Chapter

The Impact of Exchange Rates on Stock Markets in Turkey: Evidence from Linear and Non-Linear ARDL Models

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Abstract

In this chapter we investigate the asymmetric impact of exchange rates on three major stock market indices in Turkey using four different ARDL models between 2003M1 and 2018M12. This chapter also attempts to differentiate the short-run and the long-run relationship between exchange rates and stock market indices namely BIST All shares, BIST National 100 index, and BIST National 30 index. Our motivating question is whether the relationship between exchange rates and three major stock market indices are symmetric or asymmetric in Turkey? To answer this, we first use the linear bivariate and multivariate models assuming the effects are symmetric. We then use the non-linear bivariate and multivariate models to examine whether exchange rate have symmetric or asymmetric effects on selected stock stock market indices in Turkey. The findings show that exchange rates have asymmetric effects on all three major stock market indices both in the short and long run. When we look at the long-run, the currency appreciation has positive and significant impact on selected stock markets but currency depreciation does not have an effect. This finding is in line with the understanding that Turkish sectors heavily depends on the import of raw and intermediate goods. The results also show that the economic activity has positive and significant effects on all stock markets implying that it is the main determinant in the long-run. Moreover, interest rates and volatility index were negative and significant in all markets. Thus, it has important implications for policy makers to provide stable prices and diverse investors.

Keywords: asymmetric effects, exchanges rates, stock markets, ARDL models, Turkey

1. Introduction

Some of the major developments in Turkey's economy during the past decades has been the liberalization of capital markets and implementation of floating exchange rate regime. These developments with the rapid growth of Turkey's economy has attracted international investors and thus increased Turkey's integration into the global economy. Turkey, as emerging market, became attractive to foreign investors for portfolio diversification but shocks in exchange rate markets create volatility in the stock market. It can react positively or negatively to

fluctuations in foreign exchange markets. Thus, exporters can benefit from the local currency depreciation due to higher export competitiveness, while importers will pay higher prices for imported goods, thus determining a company's cash flow and market value. Causality refers to exchange rates that vary from stock markets. On the other hand, if a country's exports depend mainly on foreign inputs, the resulting relationship between equity and exchange rates may be insignificant. Since Turkey is a net importer of goods and services, potentially, the depreciation of Turkish lira will cause the value of shares to fall.

There are two main theories suggesting a relation between exchange rates and stock prices. The first is the flow-oriented exchange rate models [1] that focus on the current account or trade balance and predicts that changes in exchange rates will affects the country's real economic variables and therefore stock prices by affecting international competition and trade balance. According to this approach, there is a positive relationship between the two and the causality from exchange rate to stock prices. Fluctuations in exchange rates makes the domestic companies more competitive in case of the depreciation of the national currency, thus increase their exports. Because, these fluctuations affect the costs and profits of many companies due to borrowing in foreign currencies to finance their operations. This affects the stock prices of firms [1].

Second approach is the stock-oriented approach which predicts that movements on stock prices affect exchange rates and thus a causality from stock prices to exchange rates via capital account [2]. As capital is part of the stock, it can influence the exchange rate through the demand of money. According to this, a rising stock prices will attract capital inflows to a country and this will lead to a decline in exchange rates by increasing demand for local currency [3].

It has become a generally accepted notion that these two variables are the way to go for emerging economies to enable economic growth and development. The role of exchange rate is much more important for small open economies in particular emerging markets. In this chapter we seek to shed some light on the analysis of the symmetric and asymmetric effects of exchanges rates on the stock prices in Turkey at industry level using a linear and nonlinear framework. This study is of great interest for a country that has import-oriented economy and completed its financial liberalization in the early 1990s. Because the empirical studies trying to prove the relationship between the exchange rates and the stock prices have mixed results regarding the two main views mentioned above.

Figure 1 shows the dynamics of Turkey's three major stock market indices. The 2008 crisis is seen as the most important point of decline in the trend. Since Borsa Istanbul is generally a foreign-invested market, the performance of the Turkish stock markets is negatively affected by foreign investors via the global financial crises. During this period, the risk premium was raised for Turkey. In parallel, CDS values increased. A similar effect occurred after 2018. The Turkish economy has shown that it is not fragile and has exceeded stress tests. Thus, after 2008, the index displayed a strong rise. The depreciation of the exchange rates at the end of the period led to a downward trend in three major stock market indices.

On the other hand, **Figure 2** shows the developments in the exchange rate market in Turkey. The exchange rates displayed a stable outlook in the first half of the period, but an upward trend in the second half of the period. Recently, the depreciation of the exchange rate accelerated. Thus, it seems to have a negative impact on stock market performance especially when the index gets cheaper in Turkish Lira terms, so the trend is expected to turn up.

Therefore to see whether the relationship between exchange rates and three major stock market indices is symmetric or asymmetric in Turkey, we employed four different methods: linear bivariate ARDL model is applied to investigate linear
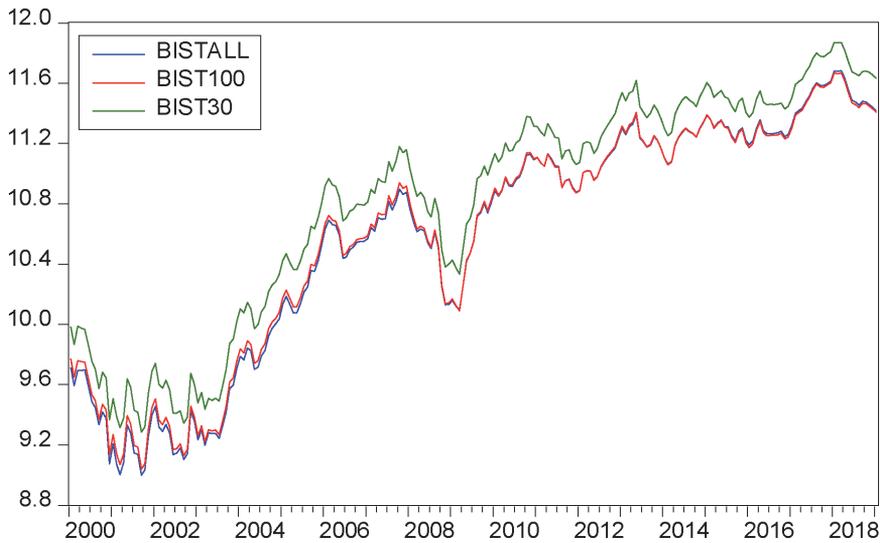
Figure 1.
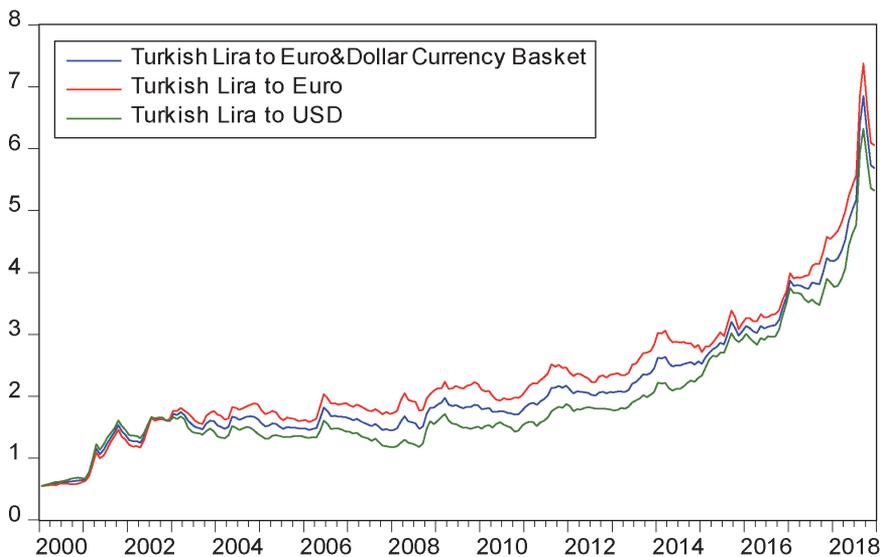*Stock market dynamics in Turkey (logs in TRY).*

Figure 2.
Turkish lira to Euro&Dollar Currency Basket.

relationship between stock prices and the exchange rates; linear multivariate ARDL model employed to show that changes in some additional variables such as interest rates and industrial production have symmetric or asymmetric effects on stock prices; as exchange rates has different impact on different sectors of the economy, multivariate ARDL models employed to analyze the relationship between them. Moreover, the relationship should not be based on the linear but also on nonlinear dimension. Thus finally, nonlinear bivariate and multivariate ARDL models applied to analyze the non-linear relationship between stock prices and the exchange rates in Turkey.

This study is of great interest for a country that has import-oriented economy, has completed its financial liberalization in the early 1990s, and become an attractive destination for foreign investors. The rationale for assessing the role of

symmetric and asymmetric effects of exchanges rate on stock prices in Turkey is based on the perception, as expressed by [1, 2], that the stock prices can react positively or negatively to fluctuations in exchange rates. Determining the factors that cause movements in stock prices is very important and is of great interest to policy makers and investors. The role of exchange rate on stock prices is much more important for small open economies in particular emerging markets. There is no sufficient research evidence showing the links between foreign exchange rate and Turkish stock market. We believe that this study will fill the gap in the literature in this area.

The rest of the chapter is organized as follows: Section 2 review the related literature; Section 3 describes data and methods applied; Section 4 presents empirical findings and discusses the implications of the analysis; and, finally, Section 5 concludes the paper and provides policy implications.

2. Literature review

The relationship between stock prices and exchange rates has been extensively studied by many researches. Some find positive association between the two [4, 5] others discover negative relations [6, 7] and even no relationship at all [8].

Studies on the relationship between exchange rate and stock prices in the literature can be summarized in different categories according to their empirical results. Firstly, there are some studies that find significant positive relationship between the two. For instance, the relationship between stock prices and exchange rates on financial, manufacturing, and services indices and fifteen sub-indices in Turkey investigated using Johansen cointegration test and the results show evidence that there is a long-run relationship among these indices and exchange rates. The results suggest that exchange rate exposure on financial and manufacturing industries have positive forex beta for the dollar exchange rate, but in terms of service industries there is negative forex beta [9]. A similar exercise undertook to investigate the effects of changes in foreign exchange on the stock returns on company level using panel data analysis. The results show evidence that changes in real exchange rate has positive and significant impact on stock returns in the manufacturing and trade sectors between the years 2006–2014 [10].

Secondly, there are some studies that find negative relationship between the two [6, 11]. For example, Akıncı and Küçükçayşı analyses the relationships between stock markets and exchange rates in 12 countries and finds that the exchange rate has negative effect on the stock market index [6]. Belen and Karamelikli investigates the causality between the exchange rates and stock returns in Turkey and finds no evidence supporting any causal relationship between the dollar exchange rate and the BIST-30 Index [11]. Tsai examine the relationship between stock price index and exchange rate in six Asian countries, namely Singapore, Thailand, Malaysia, the Philippines, South Korea, and Taiwan. Their results show that all countries in the study have negative the relationship between stock prices and exchange rates, which is in line with the portfolio balance effect [12]. Recently, the relationships between real exchange rate returns and real stock price returns in Malaysia, the Philippines, Singapore, Korea, Japan, the United Kingdom and Germany examined using dynamic conditional correlation (DCC) and multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) models. The results show that there is a negative relationship between real exchange rate return and real stock price return in Malaysia, Singapore, Korea and the UK [13].

Thirdly, there are some studies that find two-way causality between the exchange rate and stock prices [14]. For instance, Zeren and Koç examines the

relationship between exchange rates and stock market indices in Turkey, Japan and England. They use using the time varying causality test and find two-way causality between the exchange rate and stock prices for during the global crises period. However, some empirical studies find one-way causality between the exchange rate and stock prices [14]. Coskun et al. investigate the link between stock index and macroeconomic variables (USD exchange rate, exports and imports, industrial production index, and gold price using monthly data for Turkey. Using Granger causality, they find one-way causality from exchange rate to BIST, and using impulse response function their results suggest positive response of BIST to exchange rate shock [4]. Aydemir and Demirhan analyses the causality between exchange rates and stock prices for national 100, services, financials, industrials, and technology indices. The results suggest that there is positive bi-directional causal relationship from technology indices to exchange rate, but in terms of national 100, services, financials and industrials indices to exchange rate the paper does provide negative causality [15]. On the other hand, Kendirli and Çankaya (2016) analyze the causal relationship between the USD and Istanbul Stock Exchange National 30 Index from 2009:01 to 2014:12 monthly data and find no causal relationship between USD and BIST-30 index returns [8].

Fourthly, there are some studies that investigates short and long-run relationship between the two [16]. Recently, the relationship between the stock prices and exchange rates, specifically BIST 100 and 23 sectors indexes investigated using ARDL model. The results suggest that the long run relationship exist only between exchange rate and textile, wholesale and retail, and technology indices [17]. The short and long-term relations between exchange rate and financial sector index, industrial sector index, service sector index and technology sector index investigated in Turkey [18]. The results suggest that exchange rate has no long term relationship with stock prices and the sectors. However, in short term relationship, the results show that exchange rate has bidirectional causality with stock prices, technology and service sectors while a unidirectional causality with financial sector index. Akel and Gazel (2014) investigate the long-run and short-run equilibrium relationships between real effective industrial index in Turkey. Based on ARDL cointegration analysis, they find that there is a positive relationship between industrial index and Dollar Index and Euro/TL exchange rate, but there is no evidence on the relationship between real effective exchange rate and industrial index. Based on VECM model, they find that industrial index is positively related to the REER while it is negatively related to the Dollar Index and Euro/TL exchange rate [19].

3. Methodology

This study investigates symmetric and asymmetric effects of exchange rates on three major stock market indices in Turkey using four different models. Firstly, linear and nonlinear bivariate ARDL models are estimated where the exchange rates are the only determinant of stock prices. The linear models are used to capture the symmetric effects of exchange rate changes while the nonlinear models are applied to capture asymmetric effects of exchange rate changes on stock prices.

Following Pesaran et al. [20] and Shin et al. [21] we apply the following the bivariate model to account for cointegration between exchanges rate and stock prices in Turkey.

$$LnSP_t = \alpha + \beta LnEX_t + \varepsilon_t \qquad (1)$$

where a is the drift component, SP_t is the stock price index, EX_t is the nominal effective exchange rate, and ε_t is an error term. In order to estimate the short-run effects, the error correction form, proposed by Pesaran et al. [20] of the Eq. (1) can be written as follows:

$$\Delta LnSP_t = \alpha + \sum_{k=1}^{n1} \beta_k \Delta LnSP_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta LnEX_{t-k} + \gamma_1 \ln SP_{t-1} + \gamma_2 \ln EX_{t-1} + u_t$$

(2)

By now, we basically assume that exchange rate changes have symmetric effects on stock prices, but it might be possible that the effects could be asymmetric. In order to assess whether exchange rate changes have asymmetric effects on stock prices, we decompose the exchange rates into its positive and negative partial sums. For example, there might be differences between increases and decreases of the short-run interest rates. The partial sum of positive values is computed by replacing negative values with zeros as $POS_t^+ = LnEX_t^+ = \sum_{j=1}^{t} \Delta LnEX_j^+ = \sum_{j=1}^{t} max\left(\Delta LnEX_j, 0\right)$, and the partial sum of negative values are computed by replacing positive values with zeros as $NEG_t^- = LnEX_t^- = \sum_{j=1}^{t} \Delta LnEX_j^- = \sum_{j=1}^{t} min\left(\Delta LnEX_j, 0\right)$ where ΔEX_j^+ *is the* positive sum of changes in exchange rates, and ΔEX_j^- is the negative sum of changes in exchange rates.

The *LnEX* in Eq. (2) is replaced by new generated POS and NEG variables in the nonlinear ARDL models as follows:

$$LnSP_t = a + \beta POS_t + NEG_t + \varepsilon_t$$

(3)

Thus, the error correction form of the Eq. (3) takes the following form with POS and NEG variables.

$$\Delta LnSP_t = \alpha + \sum_{i=1}^{n1} \beta_i \Delta LnSP_{t-i} + \sum_{i=0}^{n2} \delta_{1,i} \Delta POS_{t-i} + \sum_{i=0}^{n3} \delta_{2,i} \Delta NEG_{t-i} + \lambda_1 LnSP_{t-1}$$
$$+ \lambda_2 POS_{t-1} + \lambda_3 NEG_{t-1} + u_t$$

(4)

Secondly, linear and nonlinear multivariate ARDL models are estimated where industrial production index (IP), volatility index (VIX) and interest rates (IR) are used as a determinants of stock prices in Turkey. In order to account the effect of these variables on stock prices we employ a linear multivariate model of Moore & Wang [22] and Bahmani-Oskooee & Saha [23] as follows:

$$ln\, SP_t = a + \beta LnEX_t + \gamma LnIPI_t + \delta LnIR_t + \theta Ln\, VIX_t + \varepsilon_t$$

(5)

where IPI_t is an index of industrial production, IR_t is the short term (overnight) interest rates, VIX_t is a measure of stock market volatility index and ε_t is an error term. The coefficient sign of β could be positive or negative depending on the firm's international competitiveness and production costs due to depreciation in exchange rates. When firms gain international competitiveness, they export more and thus exchange rate affects stock prices positively. However, increased costs due to depreciation in exchange rate are expected to affect stock prices negatively. Since there is a common consensus that economic activities affect stock prices positively [23, 24], the industrial production index is used as a proxy for measuring economic activity. Thus, we can expect stock prices to increase through increasing industrial production. Thus, we can expect the coefficient sing of γ to be positive.

As the interest rates are significant determinants of stock prices [25, 26], we use the short term (overnight) interest rates as a broad measure of financing costs. However, the effects of on stock prices are ambiguous [27, 28]. And finally, considering the international effects and theoretical predictions [29, 30], the volatility index is included in the model.

From Eq. (5), the coefficients estimate we get are the only long run effects. In order to infer the short-run effects, the Eq. (5) need to be rewrite in an error correction modeling format proposed by Pesaran et al. [20]. Therefore, we follow Pesaran et al.'s [20] bound testing approach and consider the following error-correction forms of multivariate model respectively:

$$\Delta LnSP_t = \alpha + \sum_{k=1}^{n1} \beta_k \Delta LnSP_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta LnEX_{t-k} + \sum_{k=0}^{n3} \theta_k \Delta LnIPI_{t-k}$$
$$+ \sum_{k=0}^{n4} \varphi_i \Delta LnIR_{t-k} + \sum_{k=0}^{n5} \vartheta_k \Delta LnVIX_{t-k} + \lambda_1 LnSP_{t-1} + \lambda_2 LnEX_{t-1}$$
$$+ \lambda_3 LnIPI_{t-1} + \lambda_4 LnIR_{t-1} + \lambda_5 LnVIX_{t-1} + u_t \qquad (6)$$

The Eq. (6) give short-run as well as long-run estimates in one step, where λ_1, λ_5 are the long run parameters, Δ are the first difference operator, n and q are the optimal lag lengths for each variable, and u_t is the usual White noise residuals. The estimates of coefficients attached to first-differenced variables gives the short-run effects while the estimates of $\lambda2–\lambda5$ normalized on $\lambda1$ give the long-run effects. In order for the long-run estimates to be valid, the F test proposed by Pesaran et al. [20] is applied to joint significance of lagged level variables $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4$ in equation [6] as a sign of cointegration. The F test has obviously new critical values depending on whether variables in the model are I(0) or I [1], and whether the model contains an intercept and/or a trend.

Once the cointegration established, the long-run effects of exchange rates, industrial productions, interest rates and volatility index on stock prices are captured by the estimates of $\lambda_2 - \lambda_5$ normalized on λ_1 . The short-run effects are gathered by the estimates of the coefficients of the first differenced variables such as the short-run effects of industrial production index on stock prices are determined by θ_k. The lag length of the first differences in Eq. (6) is chosen according to the Schwarz Bayesian Criteria (SBC) where we consider a maximum lag length of six.

The nonlinear multivariate ARDL models are constructed to assess the asymmetric effects of exchange rate changes on stock prices as follows:

$$\Delta LnSP_t = \alpha + \sum_{k=1}^{n1} \beta_k \Delta LnSP_{t-i} + \sum_{k=0}^{n2} \delta_{1,k} \Delta POS_{t-i} + \sum_{k=0}^{n3} \delta_{2,k} \Delta NEG_{t-i} + \sum_{k=0}^{n4} \theta_k \Delta LnIPI_{t-i}$$
$$+ \sum_{k=0}^{n5} \varphi_k \Delta LnIR_{t-i} + \sum_{k=0}^{n6} \vartheta_k \Delta LnVIX_{t-i} + \lambda_1 LnSP_{t-1} + \lambda_2 POS_{t-1} + \lambda_3 NEG_{t-1}$$
$$+ \lambda_4 LnIPI_{t-1} + \lambda_5 LnIR_{t-1} + \lambda_6 LnVIX_{t-1} + u_t$$
$$(7)$$

Where the exchange rate is replaced by new generated POS and NEG variables. Thus the nonlinearity comes from the two new variables where POS refers appreciation of home currency and NEG refers depreciation of the home currency.

4. Empirical findings

In this chapter both linear and nonlinear ARDL models are estimated for bivariate and multivariate models by using monthly data over the period of 2003 M1 to

2018 M12 for three major stock market indices in Turkey. The results of short and long-run estimates of both linear and nonlinear for the bivariate and multivariate models are reported in **Tables 1** and **2**. Each of the tables consist of three panels: Panel A reports the short run estimates, Panel B reports the long-run estimates and the diagnostic statistics are then reported in Panel C. To ensure one of the requirements of Pesaran et al.'s [20] method that the variables could be I(0) or I [1] but not I [2], we use the traditional Augmented Dickey-Fuller (ADF) tests on levels as well as the first differenced variables. The lag order of the ADF test statistics is determined by the Akaike Information Criterion (AIC) and the results show that there are no I [2] variables.

4.1 Results of the bivariate models

In the bivariate models, the exchange rates are considered as the determinant of stock markets. **Table 1** gives the result of the linear bivariate modes. Looking at the linear model from Panel A, the short run coefficients associated with exchange rates are significant for all stock markets. The results show that all stock market indices are effected negatively by exchange rates changes as expected in the economic theory. The panel B shows that there is a positive long-run relationship between exchange rates and all markets.

Panel C reports the diagnostics statistics. The results of F test are slightly above the upper bound critical value of 3.35 in all stock indices. The error-correction model denoted by ECM test which shows negative and significant coefficients for all markets. Moreover, the LM test is also applied and the results show insignificant for all markets suggesting that there is no autocorrelation in the optimum model. Ramsey's RESET statistics are also reported to judge misspecification. For instance, if the test statistics of RESET test is more than the critical value of 3.84, it indicates a misspecification problem in the model at some significance level. Given its critical

Variables	BIST All	BIST 100	BIST 30
Panel A: Short Run Estimates			
$\Delta lnSP_{t-1}$	$-0.46(-7.01)$ ***	$-0.45(6.94)$* **	$-0.45(-6.97)$ ***
$\Delta lnEX$	$-1.21\ (-5.20)$ ***	$-1.25(5.37)$* **	$-1.28(-5.46)$ ***
$ln\ \Delta EX_{t-1}$	$-0.62\ (-2.52)$ *	$-0.62(2.53)$**	$-0.6\ (-2.4)$ *
Constant	$0.46(2.93)$ **	$0\ .47(2.95)$***	$0.51(3.03)$ **
Panel B: Long Run Estimates			
$lnEX$	$1.86\ (3.45)$ ***	$1.82(3.43)$***	$1.76(3.46)$ ***
Panel C: Diagnostic Statistics			
Adjusted R^2	0.327	0.33	0.33
F	4.35	4.47	4.72
ECM_{t-1}	$-0.05\ (-2.84)$ **	$-0.04(2.87)$***	$-0.05(-2.95)$ **
LM	3.91 (0.14)	3.97(0.14)	3.68(0.16)
$RESET$	0.69 (0.56)	0.62(0.60)	0.55(0.65)
CS (CS^2) (5%)	Stable	Stable	Stable

Notes: Numbers inside the parentheses are t-ratios. Superscript *** represents the significance at 1% level, ** at the 5% level and * at the 10% level. The Δ denotes the first difference of the variables.

Table 1.
Results of the linear bivariate models.

Variables	BIST All	BIST 100	BIST 30
Panel A: Short Run Estimates			
$\Delta lnSP_{t-1}$	−0.45 (−6.76)***	−0.442(6.70)***	−0.44(−6.69)***
ΔPOS	−1.58(−5.13)***	−1.62(5.27)* **	−1.66(−5.33)**
ΔPOS_{t-1}	−0.92(−2.85)**	−0.92(2.84)* **	−0.88(−2.68)**
ΔNEG	0.02 (0.20)	0.0219(0.25)	0.02(0.23)
Constant	0.88** (3.05)**	0.88(3.09)***	0.94(3.18)**
Panel B: Long Run Estimates			
POS	0.81 (1.20)	0.81(1.20)	0.78(1.19)
NEG	0.22 (0.19)	0.266(0.23)	0.24 (0.21)
Panel C: Diagnostic Statistics			
Adjusted R^2	0.335	0.34	0.34
F	4.67*	4.76*	5,01**
ECM_{t-1}	−0.08(−2.68) **	−0.082(2.71)***	−0.09(−2.81) ***
LM	3.64 (0.16)	3.51(0.17)	3.31(0.19)
RESET	1.11 (0.35)	1.05(0.37)	0.99(0.40)
CS (CS^2) (5%)	Stable	Stable	Stable
Wald (short run)	37.99***	39.34***	38,28***
Wald (long run)	0.79	0.71	0.76

Notes: Numbers inside the parentheses are t-ratios. Superscript *** represents the significance at 1% level, ** at the 5% level and * at the 10% level. The Δ denotes the first difference of the variables.

Table 2.
Results of the non-linear bivariate models.

value, the RESET statistic is insignificant for all stock market indices, suggesting that the model is correctly specified in the sector. The CUSUM and CUSUM square tests are also reported to establish stability of the short run and the long run estimates. The test results show that the estimated parameters for all stock market indices are stable. As can be seen, estimates are stable at least by one of the tests. Based on the above results, we can conclude that the exchange rate has short-run effects on three major stock market indices (BIST All, BIST100 and BIST30) in Turkey.

However, we would also like to see whether the short-run effects change if non-linear adjustment process used. Then the answer will be based on the results of non-linear ARDL models reported in **Table 2**. The results show that the currency appreciation (ΔPOS) has significant negative short-run effects on all markets, while depreciation (ΔNEG) has no effect as it is insignificant. This results suggests that exchange rate changes in Turkey have asymmetric effect on stock indices in Turkey.

When we look at the long-run effects in Panel B, the currency appreciation has positive impact on all stock indices, but the effects are statistically insignificant. The currency depreciation also has no effect on any indices in Turkey. In order to see whether the long-run assessment is valid, we report F test and ECMt-1 test results. In order to further validate the short-run and long-run asymmetric effects, the equality of short-run and long-run coefficient estimates is also tested applying Wald test. As for the long-run asymmetry we test whether λ2 = λ3. According to the Wald test statistic, the asymmetry effects between exchange rates and stock prices are supported for all markets in the short-run.

4.2 Results of the multivariate models

Tables 3 reports the results of short and long-run estimates of linear multivariate models for BIST All Shares, BIST 100 and BIST 30 stock prices. Panel A captures the symmetric effects of exchange rates on stock prices as well as other macroeconomics explanatory variables. The results show that all markets namely, BIST All, BIST100 and BIST30, are negatively affected by exchange rate changes. These markets on the other hand have a positive and statistically significant relationship with industrial production index implying that economic activity in Turkey has a significantly positive impact on the stock markets in the short run.

However, all markets have affected negatively by an increase in interest rates which implies that high interest rates lead to decrease in the investment level in the country and hence decrease economic activity. Likewise, volatility index (VIX) have a negative relationship with all stock market indices which implies that an increase in uncertainty lead to decrease the profitability of firm and thus lead to decrease stock prices in the short run.

When we look at the long run coefficient presented in Panel B, the industrial production index carries significant and positive relationship with all markets while interest rates and volatility index carries negative and significant relationship with stock prices in Turkey. Focusing on the exchange rate on stock prices, we found that

Variables	BIST All	BIST 100	BIST 30
Panel A: Short Run Estimates			
$\Delta lnSP_{t-1}$	$-0.23(3.98)^{***}$	$-0.19(3.43)^{***}$	$-0.20(.50)^{***}$
$\Delta lnEX$	$-0.84(4.23)^{***}$	$-1.00(5.07)^{***}$	$-1.01(5.03)^{***}$
$\Delta lnEX_{t-1}$	$-0.45(2.26)^{**}$		
$\Delta lnIR$	$-0.60(3.88)^{***}$	$-0.56(3.64)^{***}$	$-0.57(3.56)^{***}$
$\Delta lnIPI$	$1.36(4.10)^{***}$	$1.41(8.24)^{***}$	$1.36(7.84)^{***}$
$\Delta lnVIX$	$-0.15(2.06)^{**}$	$-0.14(3.82)^{***}$	$-0.14(3.72)^{***}$
Constant	$0.69(2.06)^{**}$	$0.71(2.10)^{**}$	$0.87(2.56)^{**}$
Panel B: Long Run Estimates			
$lnEX$	$0.22(1.09)$	$0.13(0.65)$	$0.15(0.75)$
$lnIR$	$-2.98(4.61)^{***}$	$-2.88(4.33)^{***}$	$-2.95(4.35)^{***}$
$lnIPI$	$1.75(4.06)^{***}$	$1.74(3.93)^{***}$	$1.60(3.50)^{***}$
$lnVIX$	$-0.17(1.96)^{*}$	$-0.21(2.25)^{**}$	$-0.21(2.22)^{**}$
Panel C: Diagnostic Statistics			
Adjusted R^2	0.59	0.58	0.57
F	4.61^{**}	429^{**}	4.22^{**}
ECM_{t-1}	$-0.20(3.76)^{***}$	$-0.19(3.63)^{***}$	$-0.19(3.62)^{***}$
LM	$2.29(0.31)$	$4.28(0.11)$	$2.69(0.26)$
$RESET$	$2.48(0.06)$	$2.43(0.07)^{*}$	$1.54(0.20)$
CS (CS^2) (5%)	Unstable	Stable	Stable

*Notes: Numbers inside the parentheses are t-ratios. Superscript *** represents the significance at 1% level, ** at the 5% level and * at the 10% level. The Δ denotes the first difference of the variables.*

Table 3.
Results of the linear multivariate models.

in the long run the exchange rate changes affect stock prices positively. Thus the short run relationship between stock prices and exchange rate is not sustained in the long run. When cointegration established among variables then the long run relationship will be relevant. And thus we carry diagnostic statistics reported under Panel C. The F statistic is slightly above the upper bound critical value of 3.35 in all stock prices. The F statistic is statistically significant for all markets which establishes cointegration among variables. We also carry ECM test which is another indication of cointegration and the lagged error term (ECM_{t-1}) results show significant and negative coefficient. The results of ECM test results supports cointegration among variables. Panel C also reports Langrange Maltiplier (LM) test in order to check for autocorrelation among residuals. The LM test results are insignificant implying that there is no autocorrelation in the residuals. The Ramsey's Regression Specification Error Test (RESET) is also applied to check whether or not the model is misspecified. The results of RESET test statistics are insignificant for all models implies that the models are correctly specified except BIST100. Lastly, we applied the

Variables	BIST All	BIST 100	BIST 30
Panel A: Short Run Estimates			
$\Delta lnSP_{t-1}$	−0.22(3.83)***	−0.19(3.39)***	−0.20(3.45)***
ΔPOS	−1.07(4.11)***	−1.21(4.61)***	−1.23(4.57)***
ΔPOS_{t-1}	−0.58(2.04)**		
ΔNEG	−0.06(0.45)	−0.19(1.41)	−0.16(1.24)
$\Delta lnIR$	−0.45(2.29)**	−0.33(1.73)*	−0.35(1.74)*
$\Delta lnIPI$	1.38(7.98)***	1.37(7.83)***	1.32(7.39)***
$\Delta lnVIX$	−0.16(4.27)***	−0.17(4.37)***	−0.17(4.25)***
Constant	0.86(1.64)*	1.21(2.38)**	1.35(2.57)**
Panel B: Long Run Estimates			
POS	−0.017(0.06)	−0.26(1.06)	−0.22(0.85)
NEG	−0.029(0.46)	−0.84(1.46)	−0.77(1.27)
lnIR	−2.00(2.43)**	−1.48(1.89)*	−1.60(1.94)**
lnIPI	1.65(3.07)***	1.31(2.33)**	1.19(2.00)**
lnVIX	−0.19(1.62)*	−0.31(2.58)**	−0.30(2.42)**
Panel C: Diagnostic Statistics			
Adjusted R^2	0.59	0.58	0.57
F	4.18**	4.17**	4.08**
ECM_{t-1}	−0.22(4.16)***	−0.22(4.11)***	−0.21(4.05)***
LM	2.51(0.28)	4.56(0.11)	2.97(0.22)
RESET	1.4(0.22)	1.48(0.21)	0.77(0.50)
CS (CS^2) (5%)	Stable	Stable	Stable
Wald (short-run)	13.35***	10.06***	10.44***
Wald (long-run)	0.49	2.50	2.06

Notes: Numbers inside the parentheses are t-ratios. Superscript *** represents the significance at 1% level, ** at the 5% level and * at the 10% level. The Δ denotes the first difference of the variables.

Table 4.
The results of the non-linear multivariate models.

cumulative sum of recursive residuals (CUSUM denoted CS) and the cumulative sum of recursive residuals of square (CUSUMQ denoted CS^2) tests. According to both CS and CS^2 test results, the models are stable except BIST All Shares.

We also test the asymmetric effects of exchange rate changes on stock prices using the nonlinear multivariate models (see **Table 4**). Thus we decompose the exchange rates changes into its positive (*POS*) and negative (*NEG*) partial sums to test whether stock prices have asymmetric relationship with exchange rates changes. The results show that the currency appreciation (ΔPOS) has a negative and significant coefficient but the currency depreciation (ΔNEG) do not have significant coefficient. This implies that there is asymmetric relationship between the exchange rate and stock prices in the short-run. This asymmetric relationship is not continue in the long-run as in Panel B, *POS* and *NEG* variables have insignificant coefficients. When we look at the effects of other variables we see that the industrial production index has positive and significant effect both in the short and long run.

5. Conclusion

The aim of this chapter is multiresolution analysis with the application of advanced economic techniques using four different ARDL models to shed some light on the analysis of the symmetric and asymmetric impact of exchange rates on three major stock market indices in Turkey using monthly data from 2003M1 to 2018M12. This chapter also attempts to differentiate the short-run and long-run relationship between exchange rates and market indices. The motivating question is whether the relationship between the two is symmetric or asymmetric in Turkey? To answer the question, we employed four different methods: linear bivariate ARDL model is applied to investigate linear relationship between stock markets and the exchange rates; linear multivariate ARDL model employed to show that changes in some additional variables such as interest rates and industrial production have symmetric or asymmetric effects on stock markets; as exchange rate has different impact on different sectors of the economy, multivariate ARDL models employed to analyze the relationship between them. Moreover, the relationship should not be based on the linear but also on non-linear dimension. Thus finally, non-linear bivariate and multivariate ARDL models applied to analyze the non-linear relationship between stock market indices and the exchange rates in Turkey.

This study is of great interest for a country that has import-oriented economy, has completed its financial liberalization in the early 1990s, and become an attractive destination for foreign investors. The rationale for assessing the role of symmetric and asymmetric effects of exchanges rate on stock markets in Turkey is based on the perception, as expressed by (Dornbusch and Fischer 1980 and Frankel 1992), that the stock markets can react positively or negatively to fluctuations in exchange rates. Determining the factors that cause movements in stock markets is very important and is of great interest to policy makers and investors. The role of exchange rates on stock markets is much more important for small open economies in particular emerging markets. There is no sufficient research evidence showing the links between foreign exchange rate and Turkish stock market. We believe that this study will fill the gap in the literature in this area.

The findings show that exchange rates have asymmetric effects on all three major stock market indices both in the short and long-run. When we look at the long-run, the currency appreciation has positive and significant effect on stock market indices but currency depreciation does not have an effect. This finding is in line with the understanding that Turkish sectors heavily depends on the import of

raw and intermediate goods. The results also show that the economic activity has positive and significant effects on three major stock market indices implying that it is the main determinant in the long-run. Moreover, interest rates and volatility index were negative and significant in all markets. Thus, it has important implications for policy makers to provide stable prices and diverse investors.

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