı çevreleyen tüm olaylar, diğer bir deyişle tüm bilgiler, fiyatlara anında yansıyarak fiyatların yukarı veya aşağı hareket etmesine neden oluyorsa, piyasa bilgi açısından etkin olarak adlandırılabilir (Urquhart, 2016, s. 80). Etkin Piyasa Hipotezi'ne (EPH) göre bir piyasa tamamen etkin ise hiçbir yatırımcı normal getirilerin üzerinde kazanç elde edemez ve hiçbir

arbitraj fırsatı yoktur. Aynı zamanda, etkin bir piyasada gelecekteki fiyatların tahmini mümkün olmadığı gibi herkes aynı bilgiye aynı anda erişebilmektedir (Kang, Lee ve Park 2021, s. 2-3).

Etkin Piyasa Hipotezi ile ilgili önemli bir husus, o piyasadaki tüm aktörlerin rasyonel olması durumunda geçerli olduğu varsayımıdır. Dolayısıyla piyasaya yeni bilgiler geldikçe hisse senedi fiyatlarına da anında yansımaktadır (Aktan, İren ve Omay 2019, s. 979). Ancak, piyasaların her zaman EPH'nin özelliklerini takip etmediği literatürde gösterilmektedir. Davranışsal finans tarafından yakın zamanda önerilen bir argüman, yatırımcıların hiç de rasyonel olmadığı ve karar verirken birçok farklı duygu tarafından yönlendirildiği yönündedir. Bu olduğunda ve piyasalar EPH kurallarından saptığında, bu anomali olarak ifade edilmektedir. Genç ve değişken piyasalarda mevcut olan farklı anomalileri analiz etmenin bir yolu, momentum ve zıt etkileri belirlemektir. Momentum etkisi veya anomalisi, menkul kıymetlerin geçmiş performanslarını koruduğunda gerçekleşmektedir. Başka bir deyişle, bir menkul kıymetin değeri geçmişte azaldıysa gelecekte de düşmeye devam edeceği söylenmektedir (Tzouvanas, Kizys ve Tsend-Ayush 2020, s. 1-2). Zıtlık anomalisinde, geçmişte değeri düşen bir menkul kıymetin gelecekte artacağına ve onunla birlikte getiri oranlarının da artmasına neden olacağına inanılmaktadır. Momentum stratejisinde olduğu gibi daha iyi performans gösterenleri satın almak için düşük performans gösteren hisse senetlerini satmak ya da zıtlık stratejisi olarak adlandırılan düşük fiyatlı menkul kıymetleri satın almak için yüksek fiyatlı menkul kıymetleri satmak göstermektedir ki zamanla bu anomaliler, yatırımcıların yatırım stratejilerini oluşturmalarına zemin hazırlamıştır. Hisse senedi fiyatlarındaki gerçekleşen hareketler ve aralarındaki ilişki, hem momentum hem de karşıt stratejileri değerlendirmek için kullanılmaktadır (Doan, Alexeev ve Brooks 2016, s. 1-4; Özkan ve Çakar 2021, s. 201-202).

Hisse senedi fiyatlarındaki momentum ve zıtlık anomalileri veya stratejileri üzerine yapılan çalışmalar geçmiş literatürde kapsamlı bir şekilde bulunmaktadır. Bununla birlikte, mevcut bu çalışmaların çoğunun, dünyadaki büyük hisse senedi endekslerine odaklandığı ve kripto para piyasasını ihmal ettiği görülmektedir. Bu nedenle kripto para piyasasında momentum ve zıtlık anomalilerinin varlığını araştırmak amacıyla Bitcoin odaklı bu çalışmanın mevcut literatüre büyük katkı sağlayacağı düşünülmektedir.

Bu çalışmada 02.02.2012-27.02.2020 tarihleri arasındaki 2931 günlük Bitcoin verisi kullanılarak seri içerisindeki momentum ve zıtlık anomalileri gözlemlenmiştir. İlgili veriler Bitfinex adlı web sitesinden elde edilmiştir (Erişim Tarihi: 28.02.2020). Bitcoin fiyatlarının doğal logaritmik birinci farkları önce 100 ile çarpılmış ardından günlük getiri oranları hesaplanmıştır. Daha sonra Kim (2009) tarafından geliştirilen wild bootstrap automatic variance ratio (WBAVR) testi, Bitcoin fiyatlarında bir momentum ve/veya zıtlık anomali (strateji) olup olmadığını belirlemek için kullanılmıştır. Ancak WBAVR testi veri setlerinin durağan olmasını gerektirdiğinden, serilerin durağanlığı Augmented Dickey-Fuller (ADF) ve Phillips-Perron (PP) birim kök testleri kullanılarak test edilmiş ve Bitcoin günlük fiyatlarının durağan olmadığı tespit edilmiştir. Ancak hem ADF hem de PP birim kök testi sonuçlarına göre günlük getiri oranlarının ise durağan olduğu görülmüştür.

WBAVR testi ile ilgili bulgular ve çıkarımlar şu şekildedir:

Bulgu 1: 2013 ortasından 2014'e kadar olan geçmiş getiriler ile aynı zaman dilimindeki getiri oranları arasında pozitif bir ilişki vardır. Diğer dönemlerde getiri oranları arasında herhangi bir anlamlılık düzeyinde pozitif ilişki yoktur.

Çıkarım 1: 2013 ortalarından 2014 başlarına kadar Bitcoin için momentum anomalisi mevcuttur. İlgili tarihlerde momentum stratejisi ile anormal getiriler elde edilmiştir. Diğer dönemlerde getiri oranları arasında pozitif ilişkiler gözlemlenmesine rağmen bu ilişkiler istatistiksel olarak kanıtlanamamıştır.

Bulgu 2: 2014 yılı sonlarında 2016 yılının ilk beş ayında ve 2019 yılının altıncı ve sekizinci ayları arasında geçmiş getiri oranları ile bu dönemlerdeki getiri oranları arasında negatif yönlü bir ilişki bulunmaktadır.

Çıkarım 2: Bitcoin için zıtlık anomalisi 2014 yılının sonlarında, 2016 yılının ilk beş ayında ve 2019 yılının altıncı ve sekizinci ayları arasında mevcuttur ve bu nedenle ilgili dönemlerde zıtlık stratejileri kullanılarak anormal getiriler elde edilmiştir. Zıtlık anomalisinin (stratejisinin) geçerliliği dönemsel olarak değişmiştir.

Bulgu 3: Getiri oranları arasında negatif ilişki olan gün sayısı 1630, pozitif ilişki olan gün sayısı 936'dır.

Çıkarım 3: Bitcoin için zıtlık anomalisi, momentum anomalisinden daha yaygındır. Zıtlık anomalisini kullanarak Bitcoin yatırımı yapan kişi veya kurumların, momentum anomalisini kullanarak Bitcoin yatırımları yapanlara göre anormal getiri elde etme olasılığı daha yüksektir.

Çalışmanın genel sonuçları, Bitcoin fiyat hareketlerinde hem momentum hem de zıtlık anomalilerinin bulunduğunu ve bu fiyatların tahmin edilebileceğini göstermektedir. Başka bir deyişle, sonuçlar, Bitcoin'e yatırım yapılması durumunda momentum stratejisine kıyasla zıtlık strateji kullanarak anormal getiri elde etme fırsatını işaret etmektedir. Ancak, kripto para piyasası henüz olgunlaşmamıştır ve hala istikrarsız olarak ifade edile bilinir. Ayrıca, piyasanın gelişmesi için ise bu piyasaya büyük kurumsal yatırımcıların girmesi gerekir. Bununla beraber, yasal ve hukuki düzenlemelerdeki ve yatırımların güvenliğindeki belirsizlikler, piyasaya bir giriş engeli oluşturmakta ve bu yatırımcıları caydırmaktadır. Bu faktörler, elde edilen sonuçların rasyonel gerekçesi olarak ifade edilse de kripto para piyasaları üzerine araştırmalar henüz başlangıç aşamasındadır. Piyasanın etkinliği ve bu fiyat dalgalanmaları hakkında daha iyi bir fikir elde etmek için test edilmesi gereken birçok unsur bulunmaktadır. Çoğu çalışmada olduğu gibi, piyasanın zayıf formdaki etkinsizliği, yatırımcıların geçmiş fiyatları gözlemlemelerine ve tahminlerde bulunabilmelerine ve dolayısıyla da zıtlık stratejilerini kullanarak normalin üzerinde getiri elde etmelerine zemin hazırlamaktadır.