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A Nonlinear Causality Analysis of the Relationship Between Gold Prices, Exchange Rates and Stock Market in Türkiye

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Türkiye'de Altın Fiyatları, Döviz Kurları ve Hisse Senedi Piyasası İlişkisinin Doğrusal Olmayan Nedensellik Analizi

Abstract

With globalisation and rapidly developing technology, financial investment instruments have diversified, and investors have begun to look for ways to make the most of their investments. Consequently, the relationships between financial instruments have gained more and more importance. This study aims to determine the direction of the causality relationship between exchange rates, gold prices, and the BIST100 index by using monthly data covering the period of 2003:01-2022:06 in the Turkish economy. Diks & Panchenko's (2006) non-linear causality test was used to determine the direction of causality, and the test shows a unidirectional causality relationship from BIST100 to exchange rates.

Keywords : Exchange Rate, Gold Prices, Stock Market, Nonlinear Causality.

JEL Classification Codes : C22, F31, G11.

Öz

Küreselleşme ve hızla gelişen teknolojiyle birlikte finansal yatırım araçları çeşitlenmiş ve yatırımcılar yatırımlarından en iyi şekilde yararlanmanın yollarını aramaya başlamıştır. Bunun sonucunda finansal araçlar arasındaki ilişkiler giderek daha fazla önem kazanmıştır. Bu çalışma, Türkiye ekonomisinde 2003:01-2022:06 dönemini kapsayan aylık verileri kullanarak döviz kurları, altın fiyatları ve BİST100 endeksi arasındaki nedensellik ilişkisinin yönünü belirlemeyi amaçlamaktadır. Diks ve Panchenko (2006) doğrusal olmayan nedensellik testi nedenselliğin yönünü belirlemek için kullanılmıştır ve test BİST100'den döviz kurlarına doğru tek yönlü bir nedensellik ilişkisini göstermektedir.

Anahtar Sözcükler : Döviz Kuru, Altın Fiyatları, Hisse Senedi Piyasası, Doğrusal Olmayan Nedensellik.

1. Introduction

With globalisation and rapidly developing technology, financial investment instruments have diversified, and investors have begun to look for ways to maximise their investments. As a consequence, the relationships between financial instruments have gained increasing importance.

Strong relationships between stock markets and exchange rates have emerged due to significant developments such as removing capital access barriers and transitioning to a flexible exchange rate regime. This relationship can be explained by the "traditional" and "portfolio balance" approaches. The traditional approach deals with the changes in the exchange rates that affect the international competition of countries, their foreign trade balance, and thus their stock market returns. A positive relationship is, therefore, expected to emerge between stock indices and exchange rates. In the portfolio balance approach, on the other hand, falling stock prices reduce capital flows into a country, causing a decline in the wealth of local investors. Besides this, this situation further leads to a decrease in the demand for money and interest rates, resulting in capital outflows and, thus, increased exchange rates. In this approach, a negative relationship is, therefore, expected between stock indices and exchange rates (Şanlı et al., 2021: 930).

When uncertainties increase, investors may demand gold more than other assets. The high liquidity of gold and the fact that it is considered a substitute for stocks can be shown as the reasons for this demand. Increased gold prices may cause investors to invest more in gold, so stock market investments decline, leading to the expectation of an inverse relationship between gold prices and the stock market index. With the rise of the stock market, investors tend to invest more in the stock market, so the demand for gold decreases, which in turn leads to a drop in prices. Consequently, an inverse relationship is expected between gold prices and the stock market index (Şanlı et al., 2021: 931).

The studies of Özmen (2007), Zeren & Koç (2016), Özmen et al. (2017), Kirikkaleli et al. (2018), Yildirim et al. (2021) and Şanlı et al. (2021) are the similar studies made for the direction of causality of relevant variables for Türkiye. The details can be seen in the literature section.

This study aims to reveal the causality relationship between exchange rates, gold prices, and the BIST100 index by using monthly data covering 2003:01-2022:06 concerning the Turkish economy. Considering other studies, this study uses current approaches that consider nonlinearity for Türkiye with an updated dataset. This study consists of four sections: the second section focuses on the literature review, the third section on the method and application, and the fourth section briefly summarises the results obtained from the study.

2. Literature Review

The literature includes several studies investigating the causal relationship between stock prices, the gold market, and exchange rates. Some of the literature reviews are presented below.

Smyth & Nandha (2003), Abdalla & Murinde (1997) and Piccilo (2009) obtained unidirectional causality from exchange rates to stock prices. Özmen (2007) found a bidirectional causality between stock prices and exchange rates and a causality from exchange rates to stock prices. Alagidede et al. (2011) detected nonlinear causality from stock prices to exchange rates and linear causality in the opposite direction. Miyazaki & Hamori (2012) detected a unidirectional causality from stock to gold. Liang et al. (2013) obtained a causality from exchange rates to stock prices. Rutledge et al. (2014) found a Granger causality in one direction (i.e., from exchange rates to stock prices or vice versa). Fowowe (2014) showed that causality runs from exchange rates to domestic stock prices in Nigeria, while no causality exists in South Africa. Liang et al. (2015) showed the causality direction from stock prices to exchange rates (also in the opposite direction), while Yang et al. (2014) and Zeren & Koç (2016) showed bidirectional causalities. Partalidou et al. (2016) defined that gold, decade bonds (10-year Treasury Notes) and the US Dollar/Yen exchange rates negatively affect the returns of the Dow Jones index. Metals affect them positively, but oil prices negatively. Özmen et al. (2017) obtained a unidirectional causality from exchange rates to BIST100, bidirectional causality between BIST100 and interest rates and interest rates and exchange rates. Parsva &Tang (2017) found that stock prices and exchange rates have bidirectional causality among four Middle-East economies. Kirikkaleli et al. (2018) observed a unidirectional causality from gold price, exchange rate, and stock market to the real estate stock price. Lou & Luo (2018) showed that the relationship between the stock price index and the exchange rate is unidirectional (and in the opposite direction) and a bidirectional relationship in some countries. Akbar et al. (2019) demonstrated that during recessions, stock prices and the value of the rupee decrease, while gold prices increase and vice versa. Park et al. (2019) showed that the stock exchange drives the foreign exchange market. Alshammari et al. (2020) tested nonlinear causality and discovered a positive correlation between the stock market and exchange rate across the entire frequency spectrum. During times of crisis, the gold price has only a short-term negative correlation with the stock market. Reza et al. (2020) showed the existence of the portfolio balance approach in two countries. Şanlı et al. (2021) observed bidirectional causality between BIST100 and exchange rates and interest rates and unidirectional causality from BIST100 to gold prices. Yildirim et al. (2021) revealed that interest rates and gold prices interact. Ali Raza et al. (2021) showed that exchange rate return causes gold prices in four out of G7. Tran & Nguyen (2022) found bidirectional causality between the stock market and gold price and a unidirectional relationship between the stock market and the USD exchange rate. Bildirici et al. (2022) pointed out bidirectional causality between exchange rate and BIST. In addition, BIST does not Granger cause the gold prices and VIX. Thuy Tien (2022) found that oil prices positively impact the exchange rate, inflation, GDP, and stock market prices

across major quantiles. Nusair & Olson (2022) confirm that causality runs from stock prices to exchange rates.

3. Methodology

The study includes the US Dollar exchange rates, gold prices, and BIST100 index series. Considering other studies, this study uses a nonlinear approach to causality among variables in Türkiye. Considering that most studies are based on the linear approach, this study uses a nonlinear approach.

The study's first stage of application includes descriptive statistics for the US Dollar exchange rates, gold prices, and BIST100 index series. The data were taken from the CBRT (Central Bank of the Republic of Türkiye) EVDS Electronic Data Delivery System. Table 1 summarises the descriptive statistics for the series.

Table: 1
Descriptive Statistics for the Series

Statistics	Gold (ons/$)	BIST100	Exchange Rate ($/TL)
Mean	1145.482	720.1358	3.186410
Median	1233.930	668.8235	1.810000
Maximum	1964.400	2648.190	16.53000
Minimum	321.4000	94.75100	1.180000
Standard Deviation	458.7885	434.2206	2.868081
Skewness	-0.231691	1.442762	2.331907
Kurtosis	2.045671	6.540152	8.925323
JB (probability)	0.004142	0.000000	0.000000

After summarising the descriptive statistics of the series, the nonlinear analysis will be developed. First, linearity analysis must be developed to investigate the causality between the Dollar rates, gold prices, and the BIST100 series. The test developed by Brock, Dechert and Scheinkman was used to determine the linearity of the series. In this test, the linearity hypothesis is tested against its alternative, nonlinearity (Brock et al., 1996). The test statistic is:

$$W_{m,n}(\varepsilon) = \sqrt{n}\,\frac{T_{m,n}(\varepsilon)}{V_{m,n}(\varepsilon)} \tag{1}$$

indicating convergence to normal distribution.

($T_{m,n}(\varepsilon) = C_{m,n}(\varepsilon) - C_{1,n}(\varepsilon)^m$; $C_{m,n}(\varepsilon)$ denotes the correlation integral, $V_{m,n}(\varepsilon)$ variance, m correlation, n the number of observations, and ε Euclidean distance)

The linearity of the series will be tested using the BDS test.

Table: 2
Linearity Test for the Series

Dimension	p
2,3,4,5,6	0.0000

Table 2 shows that the null hypothesis indicating linearity is rejected, so the series is not linear. After this stage, the stationarity of the series will be investigated with the nonlinear unit root test developed by Kapetanios et al. (2003).

Kapetanios et al. (2003) aimed to combine the two nonlinear and non-stationary fields by investigating ways to distinguish non-stationary linear systems from stationary nonlinear ones.

$$\Delta y_t = \delta y_{t-1}^3 + \eta_t \tag{2}$$

It tests the hypothesis of $H_0 : \delta = 0$ against the hypothesis of $H_1 : \delta < 0$.

Nonlinear unit root test results are shown below.

Table: 3
Nonlinear Unit Root Test

Variables	t statistics
Gold	-1.568
BIST100	-2.387
Exchange rate	1.090
ΔGold	-10.161
ΔBIST100	-9.596
ΔExchange rate	-7.502

** Critical values of 1%, 5% and 10% are stated in the study of Kapetanios et al. (2003) as -3.93, -3.40 and -3.13, respectively.*

As Table 3 shows, the results show that the series are not stationary and have unit roots. For this reason, their first-order differences are taken, after which the series appears to become stationary. Following the unit root test, the causality relationship between the series can be investigated.

Diks & Panchenko (2006) devised a new test to reveal Granger causality because their simulations showed that the Hiemstra-Jones test result was seriously over-rejecting. The presence of the problem, which indicates that the probability of rejection under the null hypothesis may tend to be 1 as the sample size grows, formed the basis of why this has become a research topic to reveal the underlying reasons for such a problem. The analytical examination of the Hiemstra-Jones test has shown that it is biased even though the bandwidth tends to be zero.

DP test is a non-parametric, nonlinear causality test. The residuals from the VAR model estimation are subjected to causality analysis. The test statistics are as follows:

$$T_n(\varepsilon) = \frac{n-1}{n(n-2)} \sum_i \left(\hat{f}_{X,Y,Z}(X_i, Y_i, Z_i) \hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Y_i) \hat{f}_{Y,Z}(Y_i, Z_i) \right) \quad (3)$$

$\varepsilon_n = Cn^{-\beta}$, C is positive, and

$$\beta \in \left(\frac{1}{4}, \frac{1}{3} \right), \ \sqrt{n} \frac{(T_n(\varepsilon_n) - q)}{S_n} \xrightarrow{d} N(0,1) \quad (4)$$

DP test indicates that it converges to normal distribution.

Table: 4
Linear and Non-Linear Causality Test

Causality	Linear Granger Probability Value	Nonlinear Granger Probability Value
Gold is not a Granger cause of exchange rates.	0.8548	0.4393
The exchange rate is not a Granger cause of gold.	0.7567	0.8601
BIST100 is not a Granger cause of the exchange rate.	**0.0012**	**0.0117**
The exchange rate is not a Granger cause of BIST100.	0.3714	0.7362
BIST100 is not a Granger cause of gold.	0.6893	0.4997
Gold is not a Granger cause of BIST100.	0.2589	0.5735

** In the nonlinear causality test, the ε value was specified as 1.50 by drawing on the article by Diks & Panchenko (2006).*

Linear Granger causality test results were also included in this study. Table 4 shows the linear and nonlinear causality test results. Based on the non-linear and linear Granger test results, a unidirectional causality relationship from BIST100 to exchange rates was identified at 1%, 5% and 10% significance levels, respectively. This result supports the studies of Alagidede et al. (2011), Liang et al. (2015), Lou & Luo (2018), Park et al. (2019), Reza et al. (2020), Tran & Nguyen (2022) and Nusair & Olson (2022). The direction of causality also implies the portfolio balance approach.

4. Conclusion

This study aims to reveal the causality relationship between the exchange rate, gold prices and the BIST100 index by using monthly data covering 2003:01-2022:06 in the Turkish economy. The Diks & Panchenko (2006) causality test results revealed a unidirectional causality relationship between BIST100 and exchange rates. The reason for the fluctuating exchange rate is BIST100. An increase in the stock market index will cause foreign investors to enter the stock market, which will cause foreign currency inflows and may cause a change in the amount of foreign currency in the country. Investors (stock market, gold, foreign exchange) may turn to the stock market rather than foreign currency and gold instead of other investment instruments due to the increase in the stock market index in their portfolio. Increasing the weight of the stock market in their portfolio may affect the foreign exchange demand and cause changes in the exchange rate.

The direction of causality implies the portfolio balance approach. This suggests that changes in the economic climate will directly impact bond demand and supply, thereby influencing the exchange rate (Reza et al., 2020).

Similar to the results obtained, Alagidede et al. (2011), Liang et al. (2015), Lou & Luo (2018), Park et al. (2019), Reza et al. (2020), Tran & Nguyen (2022) and Nusair & Olson (2022) can be given. Contrary to the results obtained, Smyth & Nandha (2003), Abdalla & Murinde (1997) and Piccilo (2009) obtained unidirectional causality from exchange rates to stock prices. Özmen (2007) found a bidirectional causality between stock prices and exchange rates and a causality from exchange rates to stock prices.

This study can be expanded for future research with additional financial and macroeconomic variables and nonlinear approaches. Furthermore, different countries can be added, and nonlinear panel estimation techniques (causality, cointegration, etc.) can be used.

References

Abdalla, I.S.A. & V. Murinde (1997), "Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines", *Applied Financial Economics*, 7, 25-35.

Akbar, M. et al. (2019), "Bayesian analysis of dynamic linkages among gold price, stock prices, exchange rate and interest rate in Pakistan", *Resources Policy*, 621, 154-164.

Alagidede, P. et al. (2011), "Causal relationship between stock prices and exchange rates", *The Journal of International Trade and Economic Development*, 20(1), 67-86.

Ali Raza, S. et al. (2021), "Do exchange rates fluctuations influence gold price in G7 countries? New insights from a nonparametric causality-in-quantiles test", *Zagreb International Review of Economics & Business*, 24(2), 37-57.

Alshammari, A.A. et al. (2020), "The impact of exchange rate, oil price and gold price on the Kuwaiti stock market: A wavelet analysis", *The European Journal of Comparative Economics*, 17(1), 31-54.

Bildirici, M.E. et al. (2022), "Nonlinear Contagion and Causality Nexus between Oil, Gold, VIX Investor Sentiment, Exchange Rate and Stock Market Returns: The MS-GARCH Copula Causality Method", *Mathematics*, 10, 4035.

Brock, W. et al. (1996), "A test for independence based on the correlation dimension", *Econometric Reviews*, 15(3), 197-235.

Diks, C. & V. Panchenko (2006), "A New Statistic And Practical Guidelines For Nonparametric Granger Causality Testing", *Journal of Economic Dynamics and Control*, 30(9), 1647-1669.

Fowowe, B. (2014), "The relationship between stock prices and exchange rates in South Africa and Nigeria: structural breaks analysis", *International Review of Applied Economics*, 29(1), 1-14.

Kapetanios, G. et al. (2003), "Testing for A Unit Root in The Nonlinear STAR Framework", *Journal of Econometrics*, 112(2), 359-379.

Kirikkaleli, D. et al. (2018), "The real estate industry in Turkey: a time series analysis", *The Service Industries Journal*, 41(5-6), 427-439.

Liang, C.C. et al. (2013), "Reexamining the relationships between stock prices and exchange rates in ASEAN-5 using panel Granger causality approach", *Economic Modelling*, 32, 560-563.

Liang, C.-C. et al. (2015), "The interactions of stock prices and exchange rates in the ASEAN-5 countries: New evidence using a bootstrap panel Granger causality approach", *Global Economic Review*, 44(3), 324-334.

Lou, T. & W. Luo (2018), "Revisiting quantile granger causality between the stock price indices and exchange rates for G7 countries", *Asian Economic and Financial Review*, 8(1), 9-21.

Miyazaki, T. & S. Hamori (2013), "Testing for causality between the gold return and stock market performance: Evidence for 'gold investment in case of emergency'", *Applied Financial Economics*, 23(1), 27-40.

Nusair, S.A. & D. Olson (2022), "Dynamic relationship between exchange rates and stock prices for the G7 countries: A nonlinear ARDL approach", *Journal of International Financial Markets, Institutions and Money*, 78, 101541.

Özmen, M. (2007), "The Econometrics Analysis of the Relationship between Stock Prices and Exchange Rates under Different Exchange Rate Regimes", *Journal of Çukurova University Institute of Social Sciences*, 16(1), 519-538.

Özmen, M. et al. (2017), "The Effects of Exchange Rate, Interest Rate and Inflation on Stock Returns for Turkey", *Journal of Cukurova University Faculty of Economics and Administrative Sciences*, 21(1), 107-120.

Park, Y. et al. (2019), "Time-varying correlations and causalities between stock and foreign exchange markets: evidence from China, Japan, Korea", *Invest Anal J*, 48(4), 278-297.

Parsva, P. & C.F. Tang (2017), "A note on the interaction between stock prices and exchange rates in Middle-East economies", *Economic Research-Ekonomska Istraživanja*, 30(1), 836-844.

Partalidou, X. et al. (2016), "The impact of Gold, Bond, Currency, Metals and Oil markets on the USA stock market", *International Journal of Energy Economics and Policy*, 6(1), 76-81.

Piccillo, G. (2009), "Foreign exchange and stock market: Two related markets?", *Discussion Paper Series*, Center for Economic Studies, 1-44.

Reza, F. et al. (2020), "Causality between exchange rate and stock prices: evidence from ASEAN-5 countries", *International Journal of Finance, Insurance and Risk Management*, 10(2), 17-33.

Rutledge, R.W. et al. (2014), "A Study of the Relationship between Renminbi Exchange Rates and Chinese Stock Prices", *International Economic Journal*, 28(3), 381-403.

Şanlı, S. et al. (2021), "Econometric Analysis of the Relationship Among Interest Rate, Exchange Rate, Gold Prices and ISE100 Index: An Application on Turkey", *İzmir Journal of Economics*, 36(4), 928-948.

Smyth, R. & M. Nandha (2003), "Bivariate causality between exchange rates and stock prices in South Asia", *Applied Economics Letters*, 10, 699-704.

Tien, H.T. (2022), "Oil price shocks and Vietnam's macroeconomic fundamentals: quantile-on-quantile approach", *Cogent Economics & Finance*, 10(1), 2095767.

Tran, O. & H. Nguyen (2022), "The interdependence of gold, US dollar and stock market in the context of COVID-19 pandemic: an insight into analysis in Asia and Europe", *Cogent Economics & Finance*, 10(1), 2127483.

Yang, Z. et al. (2014), "Dynamic linkages between Asian stock prices and exchange rates: new evidence from causality in quantiles", *Applied Economics*, 46(11), 1184-1201.

Yildirim, H. et al. (2021), "The causal nexus of interest rate policy and gold market: The case of Turkey", *J Public Affairs*, 21, e2142.

Zeren, F. & M. Koç (2016), "Time-varying causality between stock market and exchange rate: evidence from Turkey, Japan and England", *Economic Research Ekonomska Istraživanja*, 29(1), 696-705.