INVESTIGATION OF THE RELATIONSHIP BETWEEN BITCOIN AND GOLD PRICES WITH THE MAKI COINTEGRATION TEST

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Abstract

The gold mine has been a commodity used for thousands of years, today it is also an investment tool with the highest reliability. However; cryptocurrencies that are recently used are affecting our portfolio. Bitcoin is the most traded cryptocurrency. Since there are alternative investment instruments involved in portfolios, the relationship between these two independent values inspired the emergence of this study. The aim of this study was to investigate whether there is a causality-cointegration relationship between daily Bitcoin prices and gold prices for the periods between 10,01,2014 and 11,12,2020. In the application section, Toda Yamamoto causality and the Maki Cointegration test were applied. According to the results of the Toda Yamamoto causality test, there is a two-way causality relationship. According to the results of the Maki cointegration test, there was no long-term relationship between the series. As a result, it is expected that in the long term, investors will have a risk-reducing effect by including both investment instruments in the same portfolio.

Keywords: *Bitcoin, Gold, Toda Yamamoto Causality Test, Maki Cointegration Test.*

JEL Classification: C01, C12, G11

BİTCOİN VE ALTIN FİYATLARI ARASINDAKİ İLİŞKİNİN MAKİ EŞBÜTÜNLEŞME TESTİ İLE İNCELENMESİ

Öz

Altın madeni binlerce yıldır kullanılan bir meta iken, günümüzde de güvenilirliği en yüksek olan yatırım aracı konumundadır. Ancak son zamanlarda kullanılan kripto paralar portföyümüzü etkilemektedir. Bitcoin kripto paraların en çok alınıp satılanıdır. Portföylerde yer alan alternatif yatırım araçları olduğu için, bu iki bağımsız değer arasındaki ilişki bu çalışmanın ortaya çıkmasına ilham kaynağı olmuştur.Bu çalışmanın amacı, 10.01.2014 ile 11.12.2020 dönemleri arasında günlük Bitcoin fiyatları ile altın fiyatları arasında bir nedensellik-eşbütünleşme ilişkisi olup olmadığını araştırmaktır. Uygulama bölümünde Toda Yamamoto nedensellik ve Maki Eşbütünleşme testi uygulanmıştır. Toda Yamamoto nedensellik testi sonuçlarına göre, çift taraflı olarak nedensellik ilişkisinin olduğu saptanmıştır. Maki eşbütünleşme testi sonuçlarına göre ise, seriler arasında uzun dönemli ilişki olmadığı görülmüştür. Sonuç olarak uzun dönemde yatırımcıların aynı portföyde her iki yatırım aracına da yer vererek riski düşürücü bir etki oluşturacağı düşünülmektedir.

Anahtar Kelimeler: *Bitcoin, Altın, Toda Yamamoto Nedensellik Testi, Maki Eşbütünleşme Testi.*

JEL Sınıflandırması: C01, C12, G11

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1. Introduction

International investors, today, are inclined to make long-term sustainable investments and they also are the followers of the information that makes this investment real. Therefore, trends in alternative financial instruments such as forecasting on gold exchanges, long-term yielding commodities, or cryptocurrencies are popular than the approach that follows up interest in financial markets. There are many reasons cause this situation. Political tensions between countries, regional conflicts of interest, fulminant epidemics (Covid 19, etc.), internal disturbance can be aligned among the effective factors. On the other hand, volatility increases the risk to reach the yield at the same ratio besides bringing along an investment opportunity. Because of this and similar reasons, it is debated whether even the US dollar, which has the most reserves in many central banks of the world, can be a long-term investment instrument.

Alternative investment tool, cryptocurrencies, that emerge by 2008 crisis in the USA, has brought along a different perspective to money use all over the world. Those new virtual monies are software-based and not monopolized by any of the countries as opposed to the coins issued by a classical country central bank. They are pretty volatile compared to gold. Much as those new virtual monies are not accepted as official money, their use has increased day by day.

This study analyzed the presence of a relationship between Bitcoin prices with the daily gold prices. The interest of international investors in these two investment tools lies behind the source of inspiration of this research. Accordingly, the first chapter reviews the process from the discovery of gold to its first use as money. The same chapter also reviews mining and cryptology and how cryptocurrencies emerged beside the comparison between the price changes of Bitcoin and gold. The second chapter shares the future price expectations of individuals and institutions that have a voice in international markets regarding Bitcoin prices; academic literature regarding the subject can be read right after. The third chapter is the analysis part; the purpose of the study, data set and the econometric method are explained. Findings of the study are separately submitted tabularizing too. The last chapter compares the findings of this study with the empirical results of previous studies in the literature. In addition to all these, at the end of the study, different suggestions are explained with the hope to guide further studies in this field.

2. Emergence of Gold Coins and Cryptocurrencies

Defining money is always an irritating problem for money theorists. Therefore, those who research this issue consider the function of money to define it (Wray, 1998: 2-3).

A commodity, first of all, needs to receive wide acceptance to be used as money. Moreover, it also should be stable, movable, divisible, and durable. Again, it should be used as a barter and saving tool at the same time. These criteria are reached as the result of the evolution of money. Commodities that were used instead of money were utilized as goods in the beginning. To give an example, American colonists used cigarettes as money, and salt was used as an instrument of payment to soldiers in Roman times. The use of a good or equity instead of money has brought along the problem that the relevant good becomes too valuable to be used. Therefore, later, metal money and then paper notes started to be used. Since the paper notes are used as an alternative to metals, they also are called representative money. Papers (notes) are called banknotes. Subsequently, banknotes were printed as unrequited.Their value was determined by the numbers written by the government and institutions. Central banks and money supply institutions control money now (Mill, 2017: 40-42).

Money has always changed in line with technology and new conditions. People, before the invention of money, used a barter system in which goods and things were exchanged. Much as this system looks like a simple approach at first view, it brought along many difficulties from the functioning of the system. The person who needs a good needs to find another person who has that relevant good; they need to agree on goods to be exchanged after finding each other. This situation occurred between the

same type and similar type of goods in the progress of time (Kishtainy, 2013: 18-19). Seashells, various animals, or food products were used instead of money in the beginning, but in time, precious metals such as copper, gold, and silver took their place. Paper and metal money superseded them in time. Regarding the 21st century, changes in technology have provided collection and payment to be performed in the electronic environment. These transactions, which banks made among themselves in the beginning, later began to be made individually by individuals and institutions. Today, the last form of money is crypto money that is also called electronic money (Cengiz, 2018: 89-90).

2.1. Using Gold as Money

Gold was mined from soils in Egypt in alloys with copper in B.C. 5000. When it comes to BC 3900, gold was melted using various heating techniques; some stamps and signs were printed on it before the invention of the gold coin. So, it took the lead of money as plates and bullion. The position of gold that was used as money in the history of world money is so remarkable from the 6th BC to the 19th century. It also laid the foundations of the Gold Money System covering the period between 1870 and 1930. Its use as a means of storage against dollars was during the Bretton Woods System between 1944-1973. The flexible exchange rate system was adopted and the uncertainty in exchange rates increased after the collapse of the Bretton Woods System. The fluctuations in exchange rates were reflected in the trade prices and caused the value of gold to be determined according to supply and demand (Açcı, 2016: 31-34)

Gold, which is used as an investment and savings tool today, was also a tool for payments in the past. Gold, which is accepted by all over the world today, has a more convertible feature than the dollar. It is possible to scrutinize the development of gold in the historical process by five periods. In the mercantilist period (15th century-18th century), the abundance in gold reserves was accepted as an indicator of wealth by the countries. Regarding the Period of the Gold Coin Standard System (1873-1914), it was allowed the circulation of gold both in the domestic market and abroad through the developments in global trade, depending on the progress in industrialization in the 19th century. Between the two world wars (1914-1944), there occurred economic crises, and then countries that adopted the gold coin standard began to move away from the existing system after the shaking of the balance of power in Europe. England was the most important pioneer among these countries. Countries that started to print paper money instead of gold during the war created an inflationary situation in this war environment. Under those circumstances, countries have agreed on the necessity of cooperation instead of separating from each other. This consensus gave birth to the Bretton Woods System. Gold Exchange Standard Period (1944-1973): This system whose other name is the Bretton Woods system took its name from the town of Bretton Woods in the USA in 1944.

The Bretton woods system caused the emergence of the Gold Exchange Standard System, which allows freely exchange with other countries' currencies based on the gold standard at a fixed exchange rate. The USA, which was on the winning side at the end of the war, made US dollar the only national currency that has the ability to convert gold. In this way, the US dollar became the international reserve currency. In the 1960s, due to the increase in public expenditures during the Vietnam War in the USA, payment disruptions occurred in this system, which progressed successfully until 1958. The USA, which preferred print money to solve these problems, caused inflation not only in its own country but also in other countries as the dollar became convertible. This situation weakened the confidence in the reserve money and strengthened the views and thoughts about the devaluation of the dollar. Free Gold Market Period (1973- …): "The Group of Ten Agreement" was signed with the participation of Switzerland on 31 August 1975. With this agreement, the obligation of the international monetary system for reserves and the official gold price were eliminated economically, and the transition to the floating exchange rate system among other countries was accepted (Öz and Fidan, 2013: 122).

Gold is one of the metals that has been used during history of humanity without loss of value. Again, gold, whose value has been increasing from past to present, is a mine used in making money and jewelry. Gold, which was used in the production of money in the past, is now used as an investment instrument in the jewelry industry. It is accepted as the most valuable metal and the indicator of richness because of the reasons such as scarcity, natural brightness and being easily processable. Its weight is 19.03 gr./ 〚cm〛 ^3, and its hardness is between 2.5-3. It has a soft structure and is alloyed with copper to be hardened. In addition to jewelry, it is utilized in the electronics industry, medallion making, dentistry, ornamental work and other industrial fields. Troy ounce or kg is used as a unit of measure in buying and selling. 1 Troy Ounce is 31.1 grams. The unit used to measure the purity of the gold mine is known as carat (carat) and gold fineness (mil). 24 karat gold indicates a purity of 1000 mil. The purity grade of bullion used in commercial works is 995 mil and above. A large part of the gold produced every year is stored in the vaults of central banks or national treasuries. For assumptions, the total gold production from the past to the present has reached 100 thousand tons. 36% of this number is in the hands of government and 24% of it belongs to private investors. It is known that 28% of the rest is used in jewelry and 12% of it is utilized in industry (Aksoy and Topcu, 2013: 59-60).

Seas and oceans, which constitute 2/3 of our world, are huge sources of gold. However, a cheap method used to extract gold from these areas has not been discovered yet. The places where it is most intense on the land are Australia, North America, South Africa, and the Urals. The price of gold depends on several factors. These are the value of the US dollar against other currencies, the prices of other metals, the geopolitical environment, the demand for ornaments and jewelry, the costs of mining companies in gold extraction (Balı and Cinel, 2011: 46-47).

2.2. Cryptocurrency

Cryptocurrencies, in general, can be reviewed under two headings; Bitcoin and other currencies. Other cryptocurrencies that are developed using Bitcoin as the base and introduced into the market after Bitcoin, they are called alternative cryptocurrency and classifed as ''Altcoin''.

We need to understand electronic money and payment systems, which have become indispensable in our lives today to understand what cryptocurrencies are. Electronic money (e-money) is the device with technical equipment that can be used to make payments with organizations other than e-money issuing institutions. Transactions with these devices act as a prepaid bearer instrument that does not need to include bank accounts. E-money products can be used as hardware-based or software-based. The purchasing power, in hardware-based products, is in a personal physical device, such as a chip card with hardware-based security features. Monetary values are transferred to a remote server through device readers that do not require real-time network connectivity. Special software that runs on common personal devices such as personal computers or tablets uses software-based products. The personal device usually needs to establish an online connection with a remote server that controls the use of purchasing power to enable the transfer of monetary values. Moreover, there also are diagrams comparing both hardware and software-based features (Ecb, 2020).

Cryptocurrencies are put in circulation representing gold and precious metal; they are issued by a particular nation and institution. They are also the monies that are created in a structure that allows the supply of virtual money created using the encryption method, unlike the representative currencies managed from a center. The value of these coins is neither measured in terms of goods nor determined by the issuing institution. Cryptocurrencies are priced according to supply and demand, regardless of a value stored in metal or paper. We have seen examples of this in our country and the world. For subjective value theory, despite the decrease in gold prices in Turkey between 2012 and 2013, the price of a quarter gold coin increased more than the quarter value compared to the price of a full gold coin; this is strange pricing. As is understood from the explanations above, even the gold, which is now assumed to be intrinsically valuable, is valued by demand (Çarkacıoğlu, 2016: 8, 10).

The cryptocurrency that is called Bitcoin was first launched in 2008 by a person or team with the pseudonym of Satoshi Nakamoto. Bitcoin is a fully digital and decentralized currency in which Blockchain technology is used. Users in the system can transfer money to each other without the need for any intermediary. Transfers are recorded with a distributed registration system. This registration system is called Blockchain while Bitcoin is called BTC. Since there is an encrypted structure in the blockchain, it can also be defined as cryptocurrency. It is a system in which Peer to peer network devices can directly communicate with each other over the internet and transfer data without any intermediaries. Every device connected to the network has the same rights as other devices on the network and can share its rights with other devices. Torrent (file sharing) is the most well-known one among peer-to-peer networks (https://www.btcturk.com/yardim/bitcoin-nedir) (Accessed 28.05.2021).

Bitcoin, which is increasingly used, has been utilized since 2009 in our country as well as in the world; its use has become popular day by day. Bitcoin is frequently used in various cities and professions in our country. Attorney and consultancy fees, transfer fees paid to football players, kiosks set up in shopping malls or airports, and holiday reservations can be aligned as examples for fields of usage. Attorney and consultancy fees, transfer fees paid to football players, kiosks set up in shopping malls or airports, and holiday reservations can be aligned as examples for fields of usage. The first Bitcoin ATM was put into service at Istanbul Atatürk Airport in Turkey. Many countries support the use of Bitcoin due to the benefits listed. USA, Sweden, Netherlands, Estonia, Canada, and Australia are among those countries and they also are known as Bitcoin-friendly countries. Bitcoin, in some of them, is defined as a commodity, while it is accepted as a financial service or payment instrument in others. While some countries impose a VAT requirement for Bitcoin, some countries have released its use. Iceland, Thailand, Bolivia, Bangladesh, and Ecuador are anti-Bitcoin countries (Dizkırıcı and Gökgöz, 2018: 98-99).

This success in Bitcoin has paved the way for the emergence of many virtual currencies such as Bitshares, Dash, Litecoin, Ethereum, and Dogecoin. Ripple has similar blockchain technology to Altcoin and Peercoin Bitcoin. For example, Litecoin aims to preserve the computational power required for coin mining while the goal of Peercoin is to increase the efficiency of mining (Ciaian et al., 2018: 174).

According to the results of research by Binance, the cryptocurrency exchange is the most correlated currency in the cryptocurrency market of Ether (ETH). Binance's research department published a report on January 22 and determined that the average correlation coefficient of Ether was 0.69 throughout 2019. It was followed by Ada with 0.66 and Eos with 0.65.

Table 1: Assets with high correlation in the Cryptocurrency Market in 2019

Symbol	Name	First Period	Second Period	Third Period	Fourth Period	Total
ETH	Ethereum	0.66	0.66	0.76	0.75	0.69
ADA	Cardano	0.64	0.64	0.74	0.70	0.66
EOS	Eos	0.64	0.64	0.72	0.74	0.65
LTC	Litecoin	0.60	0.60	0.74	0.74	0.64
XRP	Xrp	0.64	0.64	0.72	0.67	0.64
BNP	Bnb	0.42	0.42	0.70	0.71	0.53

Source: https://www.coinkolik.com/arastirma-2019-diger-kripto-paralarla-en-korele-kripto-para-ether-eth/ (Erişim: 28.05.2021).

The table regarding the relationship between Bitcoin and gold prices based on annual prices is below. It is noteworthy that there is a rapid increase in Bitcoin prices.

Table 2:1 Ounce Gold's Value Changes Against BTC Between 2011 and 2019

Years	BTC	Gold
2011	584 BTC	
2012	159 BTC	
2013	6 BTC	
2014	3.5 BTC	
2015	2.5 BTC	1 Onsa Altın
2016	1.6 BTC	
2017	0.18 BTC	
2018	0.16 BTC	
2019	0.15 BTC	

Source: https://www.coinkolik.com/gecmisten-gunumuze-altin-vs-bitcoin/ (Erişim: 28.05.2021).

3. Future Expectations and Literature Studies for Bitcoin and Gold Prices

Authorities evaluate the future of Bitcoin and what expects Bitcoin at the end in terms of financial markets. One of the examples regarding this issue is Wences Casares who created Xapo that is a Bitcoin Wallet. According to him, if Bitcoin will succeed in the future, this process will take years; he also likened this situation to a mental experiment. Wences Casares stated in an interview with Bloomberg TV that the system may or may not work. He likened the system to the internet and stated that this is what the internet was in 1992. Moreover, for him, it is impossible for Bitcoin to replace national currencies, but it will be successful if it is used as an international value standard and means of payment. The Argentine investor, known as Patient Zero, highlighted the interest in cryptocurrencies in Silicon Valley, saying that the success of Bitcoin is more likely than failure (www.Bloomberg.com. Accessed: 28.05.2021).

Robert Shiller who is a Nobel Prize-winning Professor of Economics (Yale University) once emphasized in an interview with Bloomberg Television that "I think of Bitcoin as a remarkable social phenomenon''. "This is an enthusiasm epidemic...a speculative bubble. This does not mean that it will go to zero. Speculative bubbles repeat. We had a bubble in Bitcoin in 2013 and it looks like it's over - it's dropped from 1,000 to 200 - but now, it's coming back" (www.Bloomberg.com. Accessed: 28.05.2021).

Regarding the academic studies, Yermack (2013) researched the relationship between daily Bitcoin prices and exchange rates (Euro/Usd, Yen/Usd, Frang/Usd, Gbp/Usd) and gold prices for the years between 2010 and 2013. They found a correlation close to zero between Bitcoin prices and gold with other variables. Baur and Dimpfl (2017) emphasized high volatility in Bitcoin prices. According to their causality analysis among Bitcoin prices, Dollar, Euro, and Yen, the volatility in Bitcoin prices are 30 times more volatile than these exchange rates. Again, similarly, Bouoiyour and Selmi (2017) conducted a study on Bitcoin price volatility and found that asymmetric information on Bitcoin volatility is affected by negative shocks rather than positive shocks.

İçellioğlu and Öztürk (2017) tested causality among Dollar, Euro, Pound, Yen and Yuan rates via Engel-Granger Cointegration, Johansen and Granger causality tests for the period from April 29, 2013, to September 22, 2019. They found no statistically significant relationship between Bitcoin prices and relevant exchange rates.

Dyhrberg (2016) modeled GARCH to research how bitcoin prices act as a financial asset like gold and dollar prices for the period between 19.07.2010 and 22.05.2015. Study findings reveal that the reactions of Bitcoin prices are in the same direction as the reactions of dollar and gold prices.

Korkmaz (2018) tested the effect of ballons at prices of Dolar, Euro, gold, and financial investment instruments on Bitcoin returns. In this regard, The Sup Augmented Dickey-Fuller (SADF) method was used in the study that utilized daily data for the period between 01.08.2011 and 23.08.2018. It was observed at the end of the study that the bubbles observed in the returns of the euro and dollar reduce the volatility on the returns of Bitcoin. Moreover, the returns of dollars, euros, and gold affect the returns of Bitcoin.

Yıldırım (2018) researched the presence of a statistically significant relationship between Bitcoin and gold prices in the short and long term via the EKK and Johansen cointegration test. 490 days of data were used in the relevant study that utilized daily price data of the period between February 2, 2012, and December 31, 2013. There was not found a significant relationship between variables in the long run. Moreover, according to the findings, the relationship does not occur bilaterally; there also is a one-way causality relation from only gold prices to Bitcoin prices in the long run.

Okuyan and Deniz (2019) researched the relationship between traditional financial asset prices with cryptocurrencies in terms of portfolio management. On behalf of cryptocurrencies, Bitcoin and Ethereum were included in the equation; gold, silver, and platin, on behalf of precious metals, were included in the equation; and finally, Major country stock exchanges including Turkey were in the same equation at the same time. It was determined in the study conducted using weekly data between 24.08.2015 and 03.06.2019 that there was no positive and significant relationship between crypto money returns and stock index with precious metal returns. For these results, we can talk about an emphasis regarding there is not portfolio diversification suitable for cryptocurrencies, stocks, and precious metal portfolios.

Jin et al., (2019) researched the relationship between gold, Bitcoin, and oil prices. Their study utilized Multifractal detrended cross-correlation analysis (MF-DCCA), MF-DCCA, DCC-MVGARCH models, and also the weekly data of the period between 10,05,2013 and 07,09,2018. For study results, there are significant relationships among variables; the variables are sensitive to price fluctuations in Bitcoin, gold, and crude oil. Moreover, although there are remarkable volatility spillovers among the three assets, the effects of spillovers from the gold and crude oil markets to the Bitcoin market are much stronger than other spillovers. In addition to all these, dynamic correlations between gold and crude oil markets were almost positive while dynamic correlations between Bitcoin and gold and also between Bitcoin and oil were almost negative throughout all the sample periods.

Hwang (2019) performed a survey to estimate which of the changes in gold and Bitcoin prices will be a safer port in terms of international investments. They used the Asymmetric Vector GARCH model with daily frequency data of the period between 20 July 2010 and 27 December 2017. According to the results, gold is a more sheltered and safe haven against inflation and capital markets while Bitcoin is less sheltered.
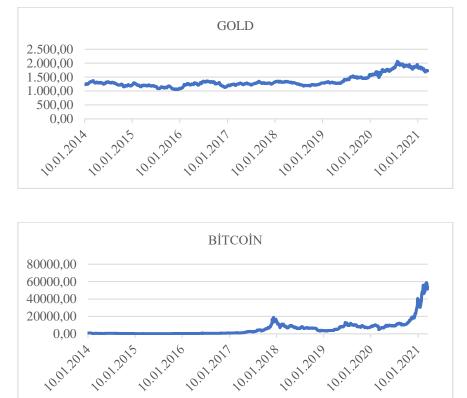
4. Method

This study researched the cointegration and causality relation between Bitcoin prices and gold prices. Time-series analyses were used within the research.
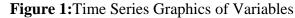
4.1 The Aim of the Study

This study aimed to research whether there is a cointegration or causality relation between Bitcoin prices and gold prices.

4.2 Data Set

Bitcoin prices and gold prices daily data (1735 observations) covering the period from January 10, 2014, to December 11, 2020, were utilized in this paper. The data of the variables used in the analyses were accessed via the https://tr.investing.com/ website. The range was determined based on the beginning of the daily data in the mentioned source. Levels of the variables were used in the analysis.

Figure 1: Time Series Graphics of Variables

4.3 Hypothesis of Study

The main hypothesis regarding the research can be expressed as follows:

H0: There is no relationship between Bitcoin prices and gold prices.

H1: There is a relationship between Bitcoin prices and gold prices.

4.4 Methodology of Study

First of all, the Zivot-Andrews unit root test that considers structural breaks and reviews whether there is a unit root in variables was applied to analyze the causality relation between Bitcoin prices and gold prices. After the variables were made stationary, the Maki cointegration test was performed to review whether there is a long-termed relationship between variables. The relevant cointegration test is one of the modern tests that endogenously determine the number of structural breaks. Finally, the Toda Yamamoto causality test was applied. The causality test in question is a Granger-based test and has more up-to-date content than the Granger causality test. In addition, this test was preferred in order to eliminate the deficiencies of the Granger causality test and to prevent emerging problems. The theoretical information about the models and tests used in the study is given below.

4.5 Zivot-Andrews Unit Root Test

A new unit root test that does not find Perron's (1989)'s exogenous breaking point assumption rationale was developed by Zivot and Andrews (1992). This relevant test allows an estimated break in trend function under the alternative hypothesis against the main hypothesis. Regarding Divot-Andrews' (ZA) stationarity test, Model A allows for a single break at a level while Model B allows for a single break at the slope. However, Model C is a model that allows for a single break at both level and slope. Relevant models as follows:

$$\text{Model A: } Y_t = \mu + \beta t + \delta Y_{t-1} + \theta_1 DU(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \tag{1}$$

$$\text{Model B: } Y_t = \mu + \beta t + \delta Y_{t-1} + \theta_2 DT(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \tag{2}$$

$$\text{Model C: } Y_t = \mu + \beta t + \delta Y_{t-1} + \theta_1 DU(\lambda) + \theta_2 DT(\lambda) + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \tag{3}$$

DU in model is the dummy variable showing the break at level while *DT* is other dummy variable showing the break at slope.

$$DU(\lambda) = \begin{cases} 1 & t > T_B \\ 0 & t \le T_B \end{cases} \qquad DT(\lambda) = \begin{cases} t - T\lambda & t > T\lambda \\ 0 & t \le T_B \end{cases}$$

t=1,2,...,T is time; T_B is breaking date and thus, $\lambda = T_B / T$ is the breaking point.

First of all, breaking point of $\lambda = T_B / T$ and (1), (2) and (3) equations within the range of $j = 2 / T$ and $j = (T-1) / T$ for each of the series are estimated by least squares method. Breaking point is chosen as the date with the minimum t statistics (Zivot and Andrews, 1992: 255). After determination of breaking date, the main hypothesis that accepts the presence of the unit root is accepted as the main hypothesis if the t statistics is less than the critical value computed by Zivot and Andrews (1992).

Model C, at first, is estimated for being applied ZA stationarity test. The proper model is chosen based on the significance of parameters belong to the dummy variables, DU and DT. Model C is the best fit if both DU and DT are statistically significant; Model A is proper if only DU is significant; and finally, the estimation of Model B is the best fit if DT is significant alone. There is no consensus on which of these three models is superior, but Model A and Model C are used in practice in general. Just as other unit root tests, this test, too, is sensitive to the lag length (Yavuz, 2006: 166-167).

4.6 Maki Cointegration Test

Since the breaking number is given as priory, Maki (2012) suggested a cointegration test in which the structural breaking number is internally determined after criticizing Gregory-Hansen's (1996) test with a single break and also Hatemi-J's (2008) test with two breaks. According to his model, the main hypothesis assumes that there is no cointegration among variables while the alternative hypothesis

accepts a cointegration relation considering the structural breaks whose number is specified by the model. One of the four models below is used for this test.

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta_i' x_t + \mu_t \qquad (4)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta_i' x_t + \sum_{i=1}^{k} \mu_i D_{i,t} + \mu_t \qquad (5)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta_i' x_t + yt + \sum_{i=1}^{k} \mu_i D_{i,t} + \mu_t \qquad (6)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \sum_{Y_i} t D_{i,t} + \beta_i' x_t + \sum_{i=1}^{k} \mu_i D_{i,t} + \mu_t \qquad (7)$$

This paper, as required by the structure of series, uses 5 numbered model allowing for change at level, trend and in variables as well. It can be said regarding the operation of the Maki cointegration test that the model is estimated for each of the possible structural breaks to reach unit root test statistics applied to residuals. The residual among the variables is determined as the first breaking point whose sum of squares is the minimum. After the first structural break is included in the selected model; second, third and other structural breaks are reviewed and finally, the examination continues until the number of upper breaks allowed by the researcher who made the application in this way. The breaking number that gives the least T statistics is accepted as the proper breaking number (Zeren et al. 2015:28).

4.7 Toda-Yamamoto Causality Analysis.

This method that was developed by Toda and Yamamoto (1995) to remedy the deficiencies of the Granger causality test and avoid the problems revealed that there can be applied causality analysis among series that stagnate at different levels; have no cointegration and even are not exposed to a stationarity test. However, the series should stagnate at the same level and there should be a cointegration relation among the series to be applied Granger causality test (Toda and Yamamoto, 1995).

4.8 Findings of Study

This chapter shows the tests and findings to reveal the causality relation between Bitcoin prices and gold prices.

4.8.1 Zivot-Andrews Unit Root Test Results

This study selected C Model as the proper one to determine the breaks in series within Zivot-Andrews(ZA) test. The first difference of series that do not get rid of the unit root and do not become stationary at level was calculated and also ZA unit root test was applied again. Table 3 shows the results.

Table 3: Assets with high correlation in the Cryptocurrency Market in 2019

Zivot-Andrews (Model C)						
Variable	**Level**	**Breaking Date of Level**	**Critical Value**	**1st Difference**	**Breaking Date of the 1st Difference**	**Critical Value**
	Test Statistics			**Test Statistics**		
Gold	-3.0223	April 20, 2018	-5.08	-20.1019*	March 16, 2020	-5.08
Bitcoin	-2.3342	March 9, 2020	-5.08	-14.6511*	February 16, 2020	-5.08

*: it is significant at 5% level

According to the results of Model C that allows for breaks in both constant and trend obtained from Zivot-Andrews's unit root test, the variable of both gold prices and Bitcoin prices become stationary at their first difference I(1). Moreover, it is also observed that there is not an extraordinary situation regarding the breaking dates arising from the ZA unit root test; the movements in ordinary, political, and economic policies have caused these breaks. The reason for the break in gold prices on March 16, 2020 is thought to be related to the fact that the US Federal Reserve (Fed) reduced the policy rate by 100 basis points to the range of 0-0.25 percent with a surprise meeting. However, it was observed that the ounce price of gold, which rose to the level of 1.575 dollars after the Fed's decisions that it would make a monetary expansion of 700 billion dollars and that it established a swap line with 6 major central banks to avoid liquidity problems, later decreased to around 1.530 dollars.

4.8.2 Maki Cointegration Test Results

Maki cointegration test was utilized to analyze whether there is a long-termed relationship between Bitcoin prices and gold prices. Maki cointegration test internally determines the number of structural breaks. Table 4 shows the results.

Table 4: Maki Cointegration Test Results

Variables	**Test Statistics**	**Critical Values**			**Breaking Dates**
		(1%)	**(5%)**	**(10%)**	
Gold←→Bitcoin	-5.94	-8,00	-7,41	-7,11	January 2015, September 2015, February 2016, June 2020, October 2020

According to the Cointegration test results in Table 4, when an investor investing in gold diversifies his portfolio, he can reduce his risk by investing in Bitcoin. Because Gold and Bitcoin have not a cointegrated structure. In other words, relevant investment instruments do not move together in the long run.

4.8.3 Toda-Yamamoto Causality Test Results

The Toda-Yamamoto causality test was utilized to analyze whether there is a causality relationship between Bitcoin prices and gold prices. The tests were performed one by one among the variables in the form of a double test. Lag length (k), during the Toda-Yamamoto test, was found based on Akaike Information Criteria (AIC); dmax which is the maximum cointegration level was found based on Zivot-Andrews (ZA) unit root test. Afterward, Wald statistics were applied to k lag lengths in this model to determine if there is a causality relation or not. Table 4 shows the findings.

Table 5: Toda-Yamamoto Causality Test Results

Dependent Variable	Independent Variable	dmax	k	Chi-Square Test Statistic	Chi-Square P-value	Relationship and Direction
Gold	Bitcoin	1	12	27.90086	0.0057	Yes
Bitcoin	Gold	1	12	36.59336	0.0003	Yes

*: dmax= maximum stasis level according to the Zivot-Andrews unit root test, K = VAR delay length It is statistically significant at 5% level. Optimal lag length was specified based on AIC criteria. dmax is the maximum stationarity level based on Zivot-Andrews unit root test.

It can be highlighted based on the findings in Table 5 that the changes in gold prices are the reason for the changes in Bitcoin prices while the changes in Bitcoin prices are the reasons for the changes in gold prices.

5. Conclusion

Commodities, from past to present, that are valued by many nations as means of exchange have been accepted by almost all societies and used as common money. These coins were first used as an item, then as a precious metal, and later as easy-to-carry banknotes. They have displayed themselves as virtual money in the last century.

The gold mine is not monopolized by any state and has been recognized as a common value measure for thousands of years besides being a reliable investment tool. Here is talked about virtual currency that is not monopolized by any nation and that only buyers and sellers have an impact on its value in our digitalized world. These coins are protected by the cryptology method, stored in encrypted account wallets, and do not have a physical appearance. Awareness and use of these virtual currencies are increasing day by day; the reason may be that their features similar to gold. This study revealed the relationship between gold and cryptocurrency by an empirical research.

First of all, the Zivot-Andrews unit root test was applied to analyze the stationarity on the raw data to test the presence of a relationship between Bitcoin prices and gold prices. For findings, both variables have unit root in their level values; series were made stationary computing their first differences. In the second phase, the Maki cointegration test was performed to see whether there is a long-termed relationship between variables. Relevant cointegration is one of the modern tests that determine the number of structural breaks internally. Finally, the Toda Yamamoto causality test was applied. This test is a Granger-based test as well as has more up-to-date content than the Granger causality test. Moreover, this was preferred to remedy the deficiencies of the Granger causality test and also avoid the problems. 1735 days of data were used for 6 years from 2014 to 2020.

For the Maki cointegration test results, there is a long-termed relationship between series; investors can use both investment tools in the same portfolio. The fact that these two variables, which do not

move in the same direction in the long run, are included in the same portfolio will have a risk-reducing effect. For the Toda Yamamoto causality test results, there is a two-way causality relationship at a 5% significance level.

In this regard, it is of the opinion that keeping the equation wider will increase the benefit in terms of shedding light on other studies in this field considering that the result obtained represents a value for both policymakers and investors. In other words, it is thought that a study that includes gold prices as precious metals, as well as other precious metals and the most demanded altcoins in the market representing cryptocurrencies, will allow a more comprehensive evaluation.

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