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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

THE IMPACT OF EXCHANGE RATES ON STOCK PRICES FOR TURKEY: AN ASYMMETRIC NON-LINEAR COINTEGRATION ANALYSIS

TÜRKİYE İÇİN DÖVİZ KURLARININ HİSSE SENEDİ FİYATLARINA ETKİSİ: ASİMETRİK DOĞRUSAL OLMAYAN EŞBÜTÜNLEŞME ANALİZİ

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Abstract

This study investigates the impact of exchange rates on stock indices for Turkey and examines whether these impacts are asymmetric. For this purpose, the non-linear autoregressive distributed lag (NARDL) model is used as an asymmetric cointegration method. In the study covering the period 2005-2020, BIST-100, BIST-100 All Shares and four stock sector indices are included in the models as stock indices representing. Thus, the response of the stock indices of the firms in different sectors to the movements in exchange rates is analyzed. The findings indicate that the impacts of exchange rate movements on the BIST-100 All Shares index and the service, industry, and technology sector indices in the short-term are asymmetrical, and the impacts on the technology sector index in the long-term are asymmetrical.
Keywords: Sectoral Stock Indices, Exchange Rate, Asymmetry Cointegration
JEL Classification: C52, C58, G10

Öz

Bu çalışma döviz kurlarının Türkiye için hisse senedi fiyatları üzerindeki etkisini araştırmakta ve bu etkilerin asimetrik olup olmadığını incelemektedir. Bu amaçla doğrusal olmayan otoregresif dağıtılmış gecikme (NARDL) modeli, asimetrik eşbütünleşme yöntemi olarak kullanılmıştır. 2005-2020 dönemini kapsayan çalışmada BIST-100, BIST-100 Tüm Hisse Senetleri ve dört hisse senedi sektör endeksi, hisse senedi fiyatlarını temsil eden modellerde yer almaktadır. Böylelikle farklı sektörlerdeki firmaların hisse senedi fiyatlarının döviz kurlarındaki değişimlere tepkisi analiz edilmiştir. Bulgular, döviz kuru değişimlerinin BIST-100 Tüm Hisse Senetleri endeksi ile kısa vadede hizmet, sanayi ve teknoloji sektörü

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endeksleri üzerindeki etkilerinin asimetrik olduğunu ve uzun vadede teknoloji sektörü endeksi üzerindeki etkilerinin asimetrik olduğunu göstermektedir.
Anahtar Kelimeler: Sektörel Hisse Senedi Endeksleri, Döviz Kuru, Asimetrik Eştümleşme
JEL Sınıflandırması: C52, C58, G10

1. Introduction

The stock market indices are one of the important indicators reflecting the economic and financial conditions of countries. It is known that the movements that occur in the economies of the countries affect the stock indices. This causes stock indices and macroeconomic variables to be closely related. Investigating the possible impacts of the exchange rate, which is one of the important financial variables, on stock indices is the center of attention by researchers. The impacts of exchange rate changes on the supply and demand sides and cost and profitability provided the exchange rate one of the important indicators that determine the stock indices of the firms.

Most studies examining the impacts of exchange rate movements on stock indices are based on the assumption that the relationship between exchange rate and stock indices is symmetrical. However, in recent years, there have been studies based on the assumption that the exchange rate possible an asymmetrical impact on stock indices. Thus, the possible impacts of the depreciation and appreciation of the national currency on stock indices can be determined more clearly. The depreciation in the national currency increases the profitability of the companies as a result of the increase in the international competitiveness of the exporting companies and as a result, the stock indices of the companies increase. Depreciation of the national currency may reduce firm profitability as a result of the increase in input costs of firms whose production is predominantly based on imports, and thus stock indices decrease. While the impact of the appreciation of the national currency on the stock indices of export firms may be negative, it may have consequences for firms engaged in import-based production to increase stock indices as a result of the decrease in production costs. In models where the relationship between variables is assumed to be symmetrical, the impacts of the depreciation and appreciation of the national currency on stock indices are also considered the same in magnitude, thus in importance. However, the impacts of the depreciation and appreciation of the national currency on stock indices may not be the same in magnitude. Thus, the estimation results of models that allow an asymmetric relationship between variables give more comprehensive findings than models that are assumed to be symmetrical.

The findings of empirical studies examining the impacts of exchange rate movements on stock indices are compiled in 5 parts below. The studies assumed symmetrical relationship between exchange rate and stock indices in the first paragraph and that are studies conducted for Turkey. Studies carried out in the second paragraph for the Turkish economy have been presented. The third paragraph has been carried out on different country economies studies outside Turkey have been compiled. The studies conducted on different sectors of the country outside of Turkey are summarized in the fourth paragraph and lastly, different groups of countries analyzed in the same study except Turkey summarized.

One of the studies assuming that the relationship between exchange rate and stock indices is symmetrical, Kasman[1] has determined that there is a long-term relationship between the exchange rate and BIST-100, finance, industry, and service indices as a result of the Johansen cointegration analysis. As a result of the Granger causality analysis, Kasman[2] determined that there is causality from the exchange rate to all of the stock indices. Ayvaz[3] showed using the Johansen cointegration analysis that there is a significant relationship between the financial, industry indices and the exchange rate in the long-term. According to the result of the same analysis, it was determined that there is no cointegration between the exchange rate and the service sector index. According to the results of the Granger causality analysis, Ayvaz[4] concluded that there is a bidirectional causality relationship between exchange rate and stock indices. According to Toda-Yamamoto causality analysis, Aydemir and Demirhan[5] revealed that there is a negative causality relationship towards the stock indices of BIST-100, services, financial, industrial, technology from the exchange rate. Özmen[6] determined that there is a significant long-term relationship between the exchange rate and stock indices using the Johansen cointegration test, and Toda Yamamato causality analysis determined that there is bidirectional causality between the variables between the periods 1989-1994 and 1994-1999. Elmas and Esen[7],examined the long term relationship between stock prices and exchange rates for 6 countries. According to the Granger causality result, they concluded that there is causality in the exchange rate towards the stock indice and that the variables are cointegrated according to the Johansen cointegration test for Turkey. In another study in which Granger causality analysis was performed, Coşkun et al.[8] determined that there is one-way causality from exchange rate to stock indices. Belen and Karamelikli[9], as a result of ARDL cointegration analysis, determined that the variables are cointegrated and the exchange rate has a negative effect on the stock indices. Türsoy[10] examined the relationship between exchange rate and stock indices for the 2001-2016 period. According to the ARDL cointegration test, it has determined that the variables are cointegrated. Türsoy[11] showed that there is bidirectional Granger causality among the variables in the long-term, and the exchange rate is the Granger cause of stock prices in the short-term.

1 Kasman, S. (2003). The Relationship Between Exchange Rates and Stock Prices: A Causality Analysis, Dokuz Eylül Üniversitsi Sosyal Bilimler Dergisi, 5(2): 70-79.

2 Kasman, S, 2003, 70-79.

3 Ayvaz, Ö. (2006). Döviz Kuru ve Hisse Senetleri Fiyatları Arasındaki Nedensellik İlişkisi, Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 8(2): 1-14.

4 Ayvaz, Ö, 2006, 1-14.

5 Aydemir, O., Demirhan, E. (2009). The Relationship between Stock Prices and Exchange Rates Evidence from Turkey, International Research Journal of Finance and Economics, 23: 207-215.

6 Özmen, M. (2007). Farklı Döviz Kuru Rejimleri Altında Hisse Senetleri Fiyatları íle Döviz Kurları Arasındaki İlişkinin Ekonometrik Analizi, Ç.Ü. Sosyal Bilimler Enstitüsü Dergisi, 16(1): 519-538.

7 Elmas, B., Esen, Ö. (2011). Hisse Senedi Fiyatları ile Döviz Kuru Arasındaki Dinamik İlişkinin Belirlenmesi; Farklı Ülke Piyasaları İçin Bir Araştırma, Muhasebe ve Finansman Dergisi, 52: 153-170.

8 Coşkun, M., Kiracı, K., Muhammed, U. (2016). Seçilmiş Makroekonomik Değişkenlerle Hisse Senedi Fiyatları Arasındaki İlişki: Türkiye Üzerine Ampirik Bir İnceleme, Finans Politik & Ekonomik Yorumlar, 53(616): 61-74.

9 Belen, M., Karamelikli, H. (2016). Türkiye'de Hisse Senedi Getirileri ile Döviz Kuru Arasındaki İlişkinin İncelenmesi: ARDL Yaklaşımı, Istanbul University Journal of the School of Business, 45(1): 34-42.

10 Türsoy, T. (2017). Causality between Stock Prices and Exchange Rates in Turkey: Empirical Evidence from the ARDL Bounds Test and a Combined Cointegration Approach, International Journal of Finacial Studies, 5(8): 1-10.

11 Türsoy, T, 2017, 1-10.

One of the studies for the Turkish economy Kaya and Soybilgen[12] , using the NARDL cointegration method the exchange rate impacts on stock indices have determined that it is asymmetric both in the short and long-term. According to their findings, the depreciation and appreciation of the Turkish Lira (TRY) in the short-term decreases the stock indices. In the long-term, the depreciation of the national currency decreases the stock indices, while the appreciation of the national currency increases the stock indices. Tiryaki et al.[13] found that the impacts of the real exchange rate on stock indices are asymmetrical in the long-term in their study, in which they examined the impacts of exchange rate on stock indices using the NARDL method. The findings of Tiryaki et al.[14] indicate that the depreciation of TRY increases the stock returns. In another study on the economics of Turkey Yacouba and Altintas[15], the real effective exchange rate of the asymmetric impact on stock indices that have been identified for both in the short and long-term. In their study using the NARDL method, in the long-term study findings indicate that the depreciation of the TRY increased the stock indices, and the appreciation of the TRY decreased the stock indices. From the first studies which examine the exchange rate of the asymmetric impact on sectoral stock prices[16] in Turkey Benli et al.[17] used the NARDL method. According to their findings, the impacts of exchange rate on stock indices are asymmetrical in all sectors except ISE information service in the short-term. In the long-term, there is an asymmetric cointegration relationship for six sectors[18].

Muller and Verschoor[19] determine by GARCH analysis that exchange rate fluctuations have asymmetric effects on US stock prices. Bahmani-Oskooee and Saha[20], one of the studies examining the effects of exchange rate movements on stock indices using the NARDL cointegration method, found that while there is an asymmetric relationship for the US in the short-term but there is no asymmetric relationship in the long-term. Another important finding is that the appreciation of the dollar increases the stock prices. One of the studies indicating that the asymmetric impacts of exchange rate on stock indices both in the short and long-term. Ajaz et al.[21] found that national currency appreciation in India in the long-term increased stock indices. Anjum et al.[22] for Germany,

12 Kaya, H., Soybilgen, B. (2019). Evaluating the Asymmetric Effects of Production, Interest Rate and Exchange Rate on the Turkish Stock Prices, Ege Akademik Bakış, 19(2): 293-300.

13 Tiryaki, A., Ceylan, R., Erdoğan, L. (2019). Asymmetric Effects of Industrial Production, Money Supply and Exchange Rate Changes on Stock Returns in Turkey, Applied Economics, 51(20): 2143-2154.

14 Tiryaki, A., Ceylan, R., Erdoğan, L, 2019, 2143-2154.

15 Yacouba, K., Altıntaş, H. (2019). The Asymmetric Impact of Macroeconomic Shocks on Stock Returns in Turkey: a Nonlinear ARDL Approach, Romanian Journal of Economic Forecasting, 22(2): 98-116.

16 ISE National 30, ISE National 100, ISE Bank, ISE Information Services, ISE Communucation, ISE Main Metal, ISE Metal Goods, ISE Insurance, ISE Textile, ISE Transportation, ISE Technology.

17 Benli, M., Durmuşkaya, S., Bayramoğlu, G. (2019). Asymmetric Exchange Rate Pass-Through and Sectoral Stock Price Indices: Evidence From Turkey, International Journal of Business and Management, 7(1): 25-47.

18 ISE National 30, ISE National 100, ISE Information Services, ISE Main Metal, ISE Metal Goods, ISE Insurance.

19 Muller, A., Verschoor, W. F. C. (2006). Asymmetric Foreign Exchange Risk Exposure: Evidence From U.S. Multinational Firms, Journal of Empirical Finance, 13(4-5): 495-518.

20 Bahmani-Oskooee, M., Saha, S. (2015). On the Relation Between Stock Prices and Exchange Rates: A Review Article, Journal of Economic Studies, 42(4): 707-732.

21 Ajaz, T., Zulquar Nain, Md., Kamaiah, B., Sharma, N. K. (2017). Stock Prices, Exchange Rate and Interest Rate: Evidence Beyond Symmetry, Journal of Financial Economic Policy, 9(1): 2-19.

22 Anjum, N., Ghumro, N. H., Husain, B. (2017). Asymmetric Impact of Exchange Rate Changes on Stock Prices: Empirical Evidence from Germany, International Journal of Economics and Financial Research, 3(11): 240-245.

Bhutto and Chang[23] for China determined that the impacts of exchange rate on stock indices are asymmetric in the long-term. Anjum et al.[24] found that the depreciation of the national currency in the long-term decreased the stock indices, while Bhutto and Chang[25] found that the depreciation of the national currency increased the stock indices in the long-term. Lee and Ryu[26] conclude that the depreciation of the national currency in the long-term reduces stock indices for South Korea. Another study concluding that the depreciation of the national currency in the long-term reduces stock indices is the study conducted for Nigeria by Effiong and Basey[27].

Cuestas and Tang[28], one of the studies investigating the likely asymmetric impacts of exchange rate on stock indices on an industrial basis, conducted their analysis with the NARDL cointegration method. In line with their findings, Cuestas and Tang[29] have concluded that the responses of stock indices to the fluctuations in exchange rates are asymmetrical in some industries in the long-term and some industries in the short-term. Cuestas and Tang[30] have concluded that the exchange rates impacts on the stock indices are asymmetrical in the two industries that are the banking, wine, and food industries, both in the long and short-term. Bahmani-Oskooee and Saha[31] investigated the impacts of exchange rate on eleven sector stock indices[32] for the USA using the NARDL cointegration method. Their findings reveal that the effects of exchange rates on stock indices are asymmetrical in the short-term in ten sectors[33] and in the long-term in six sectors[34]. Bahmani-Oskooee and Saha[35] found that the depreciation of the dollar in five[36] of these six sectors increased stock indices. Bahmani-Oskooee and Saha[37] determined that the appreciation of the dollar in the Dow Jones industrial average sector,

23 Bhutto, N. A., Chang, B. H. (2019). The Effect of the Global Financial Crisis on the Asymmetric Relationship Between Exchange Rate and Stock Prices, High Frequency, 2(3-4): 175-183.

24 Anjum, Ghumro, Husain, 2017, 240-245.

25 Bhutto, Chang, 2019, 175-183.

26 Lee, G., Ryu, D. (2018). Asymmetry in the Stock Prıce Response to Macroeconomıc Shocks: Evidence From the Korean Market, Journal of Business Economics and Management, 19(2): 343-359.

27 Effiong, E. L., Bassey, G. E. (2019). Stock Prices and Exchange Rate Dynamics in Nigeria: An Asymmetric Perspective, The Journal of International Trade & Economic Development, 28(3): 299-316.

28 Cuestas, J. C., Tang, B. (2015). Asymmetric Exchange Rate Exposure of Stock Returns: Empirical Evidence From Chinese Industries, Studies in Nonlinear Dynamics & Econometrics, 21(4):1-21.

29 Cuestas, Tang, 2015, 1-21.

30 Cuestas, Tang, 2015, 1-21.

31 Bahmani-Oskooee, M., Saha, S. (2016). Asymmetry Cointegration Between the Value of the Dollar and Sectoral Stock Indices in the US, International Review of Economics and Finance, 46: 78-86.

32 Dow Jones industrial average index, Dow Jones transport average index, Dow Jones utility average index, NASDAQ bank index, NASDAQ biotech index, NASDAQ computer index, NASDAQ industrial index, NASDAQ insurance index, NASDAQ telecom index, NASDAQ transport index, PHLX semi-conductor index.

33 Dow Jones industrial average index, Dow Jones transport average index, Dow Jones utility average index, NASDAQ biotech index, NASDAQ computer index, NASDAQ industrial index, NASDAQ insurance index, NASDAQ telecom index, NASDAQ transport index, PHLX semi-conductor index.

34 Dow Jones industrial average index, NASDAQ biotech index, NASDAQ computer index, NASDAQ industrial index, NASDAQ insurance index, NASDAQ telecom index.

35 Bahmani-Oskooee, Saha, 2016, 78-86.

36 NASDAQ biotech index, NASDAQ computer index, NASDAQ industrial index, NASDAQ insurance index, NASDAQ telecom index.

37 Bahmani-Oskooee, Saha, 2016, 78-86.

which is another sector where the impacts of exchange rate on stock indices are asymmetrical in the long-term, increased the stock indices. Adeniyi and Komuka[38] analyzed the data of fifty-four Nigeria firms using the NARDL cointegration method and their findings are that the impacts of exchange rates on stock indices are not asymmetrical. Alirezo et al.[39] The findings obtained by the NARDL cointegration method for three industries of Iran, namely petrochemical, basic metal and mining, which are export-oriented sectors, indicate the asymmetrical response of stock indices to exchange rate fluctuations both in the short and the long-term.

The studies investigating the possible short and long-term asymmetric impacts of exchange rate on stock indices for different countries, Bahmani-Oskooee and Saha[40] and Bahmani and Saha[41], employed the NARDL cointegration method. Bahmani-Oskooee and Saha[42] determined that the effects of exchange rates on stock indices in Brazil, Canada, and Mexico are asymmetrical in the short-term. Bahmani-Oskooee and Saha[43] determined that the relationship between exchange rate and stock prices is asymmetrical in the short-term and the study revealed that the impacts of exchange rate on stock indices are asymmetrical only in Canada and Malaysia in the long-term. Lugman and Kouser[44] determined that the relationships between stock indices and exchange rates are asymmetrical in the short and long-term, based on the results of their estimates obtained with the NARDL cointegration method for fourteen countries[45]. Moussa et al.[46] stated that the relationship between exchange rate and stock indices in Canada, Japan, Denmark, Hong-Kong, Singapore, Mexico and Brazil is asymmetrical based on the DCC-FIEGARCH and DCC-FIAPARCH econometric method.

In the literature, there are studies that allow the impacts of exchange rate movements on stock indices to be asymmetrical. It is seen that the econometric method used is predominantly the NARDL, which is the asymmetric cointegration method. Employing the NARDL method, it can be determined whether the exchange rate and stock indices have an asymmetric cointegration relationship and whether the effects of exchange rate movements on stock indices differ in the short and long-term. When the findings are evaluated in general, it is seen that the estimation results made in different periods for different countries' economies differ. There are a limited number of studies

38 Adeniyi, O., Kumeka, T. (2019). Exchange Rate and Stock Prices in Nigeria: Firm-Level Evidence, Journal of African Business, 21(2): 235-263.

39 Alireza, S., Zahra, H., Samira, Z. (2020). Real Exchange Rate Shocks and Export-Oriented Businesses in Iran: An Empirical Analysis Using NARDL Model, Munich Personal RePEc Archive, 1-24.

40 Bahmani-Oskooee, M., Saha, S. (2016). Do Exchange Rate Changes Have Symmetric or Asymmetric Effects on Stock Prices?, Global Finance Journal, 31: 57-72.

41 Bahmani-Oskooee, M., Saha, S. (2017). On the Relation Between Exchange Rates and Stock Prices: a Non-linear ARDL Approach and Asymmetry Analysis, Journal of Economics and Finance, 42: 112-137.

42 Bahmani-Oskooee, Saha, 2016, 57-72.

43 Bahmani-Oskooee, Saha, 2017, 112-137.

44 Luqman, R., Kouser, R. (2018). Asymmetrical Linkages Between Foreign Exchange and Stock Markets: Empirical Evidence through Linear and Non-Linear ARDL, Journal of Risk and Financial Management, 11(3): 1-13.

45 Canada, France, Germany, Italy, Japan, UK, USA, Russia, Brazil, China, India, Mexico, South Africa and Pakistan.

46 Moussa, W., Bejaoui, A., Mgadmi, N. (2020). Asymmetric Effect and Dynamic Relationships Between Stock Prices and Exchange Rates Volatility, Annals of Data Science.

examining the effects of exchange rates on sectors' stock indices. The main objective of this study is to determine whether the impacts of exchange rate movements on stock indices are asymmetrical for Turkey. In line with this purpose, in this study, the error correction model based on the NARDL asymmetric cointegration method is estimated and the short and long-term analyzes are made possible. Representing stock indices, BIST-100 and BIST-100 All Shares indices and service, financial, industrial, technology sector indices are also included in this study. Thus, it is aimed to contribute to the literature by determining the possible asymmetric impacts of exchange rate movements on sector indices. Furthermore, this study estimates the error correction models based on the ARDL models to compare the ARDL and NARDL findings. The second part of the study includes the data set and methodology part, the third part includes findings, and finally, the fourth part includes the conclusion parts of the study.

2. The Data and Methodology

In this study, we use monthly data from December, 2005 to March, 2020. The data that is used in the study obtained from the Electronic Data Delivery System (EDDS) of the Central Bank of the Republic of Turkey (CBRT). Table 1 presents a detailed data description of the variables considered in this study.

Table 1: The Definitions of the Variables

Variables	Description
XU100	The average closing prices in BIST-100 Index
XUTUM	The average closing prices in BIST-100 All Shares Index
XUHIZ	The average closing prices in BIST-Services Index
XUMAL	The average closing prices in BIST-Financial Index
XUSIN	The average closing prices in BIST-Industrials Index
XUTEK	The average closing prices in BIST-Technology Index
EX	The average closing values of spot USD/TRY foreign exchange rate
IPI	Industrial Production Index of Turkey, base year = 2015, seasonally adjusted
CPI	The Consumer Price Index of Turkey, base year = 2003
M2	The money supply measured by nominal M2

Note: The Central Bank of the Republic of Turkey, EDDS, Monthly Statistics.

The cointegration methods used to determine the long-term relationship among the variables, it is observed that the ARDL method is mostly involved in empirical studies. The ARDL cointegration method introduced by Pesaran, Shin, and Smith[47], one of the major reasons for this situation is that the variables could not be integrated in the same order with the condition that they are not the second-order I(2) integrated. The studies investigating the relationship between exchange rate and stock indices are examined, it is seen that the NARDL cointegration method is mostly used to reveal the possible asymmetric relationship. The ARDL model is expanded to the NARDL model

47 Pesaran, M. H., Shin, Y. Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships, Journal of Applied Econometrics, 16(3): 289-326.

by adding the positive and negative partial sums of the relevant variable instead of the variable in which asymmetric impacts are examined. Shin, Yu, Greenwood, Nimmo[48] showed that the steps of the ARDL bounds test approach are also valid for the NARDL model. The variables used in the ARDL and NARDL cointegration models, in which the possible impacts of exchange rate on XU100, XUTUM and four sector indices examined, based Bahmani-Oskooee and Saha[49], Bahmani-Oskooee and Saha[50]. SP represents the stock price in the models. The error correction model obtained based on the ARDL cointegration estimation method introduced by Pesaran, Shin and Smith[51] as follows:

$$\Delta lnSP_t = \alpha + \sum_{k=1}^{m1} \beta_k \Delta \, ln \, ln \, SP_{\,t-k} + \sum_{k=0}^{m2} \delta_k \Delta \, ln \, ln \, EX_{\,t-k} + \sum_{k=0}^{m3} \theta_k \Delta \, ln \, ln \, IPI_{\,t-k} + \sum_{k=0}^{m4} \gamma_k \Delta \, ln \, ln \, CPI_{\,t-k} + \sum_{k=0}^{m5} \tau_k \Delta \, ln \, ln \, M2_{\,t-k} + \lambda_1 lnSP_{t-1} + \lambda_2 lnEX_{t-1} + \lambda_3 lnIPI_{t-1} + \lambda_4 lnCPI_{t-1} + \lambda_5 lnM_{t-1} + u_t \quad (1)$$

In equation (1), by using the bounds testing approach, the estimates are made by assuming that the cointegration relationship among the variables is symmetrical. The asymmetric error correction model is obtained by adding the positive and negative partial sums of the exchange rate to the equation (1) instead of the exchange rate variable. The partial sums of positive and negative exchange rate movements, as follows:

$$POS_t = \sum_{i=1}^{t} \Delta lnEX_j^+ = \sum_{i=1}^{t} max(\Delta lnEX_j, 0) \quad (2)$$

$$NEG_t = \sum_{i=1}^{t} \Delta lnEX_j^- = \sum_{i=1}^{t} min(\Delta lnEX_j, 0) \quad (3)$$

In equation (2) POS_t denotes Turkish lira depreciation, equation (3) NEG_t denotes Turkish lira appreciation. The asymmetric error correction model obtained by using the positive and negative partial sums of exchange rate movements instead of the exchange rate variable in the ARDL model is stated as follows:

$$\Delta lnSP_t = \alpha + \sum_{k=1}^{m1} \beta_k \Delta \, ln \, ln \, SP_{\,t-k} + \sum_{k=0}^{m2} \delta_{1,k} POS_{t-k} + \sum_{k=0}^{m3} \delta_{2,k} NEG_{t-k} + \sum_{k=0}^{m4} \theta_k \Delta lnIPI_{t-k} + \sum_{k=0}^{m5} \gamma_k \Delta lnCPI_{t-k} + \sum_{k=0}^{m6} \tau_k \Delta lnM2_{t-k} + \lambda_1 lnSP_{t-1} + \lambda_2 POS_{t-1} + \lambda_3 NEG_{t-1} + \lambda_4 lnIPI_{t-1} + \lambda_5 lnCPI_{t-1} + \lambda_6 lnM_{t-1} + u_t \quad (4)$$

In equation (4), the hypothesis of $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$ is tested with the F test to investigate whether there is a long-term relationship. As in equation (1), this F test statistic obtained in equation (4) is compared with the table critical values of Pesaran, Shin and Smith[52]. The rejection of the $\frac{\lambda_2}{-\lambda_1} = \frac{\lambda_3}{-\lambda_1}$ hypothesis indicates that the impacts of exchange rates on stock indices in the long-term are asymmetrical. The hypothesis of $\sum_{k=0}^{m2} \delta_{1,k} = \sum_{k=0}^{m3} \delta_{2,k}$ is being tested to examine whether

48 Shin Y., Yu B., Greenwood-Nimmo M. (2014) Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In: Sickles R., Horrace W. (eds) Festschrift in Honor of Peter Schmidt. Springer, New York, p.281-314.

49 Bahmani-Oskooee, Saha, 2015, 707-732.

50 Bahmani-Oskooee, Saha, 2016, 78-86.

51 Pesaran, Shin, Smith, 2001, 289-326.

52 Pesaran, Shin, Smith, 2001, 289-326.

the impacts of exchange rate on stock indices are asymmetric in the short-term. The rejection of this hypothesis reveals that the impacts of exchange rates on stock indices are asymmetrical in the short-term. Normalized λ_2, λ_3 are parameters expressing long-term positive and negative exchange rate movements, respectively.

3.Empirical Findings

We study the natural logarithm of all the variables for the analysis. Firstly, the correlation among the variables we report the correlation matrix in Table 2. The correlation between the LEX and the sectoral indices is positive. As the LEX gains, the exports of the national firms traded in the stock market increase and thus their profitability increases. This situation implies that the stock indices of national firms have increased.

Table 2: The Correlation Coefficients Among the Variables

	XU100	XUTUM	XUHIZ	XUMAL	XUSIN	XUTEK	EX	IPI	CPI	M2
XU100	1.00									
XUTUM	0.95	1.00								
XUHIZ	0.96	0.95	1.00							
XUMAL	0.95	0.84	0.85	1.00						
XUSIN	0.97	0.98	0.97	0.86	1.00					
XUTEK	0.93	0.96	0.93	0.80	0.97	1.00				
EX	0.74	0.85	0.83	0.52	0.85	0.88	1.00			
IPI	0.89	0.93	0.92	0.76	0.94	0.94	0.85	1.00		
CPI	0.83	0.91	0.90	0.63	0.92	0.92	0.98	0.90	1.00	
M2	0.84	0.93	0.91	0.66	0.93	0.93	0.97	0.93	0.99	1.00

Note: We use the natural logarithm of all the variables

The most important advantage of the ARDL cointegration method is that the time series analyzed are I(0) or I(1), but not I(2). For this reason, we apply the ADF and PP unit root tests. The results are presented in Table 3 for all the variables in levels and in the first differences. According to the unit root test results, LXUTUM, LXUHIZ and LIPI variables are stationary at level, the rest are first difference stationary. Since the variables used in this study are not I(2) integrated series, we can estimate the ARDL and NARDL models.

Table 3: Unit Root Test Results

Variables	ADF test		PP test	
	Level	First Difference	Level	First Difference
LXU100	-2.8361 [0]	-12.8755 [0]*	-3.0245 [3]	-12.8748 [1]*
LXUTUM	– 4.2178 [0]*	– 9.4080 [0]*	– 4.2594 [4]*	– 9.3116 [7]*
LXUHIZ	– 3.4403 [0]*	-14.9710 [0]*	– 3.5482 [5]**	-14.9781 [3]*
LXUMAL	-2.8817 [0]	-12.9113 [0]*	-3.0132 [2]	-12.9118 [2]*
LXUSIN	-2.5445 [0]	-11.1906 [0]*	-2.8227 [2]	-11.2182 [2]*
LXUTEK	-2.5164 [0]	– 7.2457 [1]*	-2.7384 [5]	-11.6885 [5]*
LEX	-1.6508 [2]	– 9.8683 [1]*	-1.8448 [2]	– 8.8639 [4]*

LIPI	– 3.2403 [12]*	– 2.9344 [12]**	– 8.6988 [5]*	– 41.0119 [12]*
LCPI	-4.5924 [5]	-10.2785 [3]*	-0.2713 [9]	– 9.8542 [13]*
LM2	– 3.0444 [0]	-13.5414 [0]*	-2.9703 [3]	-13.9836 [9]*

Note: The values in brackets represent the optimal lag length by the SIC; *$p < 0.01$, **$p < 0.05$, ***$p < 0.1$.

Table 4: The ARDL and NARDL Estimation Results

	LXU100		**LXUTUM**		**LXUHIZ**	
	ARDL	**NARDL**	**ARDL**	**NARDL**	**ARDL**	**NARDL**
Short-Term Estimates						
ΔLEX_t	-1.21(5.66)*		-0.79(3.65)*		– 0.77(6.07)*	
ΔPOS_t		-1.21(4.88)*		-0.71(3.31)*		-0.89(4.90)*
ΔNEG_t		-1.08(2.49)**		0.01(0.15)		-0.06(0.97)
$\Delta LIPI_t$	0.05(0.65)	0.10(1.14)	0.11(1.32)	0.09(1.13)	0.08(1.35)	0.10(1.51)
$\Delta LCPI_t$	-0.40(1.95)*	-0.55(2.32)**	0.14(0.72)	0.24(0.74)	-0.02(0.15)	-0.13(0.60)
$\Delta LM2_t$	0.27(0.70)	0.27(0.71)	0.26(0.70)	0.04(0.37)	0.10(1.33)	0.03(0.32)
$\Delta LM2_{t-1}$	1.13(3.31)*	1.21(3.47)*	1.01(3.14)*			
$\Delta LM2_{t-2}$	-0.76(2.76)*	-0.67(2.32)**				
Long-Term Estimates						
LEX	0.17(0.37)		-0.38(0.94)		-0.27(0.85)	
POS		0.90(1.11)		-0.39(0.70)		0.29(0.43)
NEG		-0.35(0.58)		0.11(0.14)		-0.45(1.07)
$LIPI$	0.42(0.74)	0.82(1.34)	0.66(1.34)	0.57(1.15)	0.56(1.57)	0.70(1.59)
$LCPI$	– 3.34(1.49)	-4.49(1.70)*	0.84(0.73)	1.42(0.73)	-0.19(0.14)	-0.94(0.54)
$LM2$	2.15(1.98)**	1.35(1.25)	0.30(0.42)	0.29(0.38)	0.73(1.25)	0.22(0.32)
$Constant$	-16.99(1.75)*	2.38(0.14)	-2.22(0.24)	-4.14(0.39)	-5.57(1.05)	7.35(0.56)
Diagnostic Statistics						
F	3.66**	3.38***	3.51**	5.98*	4.22**	5.89*
ECM_{t-1}	-0.12(3.07)	-0.12(3.12)	-0.14(4.02)	-0.17(3.78)	-0.14(2.77)	-0.14(2.64)
$White$	8.80	11.49	22.54**	25.01*	11.96	14.30***
LM	5.43	4.43	4.47	1.93	0.53	1.56
$Adjusted$	0.28	0.28	0.22	0.17	0.20	0.21

Note: The absolute value of *t*-statistics in parentheses; *$p < 0.01$, **$p < 0.05$, ***$p < 0.1$.

The diagnostic tests are reported in Table 4. The White test statistic is reported to test for heteroscedasticity. The assumption of homoscedasticity is valid except for LXUTUM, LXUHIZ and LXUSIN stock indices. Therefore, since these indices have heteroskedasticity problem, the robust standard errors are estimated by the White-Huber method. The LM test is reported to test

for autocorrelation. The LM statistics are statistically insignificant. As a result, the autocorrelation problem is not in the models.

Firstly, the estimation results of the ARDL models in Table 4 are interpreted. The ARDL results indicate that there is a cointegration relationship among the variables by the F bounds testing approach for all the models. The obtained estimation results show that the LIPI has not statistically significant impact on stock indices in the long and short-term. The LCPI affects LXU100, LXUMAL, LXUSIN, LXUTEK stock indices negatively in the short-term. This effect is also valid for the long-term for the LXUMAL. The LM2 has a statistically significant effect on the LXU100, LXUMAL and LXUTEK stock indices in the long-term. While the expansion in the LM2 increases the LXU100, LXUMAL and LXUTEK stock indices in the long-term, it increases the LXUTUM, LXUSIN and LXUTEK stock indices in the short-term. The impacts of the LM2 on the LXU100 and LXUMAL stock indices differ for different lags in the short-term. It has been determined that the LM2 has no significant impact on the LXUHIZ index in the short and long-term. The ARDL results indicate that the LEX movements have negatively significant impacts on all stock indices in the short-term, but the effect of the LEX on stock indices is statistically insignificant in the long-term.

Table 5: The ARDL and NARDL Estimation Results

	LXUMAL		**LXUSIN**		**LXUTEK**	
	ARDL	**NARDL**	**ARDL**	**NARDL**	**ARDL**	**NARDL**
Short-Term Estimates						
ΔLEX_t	-1.43(5.77)*		-0.66(4.96)*		-0.87(5.02)*	
ΔPOS_t		-1.41(4.89)*		-0.82(4.27)*		-1.17(4.49)*
ΔNEG_t		-1.38(2.76)*		0.02(0.35)		0.02(0.24)
$\Delta LIPI_t$	0.009(0.10)	0.08(0.83)	0.07(0.86)	0.10(1.18)	-0.01(0.16)	0.10(0.95)
$\Delta LCPI_t$	-0.48(2.09)**	-0.67(2.53)**	-0.38(1.92)*	-0.49(2.11)**	-0.71(2.79)*	0.79(1.03)
$\Delta LM2_t$	0.11(0.26)	0.15(0.35)	0.21(2.35)**	0.15(1.40)	0.40(3.37)*	0.29(2.08)**
$\Delta LM2_{t-1}$	1.31(3.33)*	1.43(3.55)*				
$\Delta LM2_{t-2}$	-1.10(3.44)*	-0.98(2.95)*				
Long-Term Estimates						
LEX	0.14(0.29)		0.65(0.97)		2.20(1.59)	
POS		0.96(1.18)		1.38(1.17)		4.22(2.34)**
NEG		-0.55(0.85)		0.26(0.34)		0.30(0.24)
$LIPI$	0.07(0.10)	0.62(0.93)	0.86(1.11)	1.13(1.49)	-0.32(0.15)	1.49(1.11)
$LCPI$	-3.92(1.66)*	-5.09(1.98)**	-4.62(1.29)	-5.38(1.37)	-14.83(1.74)	-15.72(2.49)**
$LM2$	2.47(2.14)**	1.41(1.24)	2.57(1.50)	1.69(1.19)	8.34(1.83)*	4.24(1.77)*
$Constant$	-18.41(1.79)*	5.47(0.31)	-20.87(1.38)	-1.07(0.05)	-80.28(1.88)*	-3.65(0.10)

Diagnostic Statistics						
F	4.03**	3.62**	3.16*	4.28*	4.41*	4.93*
ECM_{t-1}	-0.12(3.24)	-0.13(3.41)	-0.08(2.20)	-0.09(2.34)	-0.04(2.06)	-0.07(2.95)
White	13.53	14.73	24.16*	25.06*	2.94	2.51
LM	3.38	3.36	0.26	0.11	3.33	4.15
Adjusted	0.32	0.32	0.13	0.15	0.15	0.19

Note: The absolute value of *t*-statistics in parentheses; $^{*}p < 0.01$, $^{**}p < 0.05$, $^{***}p < 0.1$.

Secondly, We interpret the NARDL estimation results and we conclude that the variables are cointegrated in all of the models. The F bounds testing approach confirms that the variables have a cointegration relationship. According to the NARDL results, it has been revealed that the LIPI has not a significant impact on stock indices in the short and long-term. LCPI affects statistically significantly and negatively on the LXU100 and LXUMAL stock indices in the short and long-term. The impacts of the LCPI on the LXUSIN stock index are significant and negative in the short-term, the impacts of the LCPI are negative and significant impacts on the LXUTEK stock index in the long-term. The impacts of the LCPI on the LXUTUM and LXUHIZ indices are statistically insignificant. In the long-term, the LM2 only affects the LXUTEK sector index significantly and positively. While the LM2 has no significant impact on LXUTUM, LXUHIZ and LXUSIN stock indices in the short-term, its impact on the LXUTEK stock index is significant and positive. The impacts of the LM2 on the LXU100 and LXUMAL stock indices are different for different lags in the short-term.

Table 6: The Wald Test Results

Variables	**Long-term asymmetry**	**Short-term asymmetry**
LXU100	1.3959 (0.2392)	0.0666 (0.7966)
LXUTUM	0.2879 (0.5925)	6.7334 (0.0106)**
LXUHIZ	0.8082 (0.3700)	15.4050 (0.0001)*
LXUMAL	1.8894 (0.1712)	0.0021 (0.9631)
LXUSIN	0.6476 (0.4221)	13.8041 (0.0003)*
LXUTEK	2.6544 (0.1052)	15.2732 (0.0001)*

Note: The *p*-values in parentheses; $^{*}p < 0.01$, $^{**}p < 0.05$, $^{***}p < 0.1$.

The Wald test results are conducted to detect whether the impacts of the LEX, which is one of the main objectives of this study, on stock indices are asymmetric or not are presented in Table 6. According to the Wald test results, the impacts of the LEX movements on the LXUTUM, LXUHIZ, LXUSIN and LXUTEK stock indices are asymmetrical in the short-term. The Wald test result indicates that the impacts of the LEX movements on stock indices are not asymmetrical in the long-term. However, examining the possible asymmetric impacts of the LEX movements on the LXUTEK stock index, We found that the positive LEX is significant Fand the negative LEX is insignificant in the long-term. Thus, it can be stated that the impacts of the LEX movements on the LXUTEK stock index are asymmetrical in the long-term. While the impact of the depreciation of the Turkish lira on the

LXUTEK stock index is positive, a significant impact of the appreciation of the Turkish lira could not be found. According to these findings, 1% depreciation in the Turkish lira increases the LXUTEK stock index by 4.22%. Contrary to the long-term findings in the LXUTEK sector index, which is determined to have asymmetric impacts on stock indices in the short-term, the depreciation of the Turkish lira has a negative impact on the stock indices in the short-term. The negative coefficient does not have a significant impact on the LXUTEK stock index in the short-term. The NARDL model findings indicate that the positive LEX coefficient affects LXUTUM, LXUHIZ and LXUSIN stock indices negatively and significantly in the short-term. It has been determined that the negative coefficient has a statistically significant impact on LXUTUM, LXUHIZ and LXUSIN stock indices in the short-term. It has been revealed that the depreciation of the Turkish lira has negative impacts on LXUTUM, LXUHIZ and LXUSIN stock indices in the short-term.

4. Conclusion

This study analyses exchange rates asymmetric impact on stock indices for Turkey over the period 2005 to 2020. For this purpose, the linear and non-linear ARDL models are used to the LEX, LIPI, LCPI and LM2 variables included as explanatory variables. LXU100 and LXUTUM indices and four sector indices LXUHIZ, LXUMAL, LXUSIN and LXUTEK indices are used to represent the stock indices. The ARDL, which is assumed to be symmetrical in the impacts of LEX movements on stock indices, and the NARDL cointegration method, which allows these impacts on stock indices can be asymmetrical, are employed. We estimate six models under the cointegration methods, thus enabling us to compare findings.

The estimation results obtained for all the models indicate that the variables are cointegrated according to the ARDL and NARDL methods. It has been determined that the impacts of the LEX movements on stock indices are asymmetrical only on the LXUTEK stock index in the long-term. In the LXUTEK model, the ARDL findings indicate that the LEX has not a significant impact on stock indices in the long-term, while the NARDL findings reveal that the depreciation of the Turkish lira increases the LXUTEK stock index. Thus, it has been determined that the NARDL, which is an asymmetric cointegration method in the LXUTEK model, is a more successful model for determining the impacts of LEX movements on stock indices. This finding indicates that as a result of the depreciation of the Turkish lira of export-origin firms included in the LXUTEK stock index, the competitiveness in international markets increases with the relative price impact, and firm profitability increases. Thus, the stock indices of firms with higher profitability also increase. In this study, according to the findings of NARDL, it is concluded that the impacts of the LEX on stock indices are asymmetric in the short-term and not asymmetric in the long-term. From the studies conducted for Turkey, Kaya and Soybilgen[53], Yacouba and Altıntaş[54], Benli et al.[55] have determined that the impact of the exchange rate on the BIST-100 index is asymmetric both in short and long-term. Also, Tiryaki et al.[56] showed that this impact is asymmetrical in the long-term.

53 Kaya, Soybilgen, 2019, 293-300.

54 Yacouba, Altıntaş, 2019, 98-116.

55 Benli, Durmuşkaya, Bayramoğlu, 2019, 25-47.

56 Tiryaki, Ceylan, Erdoğan, 2019, 2143-2154.

As stated by the NARDL estimation results, it has been determined that the impacts of the LEX movements on the LXUTUM stock index and the LXUHIZ, LXUSIN and LXUTEK stock indices are asymmetrical in the short-term. Thus, it has been determined that the response of the stock indices of the firms in the LXUTUM, LXUHIZ, LXUSIN and LXUTEK indices is different in the short-term against the depreciation and appreciation of the Turkish lira. It has been revealed that the depreciation of the Turkish lira decreases the relevant stock indices in the short-term. It has been determined that the appreciation of the Turkish lira has no significant effect on the same stock indices. The depreciation of the Turkish lira increases the production costs of the firms included in the relevant stock indices and causes a decrease in their profitability. Thus, it has been determined that the depreciation of the Turkish lira caused a decrease in stock indices. It can be argued that this finding may be due to the fact that the production of the firms included in the LXUTUM, LXUHIZ, LXUSIN and LXUTEK stock indices is based on imports. However, since the long-term positive coefficients are not statistically significant in the LXUTUM, LXUHIZ, LXUSIN stock indices and positive and significant in the LXUTEK stock index, this impact is not valid in the long-term. Moreover, the money supply expansion increases stock indices, while inflation decreases stock indices. It has been determined that the LIPI, which is included in the models representing economic activity, does not have a significant effect on stock indices. It can be inferred that economic activity does not affect stock indices for Turkey.

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