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LINKAGES BETWEEN STOCK PRICE AND SELECTED ECONOMIC VARIABLES IN TURKEY: EVIDENCE FROM COINTEGRATION IN STAR

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ABSTRACT

After globalization, all the markets in the world are known as competitive fields, and accordingly, economic interactions emerge more strongly. Similarly, national and international economic variables can affect the Istanbul stock market. This study analyses the relationship between stock price and some selected economic variables using cointegration in STAR, Maki (2010), and KSS (2006) in Turkey from January 2000 to June 2019. Because of the difference between the results of the Maki (2010) and KSS (2006) test, it has been tried to find the model that has less constraint, and then this model has been used to analyze these relationships. Our findings support the long-run relationship between stock price and other economic variables with STAR adjustment. Findings also show that adjusting the relationship between stock price, gold price, and exchange rate take much time, while adjusting the relationship between stock price, interest rate, and inflation does not take much time. Moreover, there is a long-run causality between stock price and other variables except for interest rate. Estimating the adjustment speed of the relationship can be helpful for portfolio management and also financial risk management.

Keywords: Stock Price, Nonlinear Cointegration, The Adjustment Speed

Jel codes: C13, C22, C49.

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TÜRKİYE'DE HİSSE SENEDİ FİYATLARI İLE SEÇİLMİŞ EKONOMİK DEĞİŞKENLER ARASINDAKİ İLİŞKİLER: STAR EŞBÜTÜNLEŞME TESTİ BULGULARI

ÖZ

Küreselleşme sonrasında dünyadaki tüm piyasalar rekabet alanı olarak bilinmekte ve buna bağlı olarak ekonomik etkileşimler daha güçlü bir şekilde ortaya çıkmaktadır. Benzer şekilde, Borsa İstanbul da hem ulusal hem de uluslararası ekonomik değişkenlerden etkilenebilmektedir. Bu çalışma, Türkiye ekonomisi Ocak 2000-Haziran 2019 dönemi hisse senedi fiyatları ile bazı seçilmiş ekonomik değişkenler arasındaki ilişkiyi STAR tipi eşbütünleşme testi, Maki (2010) and KSS (2006) ile analiz etmektedir. Maki (2010) ve KSS (2006) test sonuçları arasındaki farklılıktan dolayı daha az kısıta sahip olan model bulunmaya çalışılmış ve seçilmiş olan model bu ilişkilerin analizinde kullanılmıştır. Bulgularımız, hisse senedi fiyatları ile diğer ekonomik değişkenler arasında STAR düzeltme ile uzun dönemli bir ilişkinin varlığını desteklemektedir. Ayrıca bulgular hisse senedi fiyatları ile altın fiyatı ve döviz kuru arasındaki ilişki düzeltmesinin çok zaman aldığını ve hisse senedi fiyatı ile faiz oranı ve enflasyon arasındaki ilişki düzeltmesinin çok zaman almadığını göstermektedir. Faiz oranı dışında, hisse senedi fiyatı ile diğer ekonomik değişkenler arasında uzun dönemli nedensellik bulunmaktadır. Dengeye dönme hızının tahmin edilmesi, Portföy Yönetimi ve ayrıca Finansal Risk Yönetimi için yararlı olabilir.

Anahtar Kelimeler: Hisse Senedi Fiyatı, Doğrusal Olmayan Eşbütünleşme, Düzeltme Hızı.

Jel Kodları: C13, C22, C49.

INTRODUCTION

Since 1980, Turkey has started economic reforms to liberalize the economy and participate in the global economy. These reforms include: reforming the floating exchange rate policy, import liberalization laws, increasing exports, encouraging foreign investment, establishing free trade zones, removing government surveillance of money markets and privatizing economic institutions. Thus, Turkey has created independent foreign investment laws without discrimination between foreign and local investors; stable and rapid economic growth emerged due to these economic reforms. Thus, these developments cause the growth of the Turkish capital market (Oktayer, 2009: 74-75).

Like many developing markets, the Turkish financial market has proliferated due to several reforms. As a result of these internal reforms and favorable global financial conditions, Turkey's volume of foreign capital inflows has increased. The globalization of the Turkish economy, however, has resulted in the Turkish foreign exchange market becoming more volatile and sensitive to external factors.

The higher volatility of the real exchange rate increases investment risk and raises concerns about the impact of Turkish lira movements on the stock market. Thus, stock markets and foreign exchange markets influence domestic macroeconomic performance.

Theoretically, two approaches are developed to explain the dynamic relationship between stock and foreign exchange markets. The first approach was proposed by Dornbusch and Fisher (1980). This approach explains the effects of exchange rates changes on the stock prices of export-oriented firms. The appreciation of the domestic currency negatively affects the export competitiveness of the country and decreases the stock prices of export-oriented firms. According to this approach, the relationship between the stock price and the exchange rate depreciation is positive.

However, for an import-oriented country like Turkey, where intermediate input for domestic manufacturing firm's products is primarily imported, the high cost of production arising from the depreciation of the domestic currency cause lower stock prices.

The portfolio approach theory developed by Frankel (1983), as the second approach, explains the effect of stock prices on the exchange rate. This theory is about the vital role of wealth (income) in determining the exchange rate. The higher stock prices tend to increase wealth (income). Thus, it leads to a positive effect on domestic currency demand and interest rates. Increasing the interest rate makes the country more attractive to foreign investors, and then the demand for domestic currency increases, which will appreciate the domestic currency. According to this approach, there is a negative relationship between stock prices and exchange rates.

Turkey is the fourth gold consumer globally, and its global gold demand was about 6% in 2018. It is estimated that at least 3,500 tons of gold are physically accumulated and stored in Turkish households. There is a relationship between gold demand and income in Turkey. When income increases, gold demand also increases because people prefer to save some of their rising income in gold. Another reason to save gold is to hedge against inflation. Gold is part of the Turkish Central Bank policy at the financial system center. The Turkish Central Bank implements the reserve option mechanism (ROM) as a monetary policy. According to ROM, commercial banks should hold some of their domestic currency reserves in either gold or foreign currency. This policy has caused gold reserves to increase and mobilized Turkey's stock of gold. Thus, fluctuations in gold prices have an impact on the stock market and other macroeconomic variables (Akkoca, 2019:231-232).

Monetary policy tools are used to stabilize the economy. As an important monetary policy tool, the interest rate considers inflation, investment level, and exchange rate fluctuations directly related to the domestic gold price. Monetary authorities must control these fluctuations by interest rates. For monetary policymakers, the changes in the exchange rate are as significant as the changes in the gold price in the domestic market. It has been determined that controlling these fluctuations in the exchange rate and gold prices by changing the interest rate affects the stock market. Thus, domestic gold price, stock prices, exchange rate, and interest rate are essential variables for both policymakers and portfolio managers.

As a result of globalization, all global markets are a competitive field, and economic interactions may emerge more strongly. The stock market can be affected by both national and international economic events. Therefore, economists, policymakers, and even investors need to know the behavior of stock prices and what factors are affected.

Since the equilibrium relationship among economic variables is often characterized by nonlinear adjustment toward equilibrium, the use of standard cointegration misleads the result (Balke, Fomby, 1997:630). Nonlinear models have recently attracted much attention, whereas there is no consensus on suggesting a unique approach for specifying econometric models. Maki (2012) demonstrated that the cointegration test with threshold adjustment usually performs better than other nonlinear cointegration relationships. We decided to use the threshold cointegration test in light of this finding. Among threshold models, the STAR model is more compatible with economic structures. That is why this model has become more prevalent in econometric studies. Thus, we focus on the cointegration test with STAR adjustment in this study. We used Maki’s (2010) cointegration test, which is not seen in the literature and was applied here with the code we wrote.

This article is organized as follows: Section 1 reviews the related literature. The empirical methodology and the data are presented in Sections 2 and 3, respectively. The results in Section 4 are discussed. The conclusion can be found in Section 5.

I. LITERATURE

Many studies analyzed the relationships between stock price, gold price, exchange rates, and other macroeconomic variables for different economies. We have considered the studies evaluating these relationships with the nonlinear model because standard cointegration tests perform poorly when a cointegration relationship has nonlinear adjustment.

Prats and Esteve (2010), Hansen and Seo (2002) analyzed the relationship between US market stock price and macroeconomic variables using the threshold cointegration test. It was determined that these relationships were not linear.

In their studies of the Turkish economy and the Pakistani economy, Coşkun and Köresel (2016) and Mehar and Arshad (2018) respectively, used the Autoregressive Distributed Lag (ARDL) cointegration test, Engel-Granger test, and impulse-response function to examine the relationship between stock prices and several economic variables. They showed that there is a unidirectional relationship between stock price and selected economic variables.

Tursoy and Faisal (2018) have evaluated the relationship between gold and oil price with stock price for the Turkish economy. They found the relationship between oil price and stock price is positive, and the relationship between the gold price and stock price is negative by using (ARDL) model and Fully Modifies Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Correlation Regression (CCR) cointegration.

Tursoy (2017) investigated the linkage between stock price and exchange rate using the ARDL and Error Correction models. It is found that there is a strong long-run cointegration and also unidirectional causality from the real exchange rates to the stock prices based on the Granger causality test. Tursoy (2019) also applied ARDL and vector autoregressive cointegration test to examine the relation between stock price and interest rate for the Turkish economy. The study showed that two variables are related.

Akkoc and Civcir (2019) used the Structural Vector Auto Regression -Dynamic Conditional Correlation - Generalized Autoregressive Conditional Heteroscedasticity SVAR-DCC-GARCH model to investigate the relationship between oil and gold prices with stock returns. They focused on the volatility in the stock returns, and it was revealed that the gold price affects this volatility more strongly than the oil price.

Singhal et al. (2019) used the ARDL model to determine the relationship between stock price and gold price for the Mexican economy. They concluded that while the gold price positively affects Mexico's stock price, the oil price affects them negatively.

Kassouri and Altıntaş (2020) showed a nonlinear relationship between stock price and exchange rate for the Turkish economy by using the nonlinear ARDL cointegration.

Kumar et al. (2021) examined the nexus among natural gas price, crude oil price, gold price, exchange rate, and stock market index in Indian context using the NARDL model on weekly data for the time period of January 1997 to June 2019. The result of the study confirmed the presence of asymmetries in the short and long-run among these asset classes.

Ürkmez and Bölükbaşı (2021) investigated the impact of exchange rates on stock indices for Turkey and examined whether these impacts are asymmetric. According to the result of NARDL model, the impacts of exchange rate movements on the BIST-100 are asymmetrical.

Nusair and Olson (2022) employed linear and nonlinear ARDL models to examine the short-run and long-run relationship between stock prices and exchange rates in the G7 countries. The nonlinear ARDL model showed evidence supporting the portfolio balance approach in four of the countries. Moreover, Granger causality tests confirmed that causality runs from stock prices to exchange rates in six of the countries.

İlkhan et al. (2022) investigated the relationship between gold prices, US dollar and BIST 100 index in Turkey by using Maki (2012) cointegration and ARDL bound tests. According to the result of this study there was a long-term relationship between USD and BIST100 variables, while there was cointegration between gold prices and BIST100.

The literature on the Turkish stock price, gold price, and the exchange rate are scarce. Recent studies on this issue generally confirmed that the relationships between stock price and determining variables are not linear and there are the long run relationship between these variables. So, most of them used the nonlinear ARDL cointegration test and focused on the sign of these relationships. The present study is different from the previous studies because of employing the STAR type of cointegration and considering the speed of adjustment. Additionally, Maki (2010) cointegration test has not been used in any article as far as we have access.

II. METHODOLOGY

Before implementing the cointegration test, it is crucial to determine the order of integration and structure of variables by testing the linearity of the series. The present study utilized the Tsay (1986) and Luukkonen, Saikkonen, Terasvirta (1988) Linearity Test to identify whether wheatear series are linear or not. Based on the result of these tests, we chose the nonlinear cointegration with STAR adjustment. Therefore, two different types of STAR adjustment cointegration tests were applied and analyzed this mentioned relationship according to the better adjustment model.

A. LINEARITY TESTS

The steps of Tsay (1986) test can be listed as follows:

1- Error terms are obtained by establishing a regression between y_t and its lagged values.

2- Here, the vector z_t is derived from the cross-elements of the y_t observations. z_t is expressed as follows:

z_t^T = V $(U_t^T U_t)$

$U_t = (y_{t-1}, \dots, y_{t-M})$

3- A regression is generated between residuals X_t obtained in the second step and $\hat{e}_t$ obtained in the first step as follows.

$\hat{e}_t = \hat{X}_t \beta + \varepsilon_t$

4- The test statistic is below:

$$F = \frac{\frac{(\sum \hat{x}_t \hat{e}_t)\left(\sum \hat{x}_t^T \hat{x}_t\right)^{-1}\left(\sum \hat{x}_t^T \hat{e}_t\right)}{m}}{(\sum \hat{\varepsilon}_t^2)/\,(n-M-\,m-1)}$$

Here the null hypothesis is expressed by β= 0.

In Luukkonen, Saikkonen, Terasvirta (1988) Linearity Test, a STAR model for a time series y_t is shown like this:

$y_t + \pi_0 + w_t \pi' + (\theta_0 + \theta' w_t) F(z_t) = \varepsilon_t$

z_t is expressed in z_t = $\gamma(\alpha' w_t$-c). γ, α, and c are nuisance parameters. To avoid the problem of nuisance parameters, F(.) has been replaced with a suitable linear approach. Thus, the regression used in this test is as follows:

$y_t + \alpha_0 + w_t \alpha' + \sum_{i=1}^{p} \sum_{j=1}^{p} \emptyset_{ij}\, y_{t-i} y_{t-j} = \eta_t$

The hypotheses are written as below:

H_o': $\emptyset_{ij}$= 0

H_1': $\emptyset_{ij} \neq 0$

Here, the test statistic based on the χ^2distribution is as follows:

S_1 = T (SEE_0- SEE_1)/ SEE_0

Then, SEE_0 = $\sum \hat{\varepsilon}_t^2$ and SEE_1 = $\sum \hat{\eta}_t^2$.

B. KSS (2003) UNIT ROOT TEST

In this paper, the nonlinear unit root test was employed is KSS(2003). This test is based on ESTAR model. ESTAR model is expressed as follows:

$$\Delta y_t = \gamma y_{t-1}[1 - \exp(-\theta y_{t-d}^2)] + \varepsilon_t$$

According to this equation, the null hypothesis is $\theta = 0$. It is impossible to test this null hypothesis directly because γ parameter is not defined under the null hypothesis. To solve this problem, auxiliary regression is used. This regression is obtained by applying the first-order Taylor series to the ESTAR model as below:

$$\Delta y_t = \delta y_{t-1}^3 + \varepsilon_t$$

Therefore, the hypotheses are as follows:

$H_0 : \delta = 0$

$H_1 : \delta < 0$

The null hypothesis of unit root and the alternative hypothesis implies the nonlinear stationary with the ESTAR model.

C. KSS (2006) COINTEGRATION TEST

Kapetanios, Shin and Shell (KSS, 2006) cointegration test investigates the cointegration relationship with Smooth Transition Autoregressive (STAR) adjustment. This cointegration test is based on an Error Correction Model. KSS (2006) Error Correction Model with Smooth Transition Autoregressive model is as follows:

$$\Delta y_t = \phi u_{t-1} + \gamma u_{t-1}[1 - \exp(-\theta u_{t-1}^2)] + \omega' \Delta x_t + \sum_{i=1}^{p-1} \varphi_i' \Delta z_{t-1} + \varepsilon_t$$

Where $z_t = (y_t, (x_t)')'$ and θ = 0 is the null hypothesis of no cointegration. Because of the undefined parameters, the first-order Taylor approach is used. With the assumption ϕ = 0 the obtained auxiliary regression is expressed as follows:

$$\Delta y_t = \delta \hat{u}_{t-1}^3 + \omega' \Delta x_t + \sum_{i=1}^{p-1} \varphi_i' \Delta z_{t-1} + \varepsilon_t$$

Based on this equation, $\delta = 0$ will be the null hypothesis versus $\delta > 0$, the alternative hypothesis. Here, the null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration with ESTAR adjustment.

D. MAKI (2010) COINTEGRATION TEST

An alternative procedure to test for cointegration with STAR adjustment is proposed by Maki (2010). Because the standard cointegration tests have low power, new cointegration tests with nonlinear adjustment were provided. In fact, economic variables are often characterized by nonlinear adjustment toward equilibrium. Maki (2010) cointegration test is based on exponential STAR (ESTAR) and double logistic STAR (D-LSTAR) models.

Maki (2010) used the following regression model to test the cointegration with STAR adjustment.

$y_t = \beta' X_t + u_t$ t = 1, 2, …, T

y_t and x_t' represent the I (1) variables. $\beta' = (\beta_1, \dots, \beta_m)$ is the estimated parameters. u_t is the equilibrium error. z_t, as a vector (n× 1), is assumed to be generated in $z_t = (y_t, x_t')' = z_{t-1} + \varepsilon_t$. ε_t is a zero mean iid innovations.

By using residues (u_t) which derived from the above regression, STAR type cointegration can be tested. The following regression is considered:

$\hat{u}_t = y_t - \hat{\beta}' x_t$

$\Delta\hat{u}_t = \rho u_{t-1} F(.) + \sum_{j=1}^{p} \Psi_j \Delta\hat{u}_{t-j} + \varepsilon_t$

F (.) is a smooth transition function of u_{t-1}. Maki (2010) used three transition functions as follows:

$F(u_{t-1}; \gamma) = 1 - \exp\{-\gamma u_{t-1}^2\}$

$F(u_{t-1}; \gamma, c) = 1 - \exp\{-\gamma (u_{t-1} - c)^2\}$

$F(u_{t-1}; \gamma, c_1, c_2) = (1 + exp\{-\gamma (u_{t-1} - c_1)(u_{t-1} - c_2)\})^{-1}$

γ determines the smoothness of functions. c , c_1 and c_2 are the threshold between the regimes. It is assumed that $\gamma > 0$ ve $c_1 > c_2$. The first and second equations are the Exponential Smooth Transition Autoregressive (ESTAR) model. The third equation is the double logistic transition (LSTAR) model. The hypotheses are as follows.

$H_0: \ \rho = 0$ no cointegration

$H_1: \ \rho < 0$ cointegration with STAR adjustment.

F (·) has nuisance parameters under the null hypothesis. In ESTAR model γ, in ESTAR-c model (γ, c), and in D-STAR model (γ, c_1, c_2) are nuisance parameters. These parameters are determined only under the alternative hypothesis. First-order Taylor expansion is used to overcome this problem. In Maki's study, the t-statistics of ρ is computed for each possible nuisance parameter, and the minimum value across all possible nuisance parameters is considered a test statistics. Thus, the infimum type test statistics used are defined as follows:

$$\inf_{\gamma \epsilon \Gamma_T} t_T(\gamma) = \inf_{\gamma \epsilon \Gamma_T} \frac{\hat{\rho}}{s.e.(\hat{\rho})}$$
$$\inf_{(\gamma,c) \epsilon \Gamma_T \times c_T} t_T(\gamma, c) = \inf_{(\gamma,c) \epsilon \Gamma_T \times c_T} \frac{\hat{\rho}}{s.e.(\hat{\rho})}$$
$$\inf_{(\gamma,c_1,c_2) \epsilon \Gamma_T \times c_{1T} \times c_{2T}} t_T(\gamma, c_1, c_2) = \inf_{(\gamma,c_1,c_2) \epsilon \Gamma_T \times c_{1T} \times c_{2T}} \frac{\hat{\rho}}{s.e.(\hat{\rho})}$$

Where $\hat{\rho}$ is the OLS estimate of ρ; s.e. is the standard error of the $\hat{\rho}$; and Γ_T, c_T, c_{1T} and c_{2T} are random sequences of the parameter space given by the functions of $(\hat{u}_1, \dots, \hat{u}_T)$.

Maki (2010) presents three models; model 0 contains no deterministic terms, Model 1 contains a constant term, and Model 2 contains both constant and trend. These three models are expressed as follows:

Model 0: $\hat{u}_t = y_t - \hat{\beta}' x_t$

Model 1: $\hat{u}_t = y_t - \hat{\mu} - \hat{\beta}' x_t$

Model 2: $\hat{u}_t = y_t - \hat{\mu} - \hat{\delta} t - \hat{\beta}' x_t$

In order to make more sense to compare Maki (2010) and KSS (2006), we consider the ESTAR and ESTAR-c type of transition function of Maki (2010) due to these two transition functions containing two regimes.

III. DATA

Now we want to examine the relationship between the exchange, stock markets, and gold markets of Turkey for the new century. As an emerging economy, the Turkish economy has been impacted by two decades of reforms from the beginning of the 21st century and has made significant progress. This study includes the international price of the Borsa Istanbul Stock Index (BIST), gold (USD/troy ounce), exchange rate, interest rate, and inflation rate variables between 2000M01 to 2019M06 monthly data. The stock price data from the OECD database, inflation data from the Central Bank of the Republic of Turkey have been obtained. Other data has been taken from the International Monetary Fund. We used the logarithm values of these variables.

IV.RESULTS and DISCUSSION

First of all, the stationary properties of the variables were tested by linear unit root tests such as Augmented Dickey-Fuller (ADF), and Phillips-Perron, and stationarity test of the KPSS. Table 1 indicates the result of the linear unit root test. According to this, all variables are non-stationary at level. Also Table 1 shows that all the first differenced series are stationary. The series should be nonlinear to use the nonlinear cointegration test. In order to determine whether the series are nonlinear or not, we used Tsay (1996) and Luukkonen, Saikkonen and Terasvirta (1988) linearity tests. Then, to determine the order of integration for nonlinear series is necessary to use the nonlinear unit root test.

Table 2 reports the result of linearity tests. Based on the probability values, the null hypothesis of linearity is rejected. Thus all series are nonlinear. Because of this, we employed the nonlinear unit root. In this study was used the KSS (2003) unit root test. This test is based on the ESTAR model.

Table 1: Unit root test

	ADF Test		KPSS Test		PP Test	
Variable	Intercept	Trend	Intercept	Trend	Intercept	Trend
lgold	-1.45 (0.55)	-0.58 (0.97)	1.77	0.43	-1.41(0.57)	-0.69(0.97)
lexchang	-0.80(0.81)	-1.75(0.72)	1.65	0.41	-0.85(0.80)	-1.82(0.68)
lstock	-0.80(0.81)	-2.37(0.39)	1.82	0.25	-0.83(0.80)	-2.38(0.38)
linflation	-1.92(0.32)	-1.98(0.60)	0.99	0.38	-1.95(0.30)	-1.98(0.60)
linterest	-1.14(0.69)	-2.80(0.19)	1.96	0.09	-2.16(0.21)	-8.7(0.00)
dlgold	-12.88(0.00)	-12.90(0.00)	0.34	0.13	-12.90(0.00)	-12.69(0.00)
dlexchang	-10.19(0.00)	-10.17(0.00)	0.17	0.17	-10.31(0.00)	-10.29(0.00)
dlstock	-10.86(0.00)	-10.84(0.00)	0.08	0.08	-13.01(0.00)	-12.98(0.00)
dlinflation	-14.38(0.00)	-14.37(0.00)	0.09	0.04	-14.37(0.00)	-14.36(0.00)
dlinterest	-3.97(0.00)	-3.97(0.01)	0.30	0.13	-54.24(0.00)	-57.41(0.00)

Note: Values in parenthesis represent the p-values.

Table 2: Linearity test

	lgold	lexchang	lstock	linflation	linterest
LST Test	2.34(0.00)	4.59(0.00)	1.77(0.04)	3.33(0.00)	2.60(0.00)
Tsay Test	2.44(0.00)	4.28(0.00)	1.39(0.1)	3.85(0.00)	3.50(0.00)

Note: Values in parenthesis represent the p-values.

The statistical values shown in Table 3 were compared with the KSS (2003) critical values. If the computed statistics value lies above the critical values, the null hypothesis of no unit root is not rejected. Therefor, all series contain unit-root at levels. This satisfies the condition for testing the nonlinear cointegration.

Table 3: KSS Nonlinear unit root test

Variable	Raw	Demeaned	Demeaned and detrend
lgold	1.82 (1)	-1.13(1)	-1.25(1)
lexchang	1.17(2)	-1.38(1)	-3.13(1)
lstock	0.73(1)	-1.82(1)	-3.46(1)
linflation	-1.74(12)	-1.38(12)	-1.25(12)
linterest	-1.97(12)	-4.44(12)	-3.35(12)

Note: Values in parenthesis are the lag length. *, ** and *** indicate %1, %5 and %10 significant level.

Then KSS (2006) cointegration test with STAR adjustment was applied. The null hypothesis of the KSS (2006) tests is that there is no long-run relationship between series. Table 4 shows, this test has been applied for three different models (raw, demeaned, detrend). From the result of Table 4, we can find out that there is a long-run relationship only between stock price with the exchange rate and interest rate in the case of raw data. Nonetheless, there is a long-run relationship between stock price and gold price in the detrend model, and there is no relationship between stock price and inflation.

Table 4: Nonlinear cointegration test

KSS (2006) cointegration test			
Variable	Raw	Demeaned	Detrend
lgold-lstock	-2.31(2)	-2.50(2)	-3.06(2)**
lexchang-lstock	-2.80(3)*	-2.33(3)	-3.12(1)
linflation-lstock	-1.96(1)	-1.16(1)	-3.40(2)
linterest-lstock	-4.18(3)***	-0.49(6)	-2.42(1)

Note: Values in parenthesis represent the lag length. *, ** and *** indicate %1, %5 and %10 significant level.

Maki (2010) cointegration test as an alternative test considers three different transition STAR types: ESTAR, ESTAR-c, and D-LSTAR models. In this study, we took into account ESTAR and ESTAR-c transition functions because of having two regimes. The transition function used in KSS (2006) test has also two regimes.Three different models without deterministic terms, with constant, and with constant and trends are considered for each transition function in Maki (2010).

The null hypothesis of this test also means no cointegration, and the alternative hypothesis means cointegration with STAR adjustment.

The result of Maki (2010) cointegration test based on the ESTAR model is presented in Table 5. It is found that a long-run relationship exists between stock price and other variables. Since the transition function is ESTAR, the threshold value, c, is zero. Here the parameter γ refers to the smoothness of the transition function. If γ takes the larger value, the transition speed will be higher. The transition function is for u_{t-1} variable. When $u_{t-1}$is the threshold value, transition function will be zero. Thus, the ESTAR model contains a unit root. In other words, there will be no long-run equilibrium relationship. If u_{t-1} has a higher deviation from the threshold, u_t tends to return to equilibrium. The adjustment speed is higher regarding the relationship between stock price and interest rate. However, the equilibrium relation between stock price and inflation takes a long time to adjust. The long-run relationship with ESTAR-c adjustment is shown in table 5. This table contains the transition speed, threshold value, and lag length values. When the transition function is ESTAR-c, there is a long-run relationship between stock price and other variables for the three models.

In ESTAR-c, the adjustment of the relationship between stock price and inflation occurs at high speed. Despite that, the adjustment speed of the relationship between the gold price and the stock price is low.

Table 5: Maki (2010) cointegration test

ESTAR				
	lgold-lstock	lexchange-lstock	linflation-lstock	linterest-lstock
Non	-3.30 (25,12)**	-4.16 (13,11)***	-4.20 (3,12)***	-3.03 (820,12)**
Intercept	-3.30 (26,12)*	-4.16 (13,11)**	-4.43 (3,12)***	-3.06 (245,12)
Intercept and trend	-3.30 (26,12)*	-4.20 (14,11)*	-4.24 (3,11)	-3.21 (4,12)
ESTAR-c				
	lgold-lstock	lexchange-lstock	linflation-lstock	linterest-lstock
Non	-3.55 (1,-5,12)**	-5.77 (2,-3,10)***	-3.72 (967,1,12)***	-3.37 (683,1,11)**
Intercept	-3.55 (1,-5,12)**	-5.79 (2,-3,10)***	-3.75 (1054,1,12)**	-3.43 (350,1,11)*
Intercept and trend	-3.96 (1,-5,12)*	-4.90 (4,0,12)***	-3.72 (1053,1,12)*	-3.51 (1039,1,12)

Note: Value in parenthesis in ESTAR are gamma and lag length. Value in parenthesis in ESTAR-c are gamma, threshold value and lag length. *, ** and *** indicate %1, %5 and %10 significant level.

Table 6 shows the estimation of the ESTAR Error Correction Model. The ESTAR Error Correction Model is expressed as follows:

$$\Delta y_t = \delta \hat{u}_{t-1}^3 + \omega' \Delta x_t + \sum_{i=1}^{p-1} \varphi_i' \Delta z_{t-1} + \varepsilon_t$$

Here, δ indicates the error correction terms. The significance and the value of the error correction parameters are important. According to Table 6, the error correction term associated with the relationship between stock price and gold price is significant, and it takes -0.17 value. Thus, the error correction mechanism works, and it is expected that 17% of the disequilibrium can be corrected in a period. The error correction parameter regarding the stock price, exchange rate and stock price, inflation is significant. The estimated value of the related parameters is -0.01. Therefore, 1% of the disequilibrium can be adjusted in a period. In the case of stock price and interest rate, the error correction mechanism does not work because this error correction parameter is not significant. Therefore, there will be no long-run causality between the two variables.

Thus, it has been determined that there is a long-run causality between the stock price and the gold price, the exchange rate and the inflation rate. The error correction term indicates the speed of adjustment. Based on this, the speed of adjustment related to the relationship between stock price and gold price is higher than other relationships.

Table 6: ESTAR Error Correction Model

Parameters	lgold-lstock	lexchange-lstock	linflation-lstock	linterest-lstock
δ	-0.17(0.03)*	-0.01(0.01)*	-0.01(0.04)*	-0.004(0.70)
ω	0.17(0.20)	-0.87(0.00) ***	-0.07(0.12)	-0.10(0.00)***
φ_{1x}	0.09(0.47)	0.44(0.00) ***	0.008(0.87)	-0.04(0.04)*
φ_{2x}	0.11(0.38)	-0.04(0.69)	0.05(0.24)	-0.01(0.61)
φ_{1y}	0.18(0.00) ***	0.19(0.00) ***	0.18(0.00) ***	0.22(0.00)***
φ_{2y}	-0.09(0.15)	0.03(0.61)	-0.09(0.13)	-0.17(0.00)***

Note: Values in parenthesis represent the p-values. *, ** and *** indicate %1, %5 and %10 significant level.

The main difference between KSS (2006) and Maki (2010) tests is to resolve the identification problem of nuisance parameters. As mentioned before in KSS (2006) test, the first-order Taylor expansion is used to overcome this problem. Thus, the test statistic is obtained without the parameters of the transition function. However, the method used in Maki (2010) is based on a grid search to resolve the estimation problem of nuisance parameters. These parameters are defined only under the alternative hypothesis. That is why an infimum-type statistic was used in Maki'sapproach.

Accordingly, the main advantage of Maki (2010) test is the method used to resolve the problem of nuisance parameters. The test statistics were calculated by considering all possible threshold and transition parameters in this test. On the other hand, the test statistics were calculated without any constraint on the parameters of the transition function. Therefore, Maki (2010) test is more acceptable compared to KSS (2006) test. In Maki (2010) test, the ESTAR model threshold value was considered zero, whereas, in the ESTAR-c model, the threshold value was endogenously determined. In both ESTAR and ESTAR-c models, transition speed was also estimated.

According to the Maki (2010) result in the case of ESTAR-c, it was found that there is a long-term equilibrium relationship with STAR adjustment between stock price and gold price, exchange rate, interest rate and inflation in the Turkish economy. It has been determined that the adjustment speed of the long-term equilibrium relationship between stock price and inflation and interest rate is high, while the adjustment speed of the equilibrium relationship between stock price, gold price and the exchange rate is low. The adjustment speed indicates how long the disequilibrium takes to return to equilibrium. When the adjustment speed is low, returning to equilibrium takes a long time. Therefore, adjusting the long-run relationship between stock price and gold price and exchange rate takes much time, whereas adjusting the long-run relationship between stock price and inflation and interest rate does not take much time.

CONCLUSION

This study analyzes the long-run relationship with STAR adjustment between stock price and some selected economic variables in Turkey. For this purpose, exchange rate, gold price, inflation rate, and interest rate variables were considered from January 2000 to June 2019. After determining that the series are nonlinear by employing Tsay (1986) and Uukkonen, Saikkonen, Terasvirta (1988) tests, KSS (2003) nonlinear unit root test has been utilized to determine whether the condition is satisfied for using nonlinear cointegration. Cointegration in the STAR model, such as Maki (2010) and KSS (2006) tests, was used to examine these relationships. Most Previous studies on this issue used nonlinear ARDL cointegration and the Granger causality test and considered the sign of these relationships, but there is no consensus. This study is different from other studies due to using coıntegration in the STAR model and considering the adjustment speed.

Our findings show that the KSS (2006) and Maki (2010) tests differ. The main reason for the difference between these two tests is the method used to resolve the problem of nuisance parameters. To do so, KSS (2006) used the first-order Taylor expansion, and Maki (2010) used infimum-type statistics. Thus, in Maki's approach, the parameters of the transition function are calculated without any constraints. Accordingly, Maki's method is more acceptable. As a result of the Maki (2010) test, there is a long-run equilibrium between stock price and all selected economic variables. So, this study confirms the result of recent studies. In Maki (2010) test, the threshold value was considered zero in the ESTAR model, whereas, in the ESTAR-c model, the threshold value was endogenously determined. Therefore, the ESTAR-c model of Maki (2010) has been used to analyze these relationships.

Based on the result of the ESTAR-c model, the adjustment speed of the long-run relationship between stock price and gold price and the exchange rate is slow, whereas the adjustment speed of the long-run relationship between stock price and inflation and interest rate is high. So, estimating the speed of return to equilibrium can be helpful for portfolio management, as well as financial risk management. since gold price, exchange rate and stock price act together in the long run, it is not reasonable to invest in three assets to minimize the risk and diversity the portfolio. As the result of the ESTAR Error Correction Model, the long-run causality between stock price and other variables except interest rate was confirmed.

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