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Examining the Causality between Financial Instruments in Terms of Portfolio Management*

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ABSTRACT

In portfolio theory, the selection of financial instruments to be included in the portfolio is of great importance. For this purpose, the direction and strength of the relationship between the financial instruments to be included in the portfolio have also become important. From this point of view, the main objective of this study is to analyze the interrelationships among financial instruments. In this study, the causality relationship between gold, BIST-100 index, bitcoin and exchange rate was analyzed. The data of the financial instruments used in the study consist of 208 observations as weekly values for the years 2019-2022. Before applying causality analysis, Johensen cointegration test was performed to test whether there is a cointegration relationship between the variables. According to the results of the cointegration test, both the trace statistic and the maximum eigenvalue result indicate that there is one cointegration between the variables. According to the Toda-Yamamoto causality test, it was concluded that there is a bidirectional causality relationship between the exchange rate and bitcoin price and that the exchange rate is the cause of the BIST-100 index.

Keywords: *Financial instruments, portfolio managament, casuality test.*

***Jel Classification**: G11, G15, G32.*

Finansal Enstrümanlar Arasındaki Nedensellik İlişkisinin Portföy Yönetimi Açısından İncelenmesi

ÖZET

Portföy teorisinde portföye dahil edilecek olan finansal varlıkların seçimi büyük önem taşımaktadır. Bu amaçla portföye eklenecek olan yatırım araçlarının birbirleri ile olan ilişkilerinin yönü ve güçleri de önemli hale gelmiştir. Bu açılardan düşünüldüğünde finansal varlıkların birbirleri ile olan ilişkileri bu çalışmanın ana amacını oluşturmaktadır. Bu çalışmada altın, BIST-100 endeksi, bitcoin ve döviz kuru arasındaki nedensellik ilişkisi analiz edilmiştir. Çalışmada kullanılan yatırım araçlarına ait veriler 2019-2022 yılları için haftalık değer şeklinde 208 adet gözlemden oluşmaktadır. Nedensellik analizi uygulanmadan önce değişkenler arasında eşbütünleşme ilişkisinin var olup olmadığını test etmek amacıyla Johensen eşbütünleşme testi yapılmıştır. Eş bütünleşme testi sonucuna göre hem iz istatistiği hem de maksimum özdeğer sonucuna göre değişkenler arasında bir adet eş bütünleşmenin var olduğu görülmüştür. Toda-Yamamoto nedensellik testi sonucuna göre döviz kuru ile bitcoin fiyatı arasında çift yönlü bir nedensellik ilişkisi ve döviz kurunun da BİST-100 endeksinin nedeni olduğu şeklindeki sonuçlara ulaşılmıştır.

Anahtar Kelimeler: *Finansal enstrümanlar, portföy yönetimi, nedensellik testi*

JEL Sınıflandırması: *G11, G15, G32*

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1. INTRODUCTION

The concept of portfolio management has been one of the most important topics in the finance literature and has been studied by researchers for many years. While portfolio management was carried out in the pre-Markowitz period by diversifying the asset group and reducing the risk, Markowitz introduced the mean-variance theorem to the literature by arguing that mathematical methods can be used in portfolio management and thus the return of the portfolio can be increased and the risk can be minimized.

The most important point in portfolio construction is the correct formation of the financial instruments to be included in the portfolio. For this purpose, the relationship between the financial assets to be included in the portfolio should be investigated. If there is a strong negative correlation between the financial assets that make up the portfolio, the risk of the portfolio can be minimized, while in a strong positive correlation, gains and losses in assets will be realized together.

When selecting the assets to be included in the portfolio, the relationships between financial instruments are of great importance. When considered from this perspective, the analysis of the causality relationship between financial assets also gains importance. In this study, the causality relationship between financial assets, namely gold, bitcoin, BIST-100 index, and the exchange rate is examined and the level of co-movement of these financial assets is analyzed.

The most important contribution of the research to the literature is that it sheds light on the investment decision phase, one of the most important issues in finance. Investors who make portfolio investments can form their portfolios by considering the relationships between financial instruments. This study, which analyses the relationships between financial instruments in the context of a portfolio approach, is expected to guide investors.

The study has been formed as follows. The concept of portfolio, portfolio theories, and risk are mentioned in Section 2. A summary of the literature is presented in Section 3. Section 4 is devoted to the analysis and results of the study. The last Section is dedicated to the conclusion and discussion about the subject.

2. CONCEPTUAL FRAMEWORK

The portfolio is defined as a wallet in the literature, while in financial terms it can be expressed as an investment basket consisting of various securities (Çetindemir, 2006:3; Demir, 2013:2; Çalışkan, 2021:5). Portfolio theory is generally expressed from two perspectives. These perspectives are traditional portfolio theory and modern portfolio theory (Witt and Dobbins, 1979:4; Tekin, 2016:76; Yiğiter and Akkaynak, 2017:286; Uyar, 2019:162). According to the traditional portfolio theory, no quantitative analysis is made, and the risk value is minimized by increasing the diversification of the asset group created (Baykan, 2010:23; Demir, 2013:6; Korhan, 2013:29; Ahmad et al., 2017:2). However, the subjectivity of the traditional portfolio theory and the lack of mathematical methods show the deficiencies of the model.

After the deficiencies in the model, Markowitz developed the modern portfolio theory in 1952. Modern portfolio theory uses statistical methods to evaluate the portfolio and calculates the risk and return of the portfolio with quantitative values (Elton and Gruber, 1997:1743-1750; Çolakyan, 2013:6; Dellano et al., 2017:636). According to the modern portfolio theory, the portfolio that provides minimum risk at a certain return level and maximum return at a certain risk level is considered the best portfolio (Toroman and Yürük, 2014:135; Bayat and Yiğiter, 2022:5). Contrary to the traditional theory, Markowitz argued that the selection of the right and interrelated securities will increase portfolio performance rather than increasing the number of securities (Havley and Lukomnik, 2017:43; Güngör, 2019:14; Onacak, 2019:22).

As mentioned earlier, it is argued that risks can be minimized or even reduced to zero by including securities that are negatively correlated and highly related to each other in the portfolio rather than the number of securities (Joshi, 2015:2; Mortaş and Garip, 2016:248; Bakar and Rosbi, 2019:214; Surtee and Alagidede, 2022:528-529). In addition to standard deviation and average return, covariance (the degree to which securities move together) and correlations are also known to be very important in portfolio management (Ramazan, 2013:178; Garip, 2014:20). When financial assets that move together are included in the portfolio, their returns will increase and decrease at the same time when they are positively correlated. This will increase the risk of the portfolio (Lintner, 1965; Miller, 1977; Stulz, 1999). Therefore, it is recommended to include highly negatively correlated assets in securities for risk minimization.

The concept of risk, which is as important as return maximization in portfolio management, is also an important concept that needs to be explained at this stage. In finance, risk can be defined as the sum of negative and positive deviations from the average expected state (Emhan, 2009:211; Sayım and Aydın, 2015:6). As mentioned earlier, risks can be mitigated through the diversification of related securities, but risks are divided into systematic and unsystematic risks (Biswas, 2015:71).

Systematic risk is defined as risks arising from macroeconomic factors that cannot be mitigated through diversification and that will affect all securities. Examples of these risks include inflation, political, interest rate, etc. risks (Dichev, 1998:1132; Özbilgin, 2012:2-3; Sayım and Aydın, 2015:6-8). While systematic risks cannot be mitigated through diversification since they usually originate from the same country, they can be mitigated by including international financial assets in the portfolio. Unsystematic risks, on the other hand, can be mitigated through diversification. Systematic risks usually arise from the problems of the enterprises due to their high managerial, operational, and financial leverage and therefore, these risks can be reduced as long as they are not included in the portfolio (Beuhler, 2006:36; Usta and Demireli, 2010:27-28; Biswas, 2015:71; Sukrianingrum and Manda, 2020:183-185).

Portfolios formed based on correlations between securities are evaluated in terms of performance based on their risks and returns. The most preferred systematic and total risk-based ratios of portfolio performance will be discussed here (Uğur, 2011:1; Şahin, 2017:64). The first ratio of these is the Sharpe ratio. The Sharpe ratio shows the desired return over the risk-free interest rate in return for the total risk incurred by the investor (Sharpe, 1998; Zakamouline and Koekebakker, 2009:1244; Nguyen, 2014:665). In summary, the Sharpe ratio shows the reward obtained for the total risk incurred. In portfolio selection, the portfolio with a high Sharpe ratio is preferred. Another important performance measurement ratio was developed by Treynor (1969), who used systematic risk as a risk factor. This ratio, which is calculated based on systematic risk, i.e. market risk, known as the beta coefficient, measures the premium of the risk taken. Therefore, a portfolio with a high Treynor ratio is preferred.

The alpha measure developed by Jensen is also known as another important ratio used in portfolio performance measurement. According to this ratio, the return obtained above the return predicted by the financial asset pricing model is known as alpha (Treynor and Black, 1973; Sönmezler, 2021:57). A portfolio with a high alpha value is preferred (Uyar and Gökçe, 2015:217; Yaman and Korkmaz, 2023:208). The M2 performance measurement criterion is a widely used criterion for comparing portfolios at different risk levels (Bayramoğlu and Yayalar, 2017:6). According to this criterion, the risks of the portfolios are equalized to the market portfolio risk, and the market portfolio risk is used as the benchmark value. A portfolio with a high M2 value is said to have a high performance (Arslan, 2005:7; Gökgöz and Günel, 2012:17).

3. LITERATURE REVIEW

In this section of the study, studies that have measured the relationship between various financial instruments will be discussed. In general, the literature examines the relationship between financial instruments in a bilateral manner.

Wang and Chueh (2013) examined the relationship between gold, exchange rates, oil prices, and interest rates. Using daily data from 1989 to 2007, they found a positive relationship between gold and oil prices and a negative relationship between exchange rates and interest rates with gold prices.

Van Wijk (2013) investigated the effect of exchange rates, oil prices, and gold on bitcoin prices. They concluded that exchange rate, oil prices, and the Dow Jones index have a significant effect on bitcoin price.

Öncü et al. (2015) examined the relationship between stocks, gold, and exchange rates using Granger cointegration and causality tests. Using daily data for the years between 2002-2013, they concluded that there is a unidirectional causality relationship between the BIST-100 index, exchange rate, and gold.

Sandal et al. (2017) examined the relationship between gold price, oil, and exchange rates with the Johensen cointegration test and Granger Causality test. The results showed that there is no cointegration relationship between the variables in the long run and there is a causality relationship from gold price to stock prices.

Erdaş and Çağlar (2018) examined the causality relationship between gold, bitcoin, oil prices, the US dollar, S&P 500, and the BIST-100 index. Using the Hatemi-J test as the analysis method in their study, they found a causality relationship between Bitcoin and S&P 500, from bitcoin to S&P 500.

Güleç et al. (2018) examined the relationship between gold, the BIST-100 index, exchange rate, and interest rate variables for the period between March 2012-May 2108 by applying the Granger causality test and found only a causality relationship from bitcoin to the interest rate variable.

Raheem and Vveinhardt (2018) used daily data for the years between 2000-2016 and examined the relationship between stock prices and gold prices using the Johensen cointegration test. The study was divided into three separate periods and a significant relationship between variables was found in the long run in all three periods.

Başarır (2019) examined the relationship between stock index returns and gold returns using monthly data between April 2006 and August 2018. The Toda-Yamamoto method was used to test the causality relationship and a bidirectional relationship was found between gold and stock returns and concluded that the inclusion of gold in the portfolio would be appropriate in terms of diversification.

Telek and Şit (2020) examined the effect of gold price and dollar index price variables on bitcoin prices. ARDL bounds test was used as the analysis method for monthly data between 2012 and 2019 in their study. According to their findings, gold and foreign exchange prices have a long-run effect on bitcoin prices.

Gültekin and Oğuzhan (2021) examined the relationship between the BIST-100 index and bitcoin prices by using daily data from 14.08.2017 to 13.04.2021 and applying the Hatemi-J causality test. They found that a positive shock in the BIST-100 index causes a positive shock in bitcoin prices.

Cingöz and Kendirli (2021) analyzed the relationship between the BIST-100 index, gold, and exchange rate by taking the natural logarithms of monthly average prices for the period of 2006:01-2018:06 and applying the Johensen cointegration test and Granger causality analysis. They concluded that the exchange rate and BIST-100 index value have an effect on gold prices in the long run, but have no effect in the short run.

4. ANALYSIS AND RESULTS

4.1. Analysis Method and Dataset

Causality analysis was applied to examine the relationship between the prices of the four financial instruments used in the study. The analysis to be applied according to the stationarity levels of the variables was determined and it was concluded that the variables were non-stationary at level but stationary at I (1) level. For this reason, instead of Granger causality analysis, which can be applied to series that are expected to be stationary at level or stationary at the same level (but with differenced values), Toda-Yamamoto causality analysis was applied with variables that can be stationary at different levels and are not differenced, and which does not require the variables to be cointegrated (Tuncer, 2002:96).

The relationships between variables are evaluated as binary relationships. The VAR method was applied to determine the lag values. Lag length is a very important criterion for the Toda-Yamamoto test. The appropriate lag length, k, and the degree of cointegration, dmax, are the data that should be calculated first (Tezer, 2020: 1494). According to the k+dmax value found, Toda-Yamamoto analysis is performed (Akçalı and Şişmanoğlu, 2019:107). Then, the Wald test is applied to determine the causality relationship between the variables. According to the Wald test result, the significance of the relationships is tested and their directions are determined (Tayyar, 2019: 1948).

The models estimated in the Toda Yamamoto causality analysis for X and Y variables are given in equation (1) and equation (2) (Medetoğlu and Doğru, 2022: 751)

$$Y_t = \omega + \sum_{i=1}^{k} \alpha_{1i} X_{t-i} + \sum_{i=1}^{k} \beta_{1i} Y_{t-i} + \sum_{j=k+1}^{d_{max}} \delta_{1i} X_{t-i} + \sum_{j=k+1}^{d_{max}} \theta_{1i} Y_{t-i} + \varepsilon_{1t} \quad (1)$$

$$X_t = \varphi + \sum_{i=1}^{k} \alpha_{2i} X_{t-i} + \sum_{i=1}^{k} \beta_{2i} Y_{t-i} + \sum_{j=k+1}^{d_{max}} \delta_{2i} X_{t-i} + \sum_{j=k+1}^{d_{max}} \theta_{2i} Y_{t-i} + \varepsilon_{2t} \quad (2)$$

The hypotheses that can be formed for the equations can be formed as follows.

H_0: There is no causality relationship from variable X to variable Y.

H_1: There is a causality relationship from variable X to variable Y.

Considering these aspects, the causality relationship between gold, bitcoin, stock, and exchange rate, which are among the most preferred financial instruments in Turkiye today, has been examined and it has been tried to evaluate how effectively they can be selected in reducing portfolio risk according to the direction and strength of the relationships between them.

The data on gold, bitcoin, the BIST-100 index, and foreign exchange, which are among the financial instruments used in the study, were obtained from investing.com as weekly values for the years between 2019 and 2022. The study was conducted with 208 observations during this period. Descriptive statistics of the financial instruments used in the study are presented in Table 1.

Table 1. Descriptive Statistics of Variable Data

Descriptives	**Gold**	**BIST-100**	**Bitcoin**	**Exchange Rate**
Mean	1697.636	1664.052	23597.83	9.5843,34
Mediam	1764.900	1373.685	17005.85	7.6500,50
Minimum	1276.000	857.9600	3502.500	5.2084,00
Maksimum	2018.000	5509.160	64398.60	18.6905,0
Standart Deviation	197.3069	955.9122	17552.57	4.4574,43
Observation	208	208	208	208

Figure 1 shows how the values of the variables used in the model changed during the analysis period.

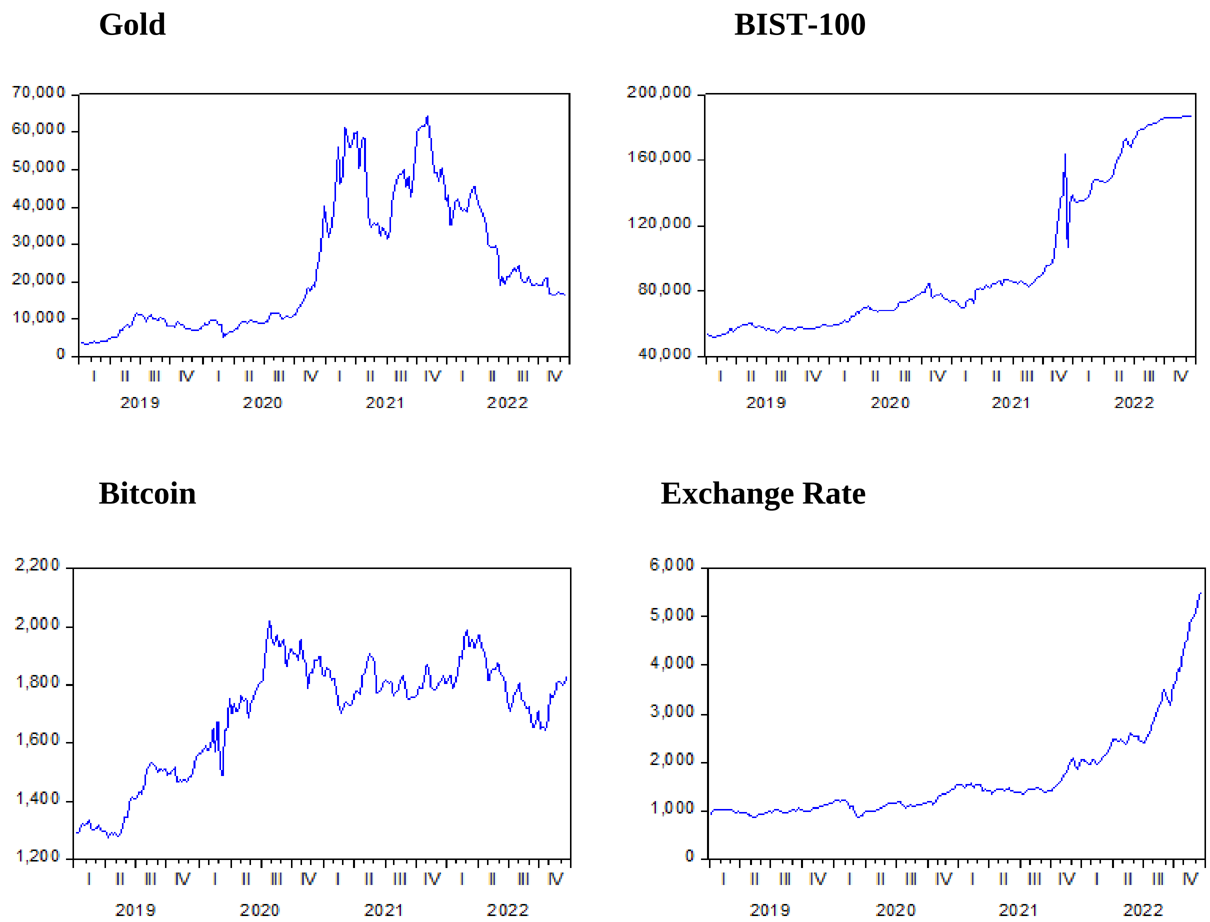

Figure 1. Price Change Graphs of Variables for the Periods

4.2. Hypothesis and Results

The bidirectional relationships between each of the four financial instruments that are the subject of the research are tested and the hypotheses of the research are stated below before proceeding with the findings.

H1a: The gold price is the cause of the BIST-100 index

H1b: BIST-100 index is the cause of gold price

H1c: The gold price is the cause of Bitcoin price

H1d: Bitcoin price is the cause of gold price

H1e: The gold price is the cause of the exchange rate

H1f: Exchange rate is the cause of Gold price

H1g: BIST-100 index is the cause of the Bitcoin price

H1h: Bitcoin price is the cause of the BIST-100 index

H1i: BIST-100 index is the cause of the exchange rate

H1j: Exchange rate is the cause of the BIST-100 index

H1k: Bitcoin price is the cause of the exchange rate

H1l: The exchange rate is the cause of Bitcoin price.

ADF (Agumented-Dikey Fuller) and KPSS ((Kwiatkowski-Phillips-Schmidt-Shin) tests were conducted to test the stationarity of the financial instruments used in the study. The results of unit root tests obtained according to Schwartz Information Criteria are presented in Table 2.

Table 2. Unit Root Test Results

Model		**ADF**				**KPSS**			
Variables		Gold	BIST-100	Bitcoin	Exchange rate	Gold	BIST-100	Bitcoin	Exchange rate
Level									
Constant	t-statistic	-2.0795	6.9147	-1.4555	0.9921	130.5752	22.2386	21.9642	30.5448
	probability	***0.2533***	***1.0000***	***0.5543***	***0.9965***	***0.0000***	***0.0000***	***0.0000***	***0.0000***
Constant +Trend	t-statistic	-2.0749	4.5106	-0.9904	-1.3718	85.7933	-0.01573	4.8229	8.1831
	probability	***0.5563***	***1.0000***	***0.9420***	***0.8664***	***0.0000***	***0.9875****	***0.0000***	***0.0000***
At first difference									
Constant	t-statistic	-16.3377	-3.8617	-12.9759	-22.5345	1.1146	2.5384	0.6099	2.5058
	probability	***0.0000****	***0.0028****	***0.0000****	***0.0000****	***0.2662****	***0.1118****	***0.5425****	***0.0129****
Constant +Trend	t-statistic	-16.3769	-12.9466	-13.0147	-22.7204	1.1533	-0.7922	0.7613	-0.5928
	probability	***0.0000****	***0.0000****	***0.0000****	***0.0000****	***0.2500****	***0.4290****	***0.4468****	***0.5539****

** significance at 1% level of significance.*

Stationarity was evaluated with unit root tests. According to ADF values, all variables are not stationary at level but all variables are stationary at first difference. Similarly, KPSS test analysis was also performed to test the stationarity of the variables and it was observed that all variables were stationary at first difference. Following the application of unit root tests, the appropriate lag length was determined with the VAR model.

Table 3. Findings on the Appropriate Lag Value

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SIC**	**HQ**
0	-7423.930	NA	2.13e+27	74.27930	74.34527	74.30600
1	-6017.770	2742.01200	1.96e+21	60.37770	**60.70753***	60.51118
2	-5985.443	61.74510	**1.66e+21***	**60.21443***	60.80813	**60.45469***
3	-5974.621	20.23712	1.75e+21	60.26621	61.12377	60.61325
4	-5970.292	7.92247	1.97e+21	60.38292	61.50434	60.83674
5	-5954.167	28.86327*	1.97e+21	60.38167	61.76696	60.94228
6	-5944.038	17.72576	2.10e+21	60.44038	62.08954	61.10777
7	-5934.855	15.70308	2.25e+21	60.50855	62.42157	61.28272
8	-5922.284	20.99389	2.34e+21	60.54284	62.71973	61.42379

* The optimal number of lags that minimises the information criterion

LR: Ordered modified LR test statistic (5% significance level)

FPE Final prediction error

AIC: Akaike information criterion

SIC: Schwarz information criterion

HQ Hannan-Quinn information criterion

For this stage of the study, the optimal number of lags is found to be two according to the final prediction error (FPE), Akaike information criterion (AIC), and Hannan-Quinn information criterion (HQ), but one according to the Schwarz information criterion (SIC). When all criteria are considered together, it can be said that the optimal number of lags is two.

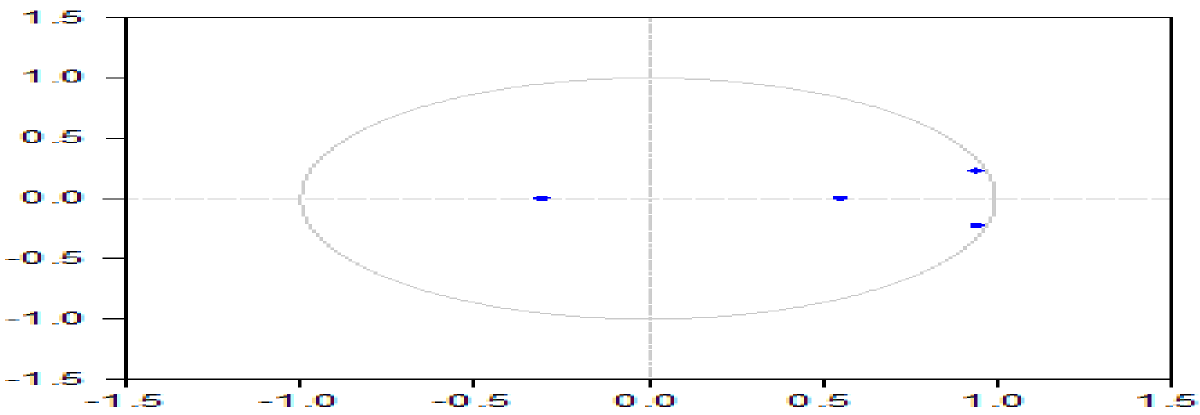

Figure 2. AR Inverted Root Polynomial

Table 4. Root and Module Values

Root	Module
0.323222	0.323222
0.993092 - 0.014630i	0.993200
0.993092 + 0.014630i	0.993200
0.968440	0.968440
-0.463876	0.463876
-0.111571	0.111571
0.078107	0.078107
-0.051229	0.051229

The obtained results show that the VAR (2) model fulfills the necessary conditions. Figure 2 shows that the inverse roots of the AR polynomial are located inside the circle. At the same time, Table 4 indicates that each root is within the unit circle. Therefore, VAR (2) satisfies the stability condition of the model. In addition, VAR (2) is also tested for autocorrelation and heteroscedasticity and the results are shown in Table 5 and Table 6.

H_0: No autocorrelation

H_1: There is autocorrelation

Table 5. Autocorrelation Test (LM) for VAR (2) model

Lag	LM value	Df	Probability
1	18.89015	16	0.2744
2	**19.47547**	**16**	**0.2448**
3	8.767661	16	0.9227
4	24.03748	16	0.0887
5	25.16203	16	0.0670
6	15.54001	16	0.4855
7	25.54372	16	0.0608
8	10.44300	16	0.8425
9	5.193116	16	0.9947
10	14.88121	16	0.5334

When Table 5 is analyzed, the H_0 hypothesis, which states that there is no autocorrelation problem at lag 2, is accepted.

Table 6. Co-variance Test for VAR (2) model (White)

Lag	Test Statistic	Probability
2	58.68562	0.2443

One of the important assumptions of the model is that there is no changing variance. According to the White test result, there is no changing variance (0.2443 > 0.05).

Before applying causality analysis, the Johensen cointegration test is performed to test whether there is a cointegration relationship between the variables. It is thought that the Johensen cointegration analysis gives more accurate results in the presence of more than one variable and non-stationary variables (Albayrak and Gökçe, 2015:294). Before applying the Johensen cointegration test, the model with a cointegration relationship and the model with the smallest Akaike Information Criterion and Schwarz Information Criterion is determined. This model was found to be model 4 without constant and trend and the cointegration test was run with model 4. The findings are presented in Table 7 and Table 8.

Table 7. Cointegration Trace Value Test Results

H_0 hypothesis	Trace Value	For %5 critical value	Probability
No cointegration	50.66710	47.85613	0.0266*
At most one cointegration	17.14212	29.79707	0.6295
At most two cointegrations	6.231615	15.49471	0.6681
At most three cointegrations	1.381528	3.841466	0.2398

Significant at 5% level of significance

Table 8. Cointegration Maximum Eigenvalue Test Results

H_0 hypothesis	Eigenvalue Statistics	For %5 critical value	Probability
No cointegration	33.52498	27.58434	0.0076
At most one cointegration	10.91051	21.13162	0.6562
At most two cointegrations	4.850087	14.26460	0.7606
At most three cointegrations	1.381528	3.841466	0.2398

Significant at 5% level of significance

According to the value of the trace statistic in Table 7, the null hypothesis H_0, which states that there is no cointegration, is rejected (0.0266 < 0.05), but the null hypothesis H_0, which states that at most one, two, and three cointegrations exist, cannot be rejected. Therefore, it can be said that there is one cointegration between the variables.

In Table 8, the results of the analysis according to the maximum eigenvalue test show similar findings. Again, the null hypothesis H_0, which states that there is no cointegration between the variables, is rejected (0.0076 < 0.05) and it is seen that there is one cointegration.

To apply the Toda-Yamamoto test, there is no requirement for cointegration between variables. Therefore, the results of the Wald test will be presented in Table 9 at this stage of the study.

Table 9. Wald Test Results at Lag 2

Causality Relationship	Chi-square Test Statistic	Probability	Hypothesis/Decision
Gold price is the cause of BIST-100 index	2.020287	0.7320	H_{1a} / Not the cause
BIST-100 index is the cause of gold price	2.183013	0.7021	H_{1b} / Not the cause
The gold price is the cause of the bitcoin price	2.953801	0.5656	H_{1c} / Not the cause
Bitcoin price is the cause of the gold price	2.016209	0.7328	H_{1d} / Not the cause
Gold price is the cause of the exchange rate	0.892481	0.9256	H_{1e} / Not the cause

The exchange rate is the cause of the gold price	2.668421	0.6148	H_{1f} / Not the cause
BIST-100 index is the cause of bitcoin price	2.362560	0.6694	H_{1g} / Not the cause
Bitcoin price is the cause of BIST-100 index	2.021553	0.7318	H_{1h} / Not the cause
BIST-100 index is the cause of exchange rate	2.649471	0.6181	$H_{1\imath}$ / Not the cause
Exchange rate is the cause of BIST-100 index	9.977845	0.0257	**H_{1j} / The Cause**
Bitcoin price is the cause of the exchange rate	8.268550	0.0422	**H_{1k} / The Cause**
The exchange rate is the cause of the bitcoin price	555.1385	0.0000	**H_{1l} / The Cause**

According to the Wald test result, a bidirectional causality relationship was found between the exchange rate and Bitcoin price at the 5% significance level. At the same time, it is also found that the exchange rate is the cause of the BIST-100 index.

5. CONCLUSION AND DISCUSSION

By creating the right portfolio, income from investments will increase and risks will be minimized. As mentioned before, the most important point in portfolio management is to provide a maximum return at a certain risk level and minimum risk at a certain return level. The correct selection of the financial instruments to be included in the portfolio constitutes the most important issue of portfolio management. While selecting the assets to be included in the portfolio, the relationships between financial instruments are of great importance. The higher the covariance of financial instruments, the more simultaneous their losses or gains will be. If there is a negative and strong relationship between the financial instruments to be included in the portfolio, the risk of the portfolio can be minimized.

In this study, before examining the causality relationship, Johensen's cointegration test was performed and it was found that there was long-term cointegration between the variables. The causality relationship was analysed by Toda Yamamoto test. The causality relationships between the financial instruments used in the study were analyzed and it was found that the change in the exchange rate affects the BIST-100 index, but the change in the BIST-100 index does not affect the exchange rate. Similarly, a bidirectional causality relationship was found between bitcoin and the exchange rate. On the other hand, there is no causality relationship between gold price, the BIST-100 index and the bitcoin price. It is concluded that the findings are similar to the studies of Erdaş and Çağlar (2018), Telek and Şit (2020), Gültekin and Oğuzhan (2021) in the literature.

One of the important findings of the study, a bidirectional causality relationship between bitcoin prices and the exchange rate shows that the two financial instruments interact with each other. Foreign exchange and bitcoin, which will be included in the portfolio, will be able to create diversification and minimize risk by moving together. In addition, the causality relationship found from the exchange rate to the BIST-100 index shows that foreign exchange and stock investments can be evaluated together and can be included in the portfolio at the same time.

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