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Bilateral J-Curve Between Türkiye and Its Major Non-EU Trading Partners: Evidence from Both Linear and Non-Linear Approach

Alper YILMAZ *(https://orcid.org/0000-0002-1253-7097), Aydın Adnan Menderes University, Türkiye; alper.yilmaz@adu.edu.tr*

Türkiye ve AB-Dışı Başlıca Ticaret Ortakları Arasındaki J Eğrisi Etkisi: Doğrusal ve Doğrusal Olmayan ARDL Yaklaşımından Kanıtlar

Abstract

This research analysed the bilateral J-curve phenomenon in the Turkish economy. For this purpose, we applied both the linear and non-linear Autoregressive Distributed Lag (NARDL) co-integration methods, in addition to the asymmetric Toda-Yamamoto causality test, to examine whether the impact of Turkish lira appreciations differs from that of lira depreciation. The findings from the linear model indicate statistically significant coefficients for the long term, and J-curve effects were observed in the case of two countries: Russia and the UAE. This suggests that when the Turkish lira depreciates, it positively affects Turkey's trade balance with these partners; however, lira appreciations have a negative impact. In contrast, the non-linear model provides more evidence, with the results revealing that asymmetry cannot be ignored, as the positive and negative variables exhibit differences in signs, magnitudes, and levels of significance. We found the J-curve effect for only three countries (India, USA, and UAE) out of seven partners in this model. Third, the lira evaluation between the short and long run affected the external balance. Furthermore, the long-run error correction mechanisms converge to steady-state equilibrium faster. Lastly, there is a unidirectional or bilateral linkage between the FX rate and the external deficit for these four partners. Therefore, exchange rate policies are a determinant that should be considered in relationships with certain trading partners.

Keywords : J-Curve, Trade balance, Exchange rate, Asymmetry effects, Nonlinear ARDL.

JEL Classification Codes: F14, F31, F32, C22.

Öz

Bu çalışmada Türkiye ekonomisi için J Eğrisi hipotezi analiz edilmiştir. Bu kapsamda, Türk lirasında meydana gelen devalüasyonların, revalüasyonlardan istatistiki olarak farklı olup olmadığı, Asimetrik Toda-Yamamoto nedensellik testine ek olarak doğrusal ve doğrusal olmayan ARDL eş bütünleşme yöntemi ile de incelenmiştir. Doğrusal modelden elde edilen sonuçlara göre J eğrisi etkisi sadece Rusya ve BAE için tespit edilmiştir ve elde edilen uzun dönem katsayıları istatistiksel olarak anlamlıdır. Bu sonuçlara göre Türk lirasının değer kaybetmesi, söz konusu partnerlerle ticarette dengeyi olumlu etkilemekte ancak Türk lirasının değerlendiği durumlarda negatif etki ortaya çıkmaktadır. Buna mukabil, kur değişkeninde ait pozitif ve negatif değişkenler, işaret, katsayı büyüklüğü ve istatistiki önem seviyesi olarak farklılık gösterdiği için asimetrik ilişki reddedilememekte ve bu bağlamda doğrusal olmayan model daha fazla kanıt sunmaktadır. Bu yöntemde J Eğrisi etkisi yedi partnerin üçünde (Hindistan, ABD ve BAE) gözlemlenmiştir. Üçüncü olarak, kısa ve uzun dönem arasında Türk lirasında oluşan değerlenme, ticaret dengesini etkilemektedir. Ayrıca, hata düzeltme parametresi, uzun dönemde, kısa döneme göre denge durumuna daha hızlı dönüldüğüne işaret etmektedir. Son olarak, kur değişkeni ile ticaret dengesi arasında, yukarıda bahsedilen dört ticaret partneri özelinde nedensellik ilişkisine dair kanıtlar sunmaktadır. Dolayısıyla belli ticari partnerlerle olan ilişkilerde kur politikalarının dikkate alınması gereken bir belirleyici olduğu söylenebilir.

Anahtar Sözcükler : J Eğrisi, Ticaret Dengesi, Döviz Kurları, Asimetrik Etki, Doğrusal Olmayan ARDL.

1. Introduction

Today, world economies are closer than ever before due to financial globalisation and economic integration. Since the mid-1980s, relaxed capital controls, reduced trade barriers (lowering of barriers has led to increased international trade and investment) and advancements in technology (made it easier for investors to access global markets and trade currencies and assets instantaneously) have enhanced interaction between exchange rates, international assets, and currency movements. Therefore, exchange rate policies now have closer ties to a country's macroeconomic indicators, including economic growth, inflation, and the balance of payments (Frieden, 2008: 344-345). Economists now understand how important exchange rates are for balancing trade deficits. Since the advent of the current floating exchange rates in 1973, exchange rates have mainly been determined by supply and demand forces instead of government intervention. This has made trade performance more dependent on exchange rate fluctuations. Money moves freely now, and in turn, it directly affects how much a country imports and exports (Ceyhan & Gürsoy, 2021: 1171).

As the relationship between exchange rates and the trade balance strengthens, theoretical debates on exchange rate systems and flexibility have also intensified. Various exchange rate management systems, including floating exchange rates, pegged exchange rates, managed float systems, fixed regimes, and currency boards, have been subjects of this debate. At the exchange rate level that maintains market balance, total foreign exchange earnings are equal to total foreign exchange expenditures, thus ensuring equilibrium in the balance of payments. In the case of any deficit or surplus, it reacts accordingly. When balance is restored at a new equilibrium level, the supply and demand for foreign exchange are again equalised, and external balance is restored once more (Seyidoğlu, 2013: 464). Suppose exchange rates are not allowed to adjust adequately. In that case, it may lead to persistent trade imbalance, market distortions (distorted market signals and misallocation of resources), loss of competitiveness for domestic industries, speculative pressures on the market, and pressure on foreign reserves. Thus, implementing a fair exchange rate policy aligning the domestic currency with its actual value is pivotal in fostering external equilibrium and attaining economic stability. It might be used as a benchmark for a long-term equilibrium level to stabilise currency markets (Aries et al., 2006: 51-53). A fair exchange rate policy that sets the domestic currency at its actual value accurately reflects a country's economic fundamentals, such as productivity, inflation rate, and external balance. In such a policy, the exchange rate is determined by market forces without significant government or central bank intervention to manipulate its value artificially. This allows the currency to find its equilibrium level based on supply and demand in the foreign exchange market (Bayoumi et al., 2005: 9, Quirk, 1990: 115-117).

In addition to exchange rate policy, we can arrange a set of strategies, including expenditure-reduction policies, fiscal or monetary tightening, expenditure-shifting policies, and currency devaluation or depreciation. Among them, currency fluctuations facilitate the attainment of external balance adjustments by responding to the supply and demand dynamics within the exchange market. When a country experiences a deficit in exports compared to its imports, there's a decrease in the supply of its domestic currency and an increase in demand for foreign currency, resulting in the depreciation of the local currency. This depreciation leads to changes in relative prices, making foreign goods relatively more expensive and domestic goods more affordable, thus incentivising consumers to switch their spending towards domestic products. As a result, a depreciation of a country's currency provides an advantage to its exports, bolstering the country's external balance. Conversely, an appreciation in nominal exchange rates elevates the cost of a nation's goods and services, making imports more attractive. This shift could reduce exports, increase imports, and weaken the country's external balance. Consequently, exchange rates have a significant influence on trade patterns, and we need to adopt a sustainable trade and exchange rate policy on a long-term basis. (Ahn et al., 2017: 2; Aytac, 2016: 116). Türkiye, as a developing country, faces structural challenges, including unfavourable terms of trade, excess reliance on imported inputs or raw materials for domestic production, limited total factor productivity, low rates of saving and investment, inefficient technological progress, an undesirable composition of foreign trade, inadequate capacity to manufacture its products efficiently, and delays in policy adjustments concerning trade dynamics over the short and long term. These factors shed light on why exchange rate policies have limited effects on the trade balance and why there are discrepancies in how the trade balance reacts to currency policies (Kutlu, 2013: 121).

Adopting a floating exchange rate regime means that exchange rates are determined by the interplay of supply and demand forces in the market, without direct intervention from the central bank to peg the currency to a specific value. The J-curve hypothesis suggests that following a currency depreciation, the trade balance may worsen before a long-term improvement occurs. This short-term deterioration is attributed to existing contracts, pricing behaviour, and adjustment lags in trade (Bahmani-Oskee & Kanitpong, 2017: 4668). However, over time, the depreciation is expected to improve the trade balance as exports become more competitive and imports become relatively more expensive. Türkiye's adoption of a floating exchange rate regime makes the connection with the J-curve hypothesis evident. Following the transition to a floating exchange rate, there may be increased volatility in exchange rates and uncertainty in the market. This could lead to a short-term worsening of the trade balance as businesses and consumers adjust to the new exchange rate environment. However, over the long term, the flexibility of a floating exchange rate regime allows for more efficient adjustments in response to changes in external conditions. As the Turkish Lira adjusts to market forces, it may become more competitive, leading to increased export competitiveness and a gradual improvement in the trade balance. Overall, the Turkish government's adoption of a floating exchange rate regime aligns with the principles of the J-curve hypothesis, suggesting that while there may be short-term challenges, the flexibility the regime provides could contribute to long-term improvements in the trade balance.

Theoretical justifications for currency policies, such as the Marshall-Lerner condition and the J-Curve hypothesis, are pivotal. In fixed exchange rate systems, countries may devalue their currency to boost exports and conserve foreign exchange by reducing imports. This devaluation triggers two effects on trade patterns: the "price effect" initially raises import costs and makes exports appear cheaper to domestic consumers, while the "volume effect" gradually adjusts trade volumes, ultimately improving the trade balance in the long run (Jamilov, 2011: 2). In this manner, we have to consider the ML condition. This hypothesis describes the conditions under which a devaluation or depreciation of a country's currency will improve the trade balance. The ML condition briefly states that $\eta_X + \eta_M > 1$, where η_x is the foreign demand elasticity of exported goods, and η_m is the domestic demand elasticity of foreign goods. To get a trade surplus, the sum of the price elasticities of demand for a country's exports and imports must be greater than 1 (Karluk, 2013: 662-3). However, they may lead to an inverse effect due to delays in economic adjustments, as Magee (1973) and Krueger (1983) discussed. During this period, the limited responsiveness of the demand curve is explained by existing bilateral trade contracts, where goods have already been sold or ordered before the currency devaluation. Additionally, it takes time for domestic producers to adjust to higher prices and increase production. Devaluation increases costs for pre-agreed imports in local currency while export values remain unaffected. Consequently, the decline in export prices only slightly boosts export demand, and the rise in import prices modestly reduces import demand. In the long term, the full impact of the exchange rate change becomes apparent, altering export and import volumes. Price elasticity becomes more evident as new contracts are based on adjusted exchange rates. Over time, lower export prices stimulate demand and reduce imports, improving trade balance. The J-curve graph illustrates an initial decline followed by a subsequent recovery in the trade balance after currency devaluation, indicating a specific period for observing positive effects (Özşahin, 2017: 226; Kılıç et al., 2018: 113-4).

Therefore, examining the relationship between the trade balance and the exchange rate is significant to economic policymakers for several reasons. Firstly, it offers insight for countries considering currency devaluation to enhance exports and stimulate economic growth. Secondly, it helps determine if there's a stable long-term connection between the exchange rate and the trade balance, which informs whether devaluation can effectively improve the trade balance. Thirdly, analysing this relationship sheds light on the short-term and long-term effects of devaluation on the trade balance. Typically, short-term devaluation may worsen the trade balance, but this trend may reverse in the long term, leading to the well-known J-curve phenomenon. To this end, the rest of the paper is structured as follows: Section 2 covers the literature background of the subject and outlines the contributions. Section 3 determines the empirical approach, detailing the data and specifying the models used in the study, along with the estimation techniques. Section 4 presents the findings from the econometric analysis. Finally, Section 5 concludes the paper with policy advice.

2. Literature Background

The role of exchange rate policy has long been studied in the empirical literature. A significant body of paper has emerged since Magee's 1973 study to investigate the connection between foreign trade balance and currency devaluation. However, empirical findings still need to be clarified. This may stem from different periods and/or methodologies used in the empirical studies and from the use of aggregated data. While some studies support the J-curve pattern and note conflicting indications, particularly in the short- and long-term coefficients of the exchange rate variable "Ln (Real Exchange Rate)" as proposed by Rose & Yellen (1989), others fail to find significant insights from empirical data. Additionally, specific research papers report mixed results regarding bilateral trade relationships. Initial papers investigate the trade balance with aggregated data. These papers combine trade data with the effective exchange rate and income proxy weighted as trading partners' incomes. Among them, Himarios (1989), Rose (1990), and Bahmani-Oskooee & Kutan (2009) analysed the subject in a multi-country framework, and they assert that devaluation causes the trade balance to deteriorate for some countries but improve for others. There are also single-country studies such as Felmingham (1988), Singh (2004), Bahmani-Oskooee & Harvey (2010), and Verheyen (2012) found evidence for the J-curve hypothesis.

Some papers found evidence for the J-curve but used different data sets. Bahmani-Oskooee & Alse (1994), Brada et al. (1997), Boyd et al. (2001), and Hacker & Hatemi-J (2003) focused on the two-country format using the total trade approach. However, total trade data may cause aggregation bias. So, Arora et al. (2003), Bahmani-Oskooee et al. (2006), Halıcıoglu (2008a), Hsing (2009), and Wang et al. (2012) employed bilateral trade data set suggest that real depreciation or devaluation provides more empirical support for improving the external balance in the long run. On the other hand, some papers do not hold any evidence about the J-Curve hypothesis. According to Miles (1979), Krugman & Baldwin (1987), Rose & Yellen (1989), Wilson & Tat (2001), and Halıcıoğlu (2007) real exchange rate does not considerably affect the bilateral balance of trade due to temporal discrepancy (e.g. currency depreciation might improve the trade balance but these improvements would take quite a long time), balancing of opposite forces (e.g. a positive impact of devaluation against one country might be offset by its negative impact against another one), and assuming that effects of exchange rate changes are symmetric.

The direction of the trade balance can be affected by differences, such as the products included in the trade basket. In this regard, Doroodian et al. (1999), Baek (2006), and Bahmani-Oskooee & Ardalani (2006) conducted their research at the industry or product level, and they concluded that depreciation in FX rates led to a recovery in the trade balance for these sectors.

The outcomes of the empirical papers on the Turkish J-curve could be more precise. According to Kale (2001), Halıcıoğlu (2008b), Yazıcı (2010), Yavuz et al. (2010), Erdem et al. (2010), Özşahin (2017), Albayrak & Korkmaz (2019), and Ünal (2021), the exchange rate has a statistically significant linear effect, and the depreciation improves the bilateral trade balance of Türkiye. So, the J curve hypothesis is valid either in the short or long term. However, Akbostancı (2004), Kimbugwe (2006), Çelik & Kaya (2010), Yazıcı & Klasra (2010), Yazıcı & İslam (2014), Gözen & Bostancı (2021), and Özdemir et al. (2022) found the opposite evidence that response of external balance to changes in FX rate is not consistent with the J curve hypothesis meaning that exchange rate adjustments do not succeed in improving trade balance. So, the J-curve effect does not exist.

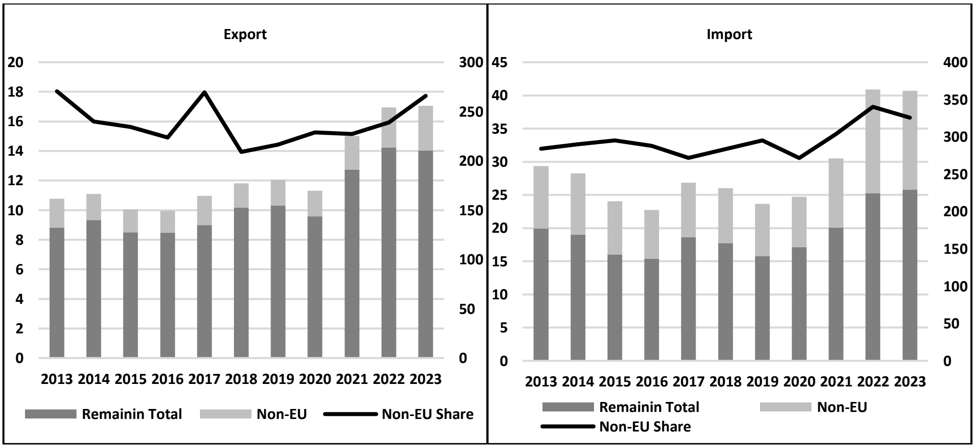
Only some studies follow non-linear methods since linear models have primarily dominated the research. However, some researchers criticised this assumption and introduced asymmetries by modelling nonlinearities into the error-correction and cointegration processes. Baldwin & Krugman (1989) demonstrated that the movement and adjustment of the trade balance could be asymmetric. When a currency appreciates, the expectation is that export revenue will decrease by a lesser extent than it would increase in the event of a similar magnitude of currency depreciation. This is because, after appreciation, new entrants into the export market intensify competition for established firms, reducing revenue. In this regard, Bahmani-Oskee & Fariditavana (2015) defined the J curve as reflecting short-run deterioration combined with long-run trade balance improvement due to currency depreciation. They claimed that the effects of exchange rate changes could be asymmetric. Thus, the authors introduced nonlinearity into the co-integration method and found evidence for five US trading partners. Bahmani-Oskee et al. (2016) examine Mexico's bilateral trade with 13 trade partners, adopting both the linear and the nonlinear version of the ARDL method. According to the results, while peso depreciation improves Mexico's trade balance in the linear model, the nonlinear ARDL model implies that peso appreciation hurts Mexico's trade balance. Karamelikli (2016) investigated the linear and nonlinear dynamics of the trade balance of Türkiye with her main trade partners (Germany, France, the United Kingdom, and the U.S.A.) using monthly time series data from 2000 to 2015. The empirical results indicate no J-curve effect during the short-run for the United States and France; it symmetrically exists in Germany and asymmetrically in the United Kingdom. Nusair (2017) examined the J-curve phenomenon for 16 European transition economies by employing both linear and non-linear approaches of the ARDL method. The author could not find support for the J-curve phenomenon; however, sufficient evidence for it was found in 12 out of the 16 countries when using a non-linear model. Similarly, Harvey (2018) applied both approaches to examine the case of the Philippines and its nine most significant trading partners. In the linear ARDL approach, two countries were found to be significant. However, under the NARDL model, evidence indicates that three countries exhibit asymmetry in the short run. In contrast, asymmetry effects were observed in the case of Indonesia, Japan, and Singapore in the long run. When considering the Turkish economy, Arı, Cergibozan & Cevik (2019) conducted both linear and nonlinear ARDL models for the Turkish economy concerning 18 "European Union" members from 1990Q1 to 2017Q3.

According to the results, the nonlinear ARDL model yielded more support for the J-curve phenomenon than the linear model. Bilgin (2020) analysed the effects of the real exchange rate changes on the sectoral exports of Türkiye's manufacturing industry using the NARDL method. Results from the model for each sector indicate that the domestic currency's depreciation and appreciation have significant asymmetric effects on sectoral exports. Similarly, Hunter (2019) found more evidence (support for the J-curve impact on three out of four models) when using a non-linear approach compared to a linear model for the Chinese economy. Bahmani-Oskee & Durmaz (2021) assess the asymmetric effects of exchange rate changes on the trade balance of 57 industries that trade between Türkiye and the EU using the *"asymmetric Co-Integration"* method. They found short-run asymmetry effects in all industries, short-run adjustment asymmetry in 24 industries, short-run impact asymmetry in 17 industries, and long-run asymmetry effects in 23 industries. Ceyhan & Gürsoy (2021) aimed to determine the validity of the J-curve hypothesis in the Turkish economy by employing the *"Toda Yamamoto (1995) Causality Test"* and *"Hatemi-J (2012) Asymmetric Causality Test"* using monthly data from 1996 to 2019. The findings indicated that the causality test confirmed a unidirectional causality relationship between the real exchange rate and imports. Conversely, the results of the Hatemi-J (2012) Asymmetric Causality Test suggested that shocks in the real exchange rate do not affect exports but decrease imports.

In this regard, our paper contributes in several ways. Firstly, we challenge the assumption of a linear relationship between variables by recognising the potential for an asymmetric trend in the trade balance's response to exchange rate devaluation. We adopted linear and nonlinear ARDL approaches, as in Bahmani-Oskooee and Halicioglu (2017). The nonlinear ARDL approach to error-correction modelling and cointegration incorporates a nonlinear adjustment process into the testing procedure. It allows us to ascertain whether currency depreciation's short-run and long-run effects on the trade balance are symmetric or asymmetric. For this purpose, we examine "*positive*" and" *negative"* changes separately, identifying asymmetrical effects only when their signs and magnitudes differ. Using the most up-to-date *"bilateral"* trade data (because the use of aggregate data suppresses the actual movements of those variables involved), we employ both *linear* and *nonlinear* cointegration methods to investigate the J-curve hypothesis between Türkiye and its primary *"non-EU"* trading partners. Secondly, we use linear and nonlinear Granger non-causality tests alongside the cointegration analysis to explore potential causal relationships and their directions (one-way or two-way) between the variables. This comprehensive method allows us to differentiate between the impacts of positive and negative shocks, considering the principle of asymmetric information. In this paper, we pose the following research question: Could failure to confirm the J-curve using disaggregated trade data stem from assuming a linear adjustment process? Can we find further evidence for the J-curve if we introduce nonlinearity into error correction and cointegration modelling methods? Lastly, we utilise recent quarterly data spanning the entire post-liberalization era, including data from non-EU countries that are significant trade partners of Türkiye regarding export revenues and import expenditures.

The primary motivation behind this research is the lack of empirical studies that have employed a non-linear approach to analyse the Turkish J-curve. After the 1980 transformation in the Turkish economy, factors such as rising capital movements, high inflation rates, price stickiness, increased volatility, and spillover effects between markets have emerged, which could give rise to non-linearity. Another motivation for this study is to address the literature gap and comprehensively analyse the case of Türkiye, given its outlier status in terms of macroeconomic indicators such as foreign exchange rates, inflation, and interest rates. In this context, it is important to seek answers to several research questions, such as whether we can plot the J-curve using linear or non-linear methods in error-correction and cointegration modelling, whether there is any difference between the short- and long-run coefficients of estimated parameters, and whether there is a statistically significant short- and long-run relationship between the trade balance with a given country and the real exchange rate. Lastly, can we find further evidence for J-curve if we introduce nonlinearity into error correction and cointegration modelling methods?

Figure: 1
Trade Composition of Turkish Economy with Non-EU Trading Partners ($ Billion)



Source: TUIK Foreign Trade Statistics.

There are several reasons for choosing non-EU economies. According to Figure 1, non-EU trading partners, such as the USA, China, Russia, India, Ukraine, S. Arabia, and UAE, in our case, account for 18% of total exports (left scales) and 37% of total imports as of 2023. The figure also provides trade volumes (suitable scales). Accordingly, as of 2023, $45 billion of Türkiye's $255 billion exports are made to these countries. Similarly, $133 billion of the total $362 billion imports are made from these countries. As can be seen from the statistics, these partners play a significant role in Türkiye's foreign trade. The importance of these partners lies in diversifying Türkiye's trade portfolio and reducing dependency on any single market. These trading partners offer opportunities for Türkiye to expand its export markets, access new technologies, and attract foreign investment. Additionally, strengthening trade ties with these countries can buffer Türkiye against economic fluctuations within the EU and provide alternative avenues for economic growth. Furthermore, fostering relationships with major global economies like Russia, China, and the USA can enhance Türkiye's geopolitical influence and position it as a key player in international trade and diplomacy.

3. Data and Methodology

For model specification in this paper, we have adopted the approach of Rose & Yellen (1989), which involves modelling the external balance between Türkiye and its partner countries as a linear function of the domestic income levels of both parties, as well as the bilateral FX rate. To eliminate scale effects and skewness, we have transformed the variables into logarithmic data;

$$LnTB_{i,t} = \beta_0 + \beta_1 LnY_{Tur,t} + \beta_2 LnY^*_{i,t} + \beta_3 LnREX_{i,t} + \varepsilon_t \quad (1)$$

The variable *LnTB* (Trade Balance) represents the trade balance, traditionally expressed as the difference between imports and exports. However, following Bahmani-Oskooee & Goswami (2006), we measure the trade deficit as the (M/X) ratio, where M is the import and X is the export volume with partners, to turn it into a series of real values. In this respect, when the value of *LnTB* exceeds one, it indicates a trade deficit, and a ratio of less than one means a trade surplus. LnY_{Tur} and LnY^*_i represent the GDP of Türkiye and its trading partner in constant 2015 US dollars, respectively. There are no a priori expectations regarding the signs of β_1 and β_2. Bahmani-Oskooee (1985), Felmingham (1988), and Bahmani-Oskooee & Goswami (2006) assert that an increase in domestic GDP leads to a rise in imports and a deterioration in the external balance. Accordingly, increases in a partner's GDP cause a rise in demand for domestic exports and, thus, an improvement in the trade balance. On the other hand, Brada et al. (1997) and Narayan & Narayan (2004) argue that increases in domestic GDP may stem from macroeconomic recovery or a boost period, in which case we expect an increase in the production of exportable goods and, in turn, a recovery in the trade deficit. Therefore, we did not specify any expectations regarding the sign of the coefficient of the income variable.

LnREX denotes the real bilateral exchange rate between Türkiye and her trading partner. As it was expressed in Himarios (1989), and Rose & Yellen (1989), we converted the nominal exchange rate into real exchange rate using the consumer price index (CPI - All Items, 2010 = 100) by $LnREX_t = NER_{i,j} * \left[CPI_t^i / CPI_t^{TUR} \right]$. When *LnREX* increases, the domestic currency depreciates, and the trading partner's currency appreciates. According to the J-curve hypothesis, it is expected that $\beta_3 < 0$ in the short run since an increase in real effective exchange rate initially deteriorates the trade balance and a significant and positive coefficient ($\beta_3 > 0$) is expected in the long run, meaning that depreciation will lead to an improvement. Lastly, β_0 is the model's constant, ε is a stochastic error term, and i and t refer to the trading partner (i= 1,... 9, countries) and quarterly period (2000Q1-2022Q4), respectively. In the study, we focused on the post-2000 period to be able to see the effects of the structural program implemented after the 2001 crisis, to analyse the impact of the exchange rate policies of the newly elected government, and the fluctuating course of the Turkish Lira against the US dollar on the external balance. Starting in September 2020, the New Economic Model, implemented to alleviate the contraction caused by the COVID-19 pandemic and to control the increasing foreign trade deficit, has been included in the study period along with its results.

The J-Curve hypothesis is generally tested by adopting time-series models. In particular, the traditional Engle & Granger (1987) or Johansen's (1988) methods of co-integration techniques (they are a powerful way of detecting the presence of steady-state equilibrium between non-stationary variables) and the Vector Error Correction Model (VECM) has gained widespread space in detecting the short-term and long-term effects of exchange rate fluctuations on bilateral trade balances. The cointegration relationship indicates that the linear combination of two non-stationary time series (e.g. trade balance and exchange rate in our case) can be stationary. It implies a long-term, or steady-state, relationship among them (Gujarati, 2004: 830).

However, the ARDL bound test method, introduced by Pesaran, Shin, & Smith (2001), has some advantages. First, when the variables in the study are integrated in different orders, traditional methods are not applicable. However, in the ARDL procedure, a series with varying orders of integration can run. Second, the ARDL method helps identify the co-integrating vector(s). Since it is determined, we can parametrise it into the Error Correction Model (ECM), which gives short-run dynamics and long-run relationships between the variables without losing long-run information. Also, both short-run dynamics and the long-run parameters of the model can be predicted contemporaneously. Third, the ARDL technique is free from residual correlation. So, endogeneity is less of a problem. Finally, the small sample properties of the ARDL are far superior to those of multivariate cointegration (Nkoro & Uko, 2016: 78-9). To sum up, following Pesaran et al. (2001), a linear version of the unrestricted error correction form of the ARDL (p;q) bound test model can be achieved by the following regression;

$$y_t = m + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + ...\alpha_\rho y_{t-\rho} + \beta_0 x_t + \beta_1 x_{t-1} + ...\beta_q x_{t-q} + \varepsilon_t \quad (2)$$

where y is the dependent variable, m is the constant, y_{t-i} is the autoregressive part, and x_t to x_{t-q} represent independent variables (distributed lag part). The bounds test uses ECM to check for cointegration. Accordingly, we can re-write this regression model as ECM;

$$\Delta y_t = m + \delta_1 y_{t-1} + \delta_2 x_{t-1} + \sum_{j=1}^{\rho} \alpha_j \Delta y_{t-j} + \sum_{j=1}^{q} \beta_j \Delta x_{t-j} + \varepsilon_t \quad (3)$$

where Δ is the difference operator with an optimal lag order, δ_1 is the error correction coefficient, δ_2 is the long-run co-integration parameter, and β_j is the error correction parameter. In this model, we have the null of *no cointegration* (H$_0$: $\delta_1 = \delta_2 = 0$) against the alternative hypothesis of at least one cointegration (H$_0$: $\delta_1 < 0$). In equation (3), the part represents the long-run error correction mechanism, and the rest of the notation gives the long-run mechanism (Bahmani-Oskee & Fariditavana, 2015: 520). To test the null hypothesis, we need residual sum square (RSS) from the restricted and unrestricted model as follows;

$$\Delta y_t = m + \sum_{j=1}^{\rho} \alpha_j \Delta y_{t-j} + \sum_{j=1}^{q} \beta_j \Delta x_{t-j} + \varepsilon_t \tag{4}$$

$$\Delta y_t = m + \delta_1 y_{t-1} + \delta_2 x_{t-1} + \sum_{j=1}^{\rho} \alpha_j \Delta y_{t-j} + \sum_{j=1}^{q} \beta_j \Delta x_{t-j} + \varepsilon_t \tag{5}$$

Restricted model of equation (4) and unrestricted model of equation (5) are estimated by ordinary least squares (OLS) and estimated RSS's are substituted in the F test to make decision; $F_{test} = \dfrac{(RSS_R - RSS_{UR}) / \text{Restriction number}}{RSS_{UR} / T - k}$, where T is the number of observation and the k is the number of explanatory variable. The calculated F statistics have any value in which they are either stationary I(0) or integrated in order one I(1). I(0) denotes the lower bound, and I(1) is the upper bound. When the F statistic exceeds the upper bound, the null hypothesis is rejected, whereas if the computed F-statistic is below the lower bound, the null hypothesis is not rejected. The results will be inconclusive if they fall inside between them (Pesaran et al., 2001: 298). To sum up, the linear ARDL(p:q$_1$:q$_2$:q$_3$) model for this study can be written by replacing equation (1) with equation (6);

$$\begin{aligned}\Delta LnTB_{i,t} &= \alpha_0 + \sum_{k=1}^{\rho} \alpha_i \Delta LnTB_{j,t-k} + \sum_{k=1}^{q} \lambda_i \Delta LnY_{Tur,t-k} + \sum_{k=1}^{r} \varphi_i \Delta LnY_{j,t-k} + \sum_{k=1}^{s} \gamma_i \Delta LnREX_{j,t-k} + \\ &\phi_i LnTB_{j,t-1} + \delta_{1i} LnY_{Tur,t-1} + \delta_{2i} LnY_{j,t-1} + \delta_{3i} LnREX_{j,t-1} + \varepsilon_t\end{aligned} \tag{6}$$

where $\phi_i = -(1 - \sum_{i=1}^{\rho_1} \alpha_i)$ is the error correction speed of the adjustment parameter of *lnTB*. $\delta_{1i} = \sum_{i=0}^{\rho_2} \lambda_i$, $\delta_{2i} = \sum_{i=0}^{\rho_3} \varphi_i$ and $\delta_{3i} = \sum_{i=0}^{\rho_4} \gamma_i$ are the long-run coefficients on the variables lnY_{TUR}, (GDP Türkiye) lnY_j (GDP partner) and $lnREX_j$ (Real exchange rates) respectively. Accordingly, α_i λ_i φ_i and γ_i are short-run coefficients. The error term $\varepsilon_{i,t} \approx$ IID $(0, \sigma^2)$, p, q, r, and s are the optimal lags based on the Schwarz-Bayesian Criterion (SBC). In the first stage, we determine whether the variables included in the analysis have a long-term relationship. If they have, long and short-term elasticity is obtained in the following stages (Özdemir et al., 2022: 1429). In the first step we test the null of H$_0$: $\phi_i = \delta_{1i} = \delta_{2i} = \delta_{3i} = 0$ against the alternative H$_1$: $\phi_i \neq \delta_{1i} \neq \delta_{2i} \neq \delta_{3i} \neq 0$. According to the model, if the short-run coefficient γ_i is negative and followed by a positive and significant long-run coefficient δ_{3i}, we can conclude that the J-curve is proved. However, Rose & Yellen (1989) define the J-curve as a short-term worsening or insignificant estimate followed by long-term *significant positive* effect (Hunter, 2019: 2).

The standard assumption is that currency appreciations and depreciations have symmetrical effects. However, exports and imports respond differently depending on the direction of the exchange rate variation. It is a widely recognised fact in the economic literature that economic agents react differently against changes from the equilibrium level. On that note, the recent focus on nonlinear structure is motivated by some empirical reasons. Rhee & Rich (1995) and Peltzman (2000) show that firms increase their prices when costs go up faster than they bring them down. Kim et al. (2019) found evidence that exchange rate appreciations are more passed through to export and import prices than depreciations, especially on differentiated goods closer to the consumer. Moreover, it is widely acknowledged in the economic literature that the effect of a decrease in prices on wages is not equivalent to that of an increase in prices. This phenomenon, known as *'sticky wages'*, is primarily attributed to price stickiness, thereby contributing to asymmetry and nonlinearity (Karimi et al., 2020: 12). Hiemstra & Jones (1992) found evidence of significant nonlinearities in aggregate trading volume. El-Bejaoui (2013) and Mahmood & Alkhateeb (2018) assert that *wealth and substitution effects* may lead to asymmetry through money demand. According to Kassi et al. (2019), the type of prevailing currency policies (fixed or floating regime), inflation level, and size of the exchange rate changes are also effective nonlinear factors. Arize & Malindretos (2012) show that asymmetry might occur in positive and negative deviations from the mean or the speed of adjustment when there is a deviation from equilibrium. Thus, the adjustment process could be nonlinear, where the trade balance responds differently to depreciations and appreciation. Shin et al. (2013) introduced a non-linear ARDL (NARDL) model to investigate whether there is long-term co-integration and an asymmetrical relationship. This method allowed us to decompose the movement of *LnREX* as $LnREX_{NEG}$ (depreciation) and $LnREX_{POS}$ (appreciation) values. Thus, we generate two new series as follows.

$$LnREX_{POS,t} = \sum_{j=1}^{t} \Delta lnREX_j^{+} = \sum_{j=1}^{t} \max(\Delta lnREX_j, 0) \quad (7)$$

$$LnREX_{NEG,t} = \sum_{J=1}^{t} \Delta lnREX_j^{-} = \sum_{j=1}^{t} \min(\Delta lnREX_j, 0) \quad (8)$$

Now we can replace *LnREX* in equation (6) with a positive and negative value in equations (7) and (8); it yields;

$$\Delta LnTB_{i,t} = \alpha_0 + \sum_{k=1}^{\rho} \alpha_i \Delta LnTB_{j,t-k} + \sum_{k=1}^{q} \lambda_i \Delta LnY_{Tur,t-k} + \sum_{k=1}^{r} \varphi_i \Delta LnY_{j,t-k} + \sum_{k=1}^{s} \gamma_i \Delta LnREX_{j,t-k}^{+} +$$
$$\sum_{k=1}^{l} \Phi_i \Delta LnREX_{j,t-k}^{-} + \phi_i LnTB_{j,t-1} + \delta_{1i} LnY_{Tur,t-1} + \delta_{2i} LnY_{j,t-1} + \delta_{3i} LnREX_{j,t-1} + \varepsilon_t \quad (9)$$

Eventually, we achieved a non-linear expression of the ARDL model in equation (6) by introducing a partial sum of LnREX in equations (7) and (8). It enables us to examine whether fluctuations in the exchange rates have a symmetric or asymmetric impact on the trade balance between trading partners. Lastly, we have also checked the stability of the ARDL model by cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests based on the recursive regression residuals. Because the existence of a cointegration does not necessarily imply that the estimated coefficients in regression are stable. If it is concluded that the coefficients are stable according to the CUSUM test, it is decided that there is no structural change.

In the second step, we checked the possible causal relationship between variables. Standard Granger (1969) non-causality tests are commonly used to investigate causal interactions. These models assume that the causal impacts of positive and negative shocks are identical. However, the causal relation could also be nonlinear. On that note, Akerlof (1970) introduced asymmetric information. According to the theory, economic agents react differently to negative shocks than positive ones. Dennis et al. (2006) and Talpsepp & Rieger (2009) found that volatility might respond heavily to negative return shocks rather than positive ones in financial markets due to asymmetric information and the heterogeneity of economic agents. Granger & Yoon (2002) introduced the concept of hidden cointegration based on cumulative positive and negative shocks to clarify this relationship. Finally, Hatemi-J (2011) extended the causality test to allow for asymmetric causal effects, with the understanding that positive and negative shocks may have different causal impacts (Umar & Dahalan, 2016: 420-1). Thus, the causal relationship between the real exchange rate and the trade balance is further investigated using the Bootstrap Toda-Yamamoto test. Granger & Yoon (2002) defined the stochastic process between two integrated variables, x_t and y_t, in line with the cumulative sums approach;

$$y_t = y_{t-1} + e_{1t} = y_0 + \sum_{i=1}^{t} \varepsilon_{1i} \tag{10}$$

$$x_t = x_{t-1} + e_{2t} = x_0 + \sum_{i=1}^{t} \varepsilon_{2i} \tag{11}$$

where x_0 and y_0 are the initial values of the random walk process, e_{1i} and e_{2i} are the white noise terms. Positive and negative shocks can be defined as the maximum and the minimum value of disturbance term, $\varepsilon_{1i}^{+} = \max\ (\varepsilon_{1i};0)$, $\varepsilon_{2i}^{+} = \max\ (\varepsilon_{2i};0)$, $\varepsilon_{1i}^{-} = \min\ (\varepsilon_{1i};0)$ and $\varepsilon_{2i}^{-} = \min\ (\varepsilon_{2i};0)$ (Hatemi-J, 2012: 449). Accordingly, new error terms are $\varepsilon_{1i} = \varepsilon_{1i}^{+};\varepsilon_{1i}^{-}$ and $\varepsilon_{2i} = \varepsilon_{2i}^{+};\varepsilon_{2i}^{-}$. Now, we defined the following decomposition of negative and positive shocks of x and y;

$$y_t = y_{t-1} + \varepsilon_{1t} = y_0 + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-} \tag{12}$$

$$x_t = x_{t-1} + \varepsilon_{2t} = x_0 + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{13}$$

Then, we denote the positive and negative shocks of variables x and y in cumulative form as follows;

$$y_t^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+} \ ; \ y_t^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-} \ ; \ x_t^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+} \ ; \ x_t^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{14}$$

In equation (14), each shock has a permanent effect. We can estimate each effect using the Vector Autoregressive Model (VAR) p model.

$$y_t^{+} = \alpha_0 + \alpha_1 y_{t-1}^{+} + ...\alpha_\rho y_{t-\rho}^{+} + \beta_1 x_{t-1}^{-} + \beta_2 x_{t-2}^{-} + ...\beta_\rho x_{t-\rho}^{-} + u_t \tag{15}$$

Equation (15) provides the causal linkage that arises from the negative shocks of variable x toward the positive shocks of variable y. This is the standard Granger non-causality model. In the traditional causality tests, F and χ^2 distributions may have non-standard asymptotic properties when the series under consideration are stationary at different orders and the ARCH effect is present. The "bootstrap" distribution would be better than the F or χ^2 distributions. Conventional causality tests require the stability of time series data, and the integration process should be identical. The Toda Yamamoto method will improve if the time series integration process differs. The causality test by Toda & Yamamoto (1995) requires estimating the following VAR(ρ+d_{Max}) model (Moftah & Dilek, 2021: 62). In this respect, Hatemi-J (2012) modified the lag length (ρ) in the equation (15) and estimate VAR (ρ+d_{Max}) model.

$$y_t^{+} = \alpha_0 + \alpha_1 y_{t-1}^{+} + ...\alpha_\rho y_{t-\rho}^{+} + \alpha_{\rho+d} y_{t-(\rho+d)}^{+} + \beta_1 x_{t-1}^{-} + ...\beta_\rho x_{t-\rho}^{-} + \beta_{\rho+d} x_{t-(\rho+d)}^{-} + v_t \tag{16}$$

VAR (ρ+d_{Max}) model in Equation (16) measures the causal linkage between negative x and positive y under the null hypothesis of *"negative shocks of variable x does not granger cause positive shocks of variable y"*, H_0: $\beta_1 = \beta_2 = \ldots \beta_\rho = 0$ against the alternative, $H_1 \neq \ldots \beta_\rho = 0$.

4. Empirical Findings

In this section, we estimated the primary model by adopting linear and non-linear methods using bilateral trade data from the 2000Q1-2022Q4 period. The data are retrieved from the electronic databases of the World Bank (2023) World Development Indicators, the IMF (2023) International Financial Statistics, the Turkish Statistical Institute (TUIK), and the Central Bank of the Republic of Türkiye (EVDS). We gathered bilateral trade data to avoid the problem of aggregate bias. Our study covers seven major non-EU trading partners of Türkiye, namely China, India, Russia, the USA, Ukraine, Saudi Arabia, and the United Arab Emirates (UAE). Before estimating the models, it would be helpful to demonstrate the statistical properties of the time series. On that note, we present common statistics (such as mean, median, skewness, and kurtosis) of the dataset to describe the basic features of variables in Table 1. A normal distribution has a zero skewness (perfectly symmetrical around the mean) and a kurtosis of three. Based on the provided kurtosis and skewness values, it can be inferred that the dataset closely approximates a normal distribution. However, to be more precise, the Jargue-Bera test statistic should be evaluated.

Table: 1
Descriptive Statistics of Data Set

Statistics	TB	GDP	REX	Covariance Analysis			
Mean	3.984	1.07E+12	0.590		TB	GDP	REX
Median	2.664	2.75E+11	0.313	TB	1.157	0.425	-0.801
Maximum	28.761	5.24E+12	4.926	GDP	0.425	2.691	0.713
Minimum	0.168	1.31E+10	0.025	RER	-0.801	0.713	1.792
Std. Dev.	1.077	1.64E+00	1.340	Correlation Analysis			
Skewness	-0.27	0.45	-0.06		TB	GDP	REX
Kurtosis	2.82	2.96	3.10	TB	1	0.641	-0.576
Jarque-Bera	4.43	3.32	15.66	GDP	0.641	1	0.513
Probability	0.10	0.19	0.00	RER	-0.576	0.513	1

According to the Jarque-Bera test statistic (it is usually used for large data sets because other normality tests are not reliable when n is large), the null hypothesis of the error term is not rejected (0.10 and 0.19 > 0.01) in terms of their probability means that series are normally distributed except for RER variable. Secondly, correlation analysis assesses the linear relationship between variables, with correlation values ranging from -1 to +1. In this case, both variables exhibit a moderate correlation, surpassing the 0.5% significance level. The negative sign indicates that changes in the variables occur in opposite directions. Additionally, covariance, denoted as cov (x; y), quantifies how two random variables vary together, representing the direction of their linear relationship and how they change in tandem. In Table 1, the negative covariance coefficient between TB and REX implies that these variables tend to exhibit opposite behaviour, while the remaining pairwise comparisons show positive movement.

After descriptive statistics, we must determine the order of integration of the time series to ensure that they combine I(0) and I(1). We cannot run the ARDL bound test if any series are integrated in the second order. To this end, all variables were tested using the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) unit root test.

Table: 2
Unit Root Tests

	TB		GDP(Y)		REX	
	ADF	PP	ADF	PP	ADF	PP
Trade Partner	H_0=I(0)	H_0=I(0)	H_0=I(1)	H_0=I(1)	H_0=I(1)	H_0=I(1)
China	-4.33***	-4.39***	-3.85***	-4.76***	-8.75***	-8.63***
India	-4.51***	-4.10***	-7.36***	-9.64***	-10.79***	-9.47***
Russia	-3.16**	-3.52***	-4.34***	-12.05***	-4.62***	-9.15***
USA	-1.39*	-1.05	-11.73***	-9.08***	-9.08***	-9.07***
Ukraine	-1.96*	-1.64*	-7.41***	-10.07***	-8.53***	-8.67***
S. Arabia	-2.73*	-2.61*	-10.68***	-11.88***	-9.40***	-8.59***
UAE	-2.79*	-2.74*	-10.59***	-11.51***	-9.32***	-8.72***
Türkiye	-	-	-4.37***	-8.64***	-	-

*Note: H_0 = I(0) and H_0 = I(1) of the ADF and PP tests show that the variable is stationary at their level and first difference against the alternative hypothesis, respectively. The numbers in parentheses are probability values. ***, **, and* denote statistical significance at the % 1, % 5, and 10% levels. The Schwarz Bayesian Criterion (SBC) determines the lag order.*

In Table 2, we reported the test results of the model. Accordingly, the TB variable is stationary at its level for all partners. The null hypothesis (unit root) has been rejected at conventional test size, and it can be concluded that TB series are stationary at level I(0). However, Y (income) and REX variables follow the I(1) process. We fail to reject the null hypothesis for these variables at the 1% level. Therefore, it is proved that Y and REX are integrated in order one for all trading partners. Also, we ensure that none of our variables are integrated in the second order, I(2). Thus, we can go further and safely estimate the ARDL model.

At the first stage, we estimate both the linear (equation 6) and nonlinear (equation 9) ARDL models, respectively, based on SBC criteria with optimum lags to select the best-fitted model using bilateral data between Türkiye and each of its seven major trading partners. We present the results in Tables 3-9. We split the tables into two groups: linear and non-linear models. Finally, we provided their diagnostics for each. We impose a maximum of 4 lags on each first-difference variable since we use quarterly data and employ the SCB to select the optimum number of lags for the model. As suggested by Pesaran et al. (2001), we selected the orders of the model specified as ARDL ($p{:}q_1{:}q_2{:}q_3$) representing the lags belonging to four variables: TB, $GDP_{Partner}$, GDP_{Tur}, and REX.

Initially, we reported the short-run model to determine the j-curve. Following Rose & Yellen (1989), we defined the evidence for the J curve as a *"short-run deterioration or insignificant estimates of the FX rate"*, together with *"long-run significantly positive effects" instead of the* traditional definition. Accordingly, our findings indicate a linear confirmation of the J-curve only for Russia and the UAE. This is due to the positive and statistically significant coefficient observed in the long run, at least at the 10% significance level. A real depreciation of the Turkish lira against the currencies of these countries appears favourable to the trade balance. We also gather that the income levels in Russia and Saudi Arabia have negative coefficients but are statistically insignificant. UAE has a positive coefficient at the 10% significance level, which affects external balance positively with this partner. For the remaining countries, namely China, India, the USA, Ukraine, and Saudi Arabia, exchange rate depreciation has some short-term effects but doesn't last in the long term, and so they are not considered in the decision criteria building as they have a negative sign of exchange rate variables. The long-run results revealed that the real depreciation of the Turkish lira against the currencies of those countries has unfavourable impacts on Türkiye's external balance with these partners since the lnREX has a negative and significant coefficient. This result also indicates that the Marshall-Lerner (ML) condition does not hold. In the long run, trade with these partners (such as China, India, the USA, Ukraine, and Saudi Arabia) may result from the positive impact of devaluation against one country, but this effect could be counteracted by its negative impact against another. Additionally, the high foreign dependency of the Turkish economy, particularly in terms of intermediate goods and inputs (e.g. energy), plays a significant role in shaping these dynamics.

Diagnostic tests and cointegration results are required to verify the short-run results. If the variables are co-integrated, the lagged level of the variables must be retained, which jointly forms the lagged error correction term. Section C in Part I reports the cointegration relationship between Türkiye and these partners since the calculated F-stats are higher than the critical upper bound value. Thus, we can reject the null hypothesis of *"no cointegration"* with at least a 10% significance level for Russia, the UAE, and other partners and infer a long-run relationship among variables. A negative and significant coefficient obtained for ECM_{t-1} is also an indication of cointegration. It measures the speed of adjustment needed to restore equilibrium in the long run. The results show that they have a negative sign as expected, and they are statistically significant at the 1% confidence level in almost all cases, supporting gradual convergence toward long-run equilibrium or cointegration. The average coefficient of -0.29 for the entire model means that deviation from the long-run equilibrium due to an external shock is attained only after 3,44 quarter periods. Another diagnostic test is the Lagrange multiplier (LM) statistic for detecting serial correlation. Probability values in the parenthesis support the autocorrelation-free residuals since we cannot reject the null hypothesis that "no serial correlation" exists for all partners. In addition, we conducted white tests to determine the heteroscedastic (differently dispersed) errors. We cannot reject the null hypothesis because the variances for the errors are not equal due to probability values in the parenthesis, and we get evidence that there is no heteroskedasticity. The third diagnostic test is the Ramsey Reset test to check model specifications. According to the probability values in parenthesis, test results prove we cannot reject the null hypothesis of "the model is correctly specified" for all cases. We also applied the cumulative sum (CUSUM) and cumulative sum of the squares (CUSUMSQ) tests for parameter stability. We denote the stable coefficient of the ARDL model as "S" and the unstable one as "US". The results for the sample countries yielded the same outcomes, and the CUSUM test or the CUSUMSQ test appeared stable except in Ukraine. Lastly, adjusted R^2 is also reported to assess the goodness of fit.

In the second step, we analysed the NARDL model reported in Part 2. We detected asymmetric formation with some trade partners since the coefficient estimates obtained for $\Delta LnREX_{POS}$ and $\Delta LnREX_{NEG}$ variables differ in size, sign, and duration, except for Ukraine and Saudi Arabia. We gather that, at least at the 10% significance level, the NEG and POS variables carry significant coefficients in the short run. However, asymmetric effects have lasted only for India, the USA, and the UAE in the long run. The NEG (depreciation) and

POS (appreciation) variables of exchange rates have either a positive or negative sign. The estimates indicate the j-curve pattern for these partners, and their coefficients are statistically significant at various confidence levels. For instance, in the results for India, the effects of the $LnREX_{POS}$ and $LnREX_{NEG}$ variables are different, and both are significant at the 10% level. For this partner, the results support the existence of the J-curve, as indicated by the positive and statistically significant coefficient (4.08) of $LnREX_{POS}$ in the long term. This suggests that an appreciation of the Turkish lira leads to an improvement in India's trade balance. Additionally, these effects were asymmetric, with lira depreciation having a less negative impact on mutual trade. The significance of the difference between the positive and negative coefficients is uncertain, and further evaluation is needed through a statistical test such as the t-test to determine the normalised coefficient of positive $LnREX_{POS}$ and $LnREX_{NEG}$ variables for each country. As a result, our analysis revealed evidence supporting both short and long-run asymmetry, further corroborating the existence of the J curve phenomenon. This aligns with the findings of studies utilising non-linear models such as Bahmani-Oskee & Fariditavana (2015), Nusair (2017), Arı, Cergibozan & Cevik (2019), Hunter (2019), Bahmani-Oskee & Durmaz (2019), and Bhat & Bhat (2021).

To do this, we can use the formula as suggested by Bahmani-Oskee et al. (2016) $t = \beta_{Pos} - \beta_{Neg} / \sqrt{\sigma_{Pos}^2 + \sigma_{Neg}^2}$, where β denotes the normalised coefficient estimate, which is obtained for $\Delta LnREX_{POS}$ and $\Delta LnREX_{NEG}$ variable for tables 2-8 and σ is the corresponding standard error term. We reported the t-statistics in the parentheses as (0.55) for China, (2.98) for India, (3.12) for Russia, (3.33) for USA, (1.24) for Saudi Arabia, (1.65) for Ukraine, and (3.53) for UAE. It can be inferred that except for China and Saudi Arabia, t ratios are significant, at least at the 10% level, supporting asymmetric effects of exchange rate changes on the trade balance of Türkiye.

To verify these results, we have to conduct the diagnostic tests again. For all non-linear models, cointegration is supported by the F tests. Next, the term error carries a negative sign and is statistically significant in all cases. The "average" of the significant negative error term (ECM_{t-1}) is 0.36 for all models, indicating convergence, which means that deviations from the steady state condition are corrected nearly 2,77 quarters later. According to the LM and White tests, residuals are all autocorrelation and heteroscedasticity-free. Ramsey Reset tests point out that there is no model specification error in the non-linear models. Finally, the CUSUM and CUSUMSQ plots remain within the critical bounds of a 5% significance level, indicating the stability of the estimated coefficients except in Ukraine and Saudi Arabia. Consequently, we found evidence of the j-curve in 2 out of 7 trading partners in Türkiye for the linear model and in 4 trading partners for the non-linear model.

Table: 3
Estimates of the Türkiye-China Trade Model

Part 1: Linear Estimation of ARDL			
Section A: Short-Term Model			

Lag Length	0	1	2	3	4		
ΔLnTB	-	0.66 (5.76***)					
ΔGDP_{TUR}	0.38 (1.02)						
ΔGDP_{CHINA}	-0.22 (0.75)						
ΔLnREX	-0.04 (0.75*)						
Section B: Long-Term Model							
Constant	-8.72 (0.42)						
GDP_{TUR}	0.86 (0.45)						
GDP_{CHINA}	-1.63 (0.62)						
LnREX	0.42 (0.45)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.42**	-0.31 (4.28***)	0.55 [0.57]	1.34 [0.20]	0.32 [0.57]	S	S	0.58
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	-0.65 (5.65***)					
ΔGDP_{TUR}	0.26 (0.43)						
ΔGDP_{CHINA}	-0.36 (1.74*)						
$\Delta LnREX_{Pos}$	-0.17 (5.65***)						
$\Delta LnREX_{Neg}$	2.02 (1.75*)	-3.20 (1.64*)					
Section B: Long-Term Model							
Constant	-19.42 (2.86***)						
GDP_{TUR}	-1.77 (2.11***)						
GDP_{CHINA}	-1.60 (2.04***)						
$LnREX_{Pos}$	0.19 (0.16)						
$LnREX_{Neg}$	-1.21 (0.53)						
Section C: Stability Tests							
F Test	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
3.58*	-0.34 (4.32***)	1.45 [0.21]	1.12 [0.34]	0.30 [0.58]	S	S	0.42

*Note: Absolute t-ratios are in parentheses. ***, **, and * indicate the null hypothesis to be rejected at 1% (2.58), 5%, (1.96) or 10% (1.64) significance level, respectively. Numbers inside the brackets are probability values. The corresponding critical values of lower: I(0) and upper bounds: I(1) to test the null hypothesis of no cointegration are 2.72 and 3.77 at 10%, 3.23 and 4.35 at 5%, 4.29 and 5.61 at 1% confidence level in the linear model and 2.45 and 3.52 at 10%, 2.86 and 4.01 at 5%, 3.74 and 5.06 at 1% confidence level in the non-linear model. The models have been estimated following the general-to-specific approach (uni-directional method and p-value backwards 10% significance level as stopping criteria) with maximum lag length 4 (Campa & Goldberg, 2005; Dellatte & Villavicencio, 2012).*

Table: 4
Estimates of the Türkiye-India Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	-0.68 (6.48***)	-0.19 (1.55)	0.20 (1.94*)			
ΔGDP_{TUR}	0.22 (0.56)						
ΔGDP_{INDIA}	0.20 (0.35)						
ΔLnREX	-0.18 (1.66*)						
Section B: Long-Term Model							
Constant	-7.23 (1.82*)						
GDP_{TUR}	0.55 (1.52)						
GDP_{INDIA}	-0.28 (1.32)						
LnREX	-0.70 (1.69*)						
Section C: Stability Tests							
F Test	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
7.83***	-0.32 (4.56***)	1.05 [0.35]	1.68 [0.09*]	0.12 [0.87]	S	S	0.45
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	0.68 (8.01***)	-0.20 (1.57)	0.19 (1.95*)			
ΔGDP_{TUR}	0.18 (0.43)						
ΔGDP_{INDIA}	-0.17 (0.35)						
$\Delta LnREX_{Pos}$	-0.52 (1.71*)						
$\Delta LnREX_{Neg}$	0.65 (1.68*)						
Section B: Long-Term Model							
Constant	-16.65 (1.89*)						
GDP_{TUR}	0.51 (0.38)						
GDP_{INDIA}	0.71 (0.57)						
$LnREX_{Pos}$	4.08 (1.72*)						
$LnREX_{Neg}$	-2.93 (2.21**)						

Section C: Stability Tests							
F Test	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
3.89*	-0.36 (4.47***)	1.27 [0.25]	1.10 [0.37]	0.26 [0.60]	S	S	0.63

Note: Same as Table 2.

Table: 5
Estimates of the Türkiye-Russia Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	-0.74 (4.52***)					
ΔGDP_{TUR}	-0.52 (2.20**)	0.94 (4.77***)					
ΔGDP_{RUSSIA}	-0.28 (1.24)						
$\Delta LnREX$	-0.21 (1.95**)						
Section B: Long-Term Model							
Constant	13.25 (0.39)						
GDP_{TUR}	1.59 (2.97***)						
GDP_{RUSSIA}	-1.10 (1.25)						
LnREX	0.78 (2.03**)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.27**	-0.22 (4.20***)	0.20 [0.97]	1.49 [0.10]	0.31 [0.56]	S	S	0.65
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	0.73 (9.65***)					
ΔGDP_{TUR}	-0.64 (2.56**)						
ΔGDP_{RUSSIA}	-0.13 (0.55)						
$\Delta LnREX_{Pos}$	1.21 (1.74*)	-1.56 (2.18**)					
$\Delta LnREX_{Neg}$	-1.63 (3.51***)						
Section B: Long-Term Model							
Constant	14.07 (2.03*)						
GDP_{TUR}	2.13 (2.34**)						
GDP_{RUSSIA}	-0.96 (1.70*)						
$LnREX_{Pos}$	2.43 (0.34)						
$LnREX_{Neg}$	-4.10 (0.89)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.03**	-0.27 (4.58***)	0.15 [0.83]	1.52 [0.12]	0.11 [0.72]	S	S	0.68

Note: Note: Same as Table 2.

Table: 6
Estimates of the Türkiye-USA Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	0.49 (4.72***)	0.30 (3.11***)				
ΔGDP_{TUR}	-0.13 (0.55)	0.63 (2.79***)					
ΔGDP_{USA}	2.34 (2.75***)						
$\Delta LnREX$	-0.32 (3.42***)						
Section B: Long-Term Model							
Constant	-4.13 (0.78)						
GDP_{TUR}	-4.98 (1.49)						
GDP_{USA}	15.30 (1.65*)						
LnREX	-1.99 (2.97***)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
5.71***	-0.18 (3.80***)	0.77 [0.46]	0.77 [0.46]	1.27 [0.26]	S	S	0.87

Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	-0.49 (4.82***)	-0.28 (2.99***)				
ΔGDP_{TUR}	0.14 (0.41)	-0.45 (2.05**)					
ΔGDP_{USA}	0.31 (1.67*)						
$\Delta LnREX_{Pos}$	-0.62 (2.88***)						
$\Delta LnREX_{Neg}$	1.03 (3.71***)						
Section B: Long-Term Model							
Constant	-21.07 (2.44**)						
GDP_{TUR}	-3.29 (2.23**)						
GDP_{USA}	2.89 (2.27**)						
$LnREX_{Pos}$	-3.23 (3.18***)						
$LnREX_{Neg}$	4.05 (4.41***)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.72**	-0.21 (4.20***)	0.75 [0.43]	0.73 [0.79]	0.09 [0.83]	S	S	0.85

Note: Same as Table 2.

Table: 7
Estimates of the Türkiye-Ukraine Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	-0.41 (4.74***)					
ΔGDP_{TUR}	0.34 (0.93)	1.10 (2.51**)	-1.90 (4.96***)				
$\Delta GDP_{UKRAINE}$	-0.58 (3.39***)	0.10 (0.51)	0.88 (5.14***)	0.28 (2.33**)			
$\Delta LnREX$	-0.25 (2.48**)						
Section B: Long-Term Model							
Constant	18.14 (3.13***)						
GDP_{TUR}	-0.79 (1.03)						
$GDP_{UKRAINE}$	0.86 (5.52***)						
LnREX	-0.25 (2.48**)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
6.50***	-0.53 (7.33***)	0.51 [0.59]	1.78 [0.03**]	0.41 [0.51]	S	US	0.74
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	-0.39 (4.36***)					
ΔGDP_{TUR}	-2.04 (5.04***)	1.16 (2.71**)	0.14 (0.38)				
$\Delta GDP_{UKRAINE}$	-0.49 (3.19**)	-0.34 (1.85**)	0.95 (6.09**)				
$\Delta LnREX_{Pos}$	1.81 (1.79*)						
$\Delta LnREX_{Neg}$	-1.32 (3.30***)						
Section B: Long-Term Model							
Constant	24.33 (4.41***)						
GDP_{TUR}	1.26 (1.86*)						
$GDP_{UKRAINE}$	-0.46 (1.95*)						
$LnREX_{Pos}$	-1.80 (3.38***)						
$LnREX_{Neg}$	-0.78 (1.92*)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
9.28***	-0.27 (7.21***)	3.46 [0.03**]	1.45 [0.17]	0.24 [0.62]	S	US	0.77

Note: Same as Table 2.

Table: 8
Estimates of the Türkiye-Saudi Arabia Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
$\Delta LnTB$	-	1.07 (5.38***)	-0.37 (2.94***)				
ΔGDP_{TUR}	1.33 (2.10**)	-1.06 (1.77*)	2.34 (3.90***)	-1.84 (3.04***)			
$\Delta GDP_{S.ARABIA}$	-0.77 (1.60)						
$\Delta LnREX$	0.19 (1.09)						

Section B: Long-Term Model							
Constant	17.02 (069)						
GDP_{TUR}	2.39 (0.99)						
$GDP_{S.ARABIA}$	-1.75 (0.55)						
LnREX	-0.81 (1.65*)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.38**	-0.21 (4.24***)	1.37 [0.25]	1.52 [0.12]	7.94 [0.00***]	S	S	0.81
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	-0.31 (2.98***)	1.06 (9.98***)				
ΔGDP_{TUR}	0.98 (1.34)	-1.15 (1.89*)	2.31 (3.86***)	-1.92 (3.14***)			
$\Delta GDP_{S.ARABIA}$	0.24 (0.33)						
$\Delta LnREX_{Pos}$	0.94 (1.68*)						
$\Delta LnREX_{Neg}$	-0.11 (0.92)						
Section B: Long-Term Model							
Constant	17.48 (1.97**)						
GDP_{TUR}	-1.60 (0.46)						
$GDP_{S.ARABIA}$	-9.43 (1.53)						
$LnREX_{Pos}$	3.91 (1.43)						
$LnREX_{Neg}$	-0.49 (0.21)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
3.68*	-0.23 (4.72***)	2.72 [0.07*]	1.62 [0.07*]	1.37 [0.17]	S	US	0.85

Note: Same as Table 2.

Table: 9
Estimates of the Türkiye-UAE Trade Model

Part 1: Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	0.73 (6.65***)					
ΔGDP_{TUR}	1.12 (1.64*)						
ΔGDP_{UAE}	-1.16 (1.64*)						
ΔLnREX	-1.11 (1.99**)	1.29 (2.08***)					
Section B: Long-Term Model							
Constant	-11.56 (1.21)						
GDP_{TUR}	1.78 (1.04)						
GDP_{UAE}	1.99 (0.77)						
LnREX	0.66 (1.69*)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
4.15*	-0.23 (3.40***)	0.61 [0.50]	0.83 [0.71]	0.70 [0.40]	S	S	0.71
Part 2: Non-Linear Estimation of ARDL							
Section A: Short-Term Model							
Lag Length	0	1	2	3	4		
ΔLnTB	-	0.59 (6.60***)					
ΔGDP_{TUR}	-0.37 (1.79*)						
ΔGDP_{UAE}	-0.97 (1.39)						
$\Delta LnREX_{Pos}$	-3.14 (2.85***)						
$\Delta LnREX_{Neg}$	2.15 (2.70***)						
Section B: Long-Term Model							
Constant	-9.32 (1.72*)						
GDP_{TUR}	6.38 (2.13**)						
GDP_{UAE}	-5.32 (1.70*)						
$LnREX_{Pos}$	6.39 (2.46**)						
$LnREX_{Neg}$	-4.37 (2.81***)						
Section C: Stability Tests							
F	ECM_{t-1}	LM	White Test	Ramsey Reset	CUSUM	$CUSUM^2$	Adj. R^2
6.34***	-0.49 (4.77***)	0.96 [0.38]	0.95 [0.53]	0.17 [0.85]	S	S	0.74

Note: Same as Table 2.

After estimating the ARDL model for each partner, we can use the first differences to investigate the causal connection between the exchange rate and trade balance. For this purpose, we employed the linear Granger causality test. It investigates whether the historical information of one time series could help improve the predictability of the present and future estimations for another time series (Yu et al., 2015: 304).

Table: 10
Linear Granger Causality Test

Country	Null Hypothesis	Lag Lenght	$\chi 2$ Test Statistic	Probability Value
China	*LnTB≠> LnRex*	1	0.47	0.78
	LnRex≠> LnTB		2.58	0.27
India	*LnTB≠> LnRex*	3	1.82	0.40
	LnRex≠> LnTB		0.73	0.69
Russia	*LnTB≠> LnRex*	4	3.64	0.16
	LnRex≠> LnTB		0.38	0.82
USA	*LnTB≠> LnRex*	2	2.61	0.26
	LnRex≠> LnTB		5.77**	0.04
Ukraine	*LnTB≠> LnRex*	3	5.41	0.14
	LnRex≠> LnTB		6.97**	0.03
S. Arabia	*LnTB≠> LnRex*	2	0.18	0.91
	LnRex≠> LnTB		0.47	0.78
UAE	*LnTB≠> LnRex*	2	2.63	0.10
	LnRex≠> LnTB		0.39	0.53

*Note: ***, **, and * indicate the null hypothesis to be rejected at 1%, 5%, or 10% significance level, respectively.*

Table 10 shows the results from the linear Granger non-causality test. We estimated $\chi 2$ statistics and p-values based on the SCB criteria. The lag length was determined with robustness in mind, and we ensured the models were stable by confirming that all characteristic roots were less than one and that all models were free from heteroscedasticity and autocorrelation. Our tests revealed evidence of unidirectional causality, where the exchange rate is the cause of the trade balance with the USA and Ukraine at a 5% confidence level. However, for the remaining partners, we could not reject the null hypothesis of no Granger causality between the series. Due to some drawbacks, we did not find enough evidence to support a co-integration relationship, as was the case for most partners.

A limitation of the linear causality technique is the potential for disregarding non-linear connections. Indeed, there can be relationships between asymmetry and nonlinearity in economic agents or macroeconomic variables, especially when considering threshold effects. For example, in monetary policy, the impact of interest rate changes on economic activity may be asymmetric, with different effects observed below and above a specific interest rate threshold. Second, asymmetry and nonlinearity can also interact through feedback mechanisms in economic systems. Feedback loops can amplify or dampen the effects of shocks or changes in economic variables, leading to nonlinear responses. Lastly, in complex economic systems, asymmetry and nonlinearity often arise from the interactions between multiple agents and variables. Therefore, exploring non-linear causal connections among the relevant variables is crucial. In that respect, we reported the asymmetric Granger non-causality test results between LnREX and the LnTB variable. Exchange rate effects are expected to be more sensitive to negative shocks than positive ones. Therefore, the markets could have asymmetric causal effects (Erdoğan et al. 2022: 31729). In this context, four types of directions can be defined for positive or negative shocks that follow from LnREX to LnTB. Table 11 presents the results of the bootstrap panel Granger causality analysis according to four directions for the null hypothesis that real exchange rate changes do not cause trade balance and vice versa. We make decisions according to our critical values. The underlying empirical data is used in a bootstrap simulation conducted 10,000 times to generate critical values. After each iteration, MWALD t-statistics are estimated to determine the upper αth quantile of the bootstrapped distribution of MWALD t-statistics, which generates 1%, 5%, and 10% confidence levels. If the MWALD statistics are greater than the bootstrapped critical values, the null hypothesis of non-Granger causality is typically rejected. The bootstrap method can yield robust results even if there are ARCH effects and deviations from a normal distribution in the model (Pata & Terzi, 2016: 62-4).

Table: 11
Asymmetric Bootstrap Toda-Yamamoto Test

Country & Null Hypothesis	Optimal Lag Length	M. Wald Test Statistics	Asymptotic χ2 Probability Values	Leverage Bootstrap		
				1% CV	5% CV	10% CV
China						
$LnRex^{+} \not\Rightarrow LnTB^{+}$	2	0.97	0.55	8.46	4.02	2.77
$LnRex^{+} \not\Rightarrow LnTB^{-}$	1	1.89	0.16	12.15	4.46	2.53
$LnRex^{-} \not\Rightarrow LnTB^{+}$	3	0.38	0.86	11.38	4.88	2.66
$LnRex^{-} \not\Rightarrow LnTB^{-}$	1	0.89	0.51	12.06	4.24	2.84
$LnTB+ \not\Rightarrow LnRex+$	2	1.11	0.29	8.28	4.29	2.79
$LnTB+ \not\Rightarrow LnRex-$	1	2.45	0.11	8.65	3.88	2.59
$LnTB- \not\Rightarrow LnRex+$	3	2.56	0.10	9.45	4.60	3.17
$LnTB- \not\Rightarrow LnRex-$	1	1.54	0.21	9.617	5.38	3.17
India						
$LnRex^{+} \not\Rightarrow LnTB^{+}$	1	17.14**	0.00	27.09	16.50	13.52
$LnRex^{+} \not\Rightarrow LnTB^{-}$	2	0.23	0.88	8.74	4.61	3.05
$LnRex^{-} \not\Rightarrow LnTB^{+}$	1	0.31	0.57	6.53	3.69	2.64
$LnRex^{-} \not\Rightarrow LnTB^{-}$	1	0.29	0.69	9.57	4.30	2.97
$LnTB+ \not\Rightarrow LnRex+$	3	3.82*	0.05	9.85	4.74	3.23
$LnTB+ \not\Rightarrow LnRex-$	1	0.72	0.39	7.41	3.99	2.54
$LnTB- \not\Rightarrow LnRex+$	2	1.92	0.16	7.61	4.76	2.94
$LnTB- \not\Rightarrow LnRex-$	1	0.20	0.64	10.53	5.06	3.51
Russia						
$LnRex^{+} \not\Rightarrow LnTB^{+}$	1	1.29	0.25	9.01	4.36	3.05
$LnRex^{+} \not\Rightarrow LnTB^{-}$	1	0.62	0.43	7.81	3.83	2.66
$LnRex^{-} \not\Rightarrow LnTB^{+}$	2	0.20	0.65	11.83	6.51	4.70
$LnRex^{-} \not\Rightarrow LnTB^{-}$	1	13.22***	0.00	9.07	5.10	2.98
$LnTB+ \not\Rightarrow LnRex+$	2	0.25	0.65	6.69	4.04	3.01
$LnTB+ \not\Rightarrow LnRex-$	1	0.30	0.58	8.54	4.66	3.31
$LnTB- \not\Rightarrow LnRex+$	3	15.47***	0.00	10.86	4.48	2.70
$LnTB- \not\Rightarrow LnRex-$	2	5.60**	0.01	8.82	4.39	3.00
USA						
$LnRex^{+} \not\Rightarrow LnTB^{+}$	1	0.52	0.81	5.96	3.70	2.59
$LnRex^{+} \not\Rightarrow LnTB^{-}$	1	0.18	0.66	6.99	4.23	3.07
$LnRex^{-} \not\Rightarrow LnTB^{+}$	1	6.93**	0.04	13.91	7.30	5.04
$LnRex^{-} \not\Rightarrow LnTB^{-}$	1	0.17	0.67	8.99	4.15	2.81
$LnTB+ \not\Rightarrow LnRex+$	3	0.14	0.89	8.55	4.73	3.30
$LnTB+ \not\Rightarrow LnRex-$	3	0.32	0.84	20.03	7.32	4.98
$LnTB- \not\Rightarrow LnRex+$	1	0.37	0.54	13.08	4.27	2.63
$LnTB- \not\Rightarrow LnRex-$	2	6.39**	0.04	13.91	7.30	5.04
Ukraine						
$LnRex^{+} \not\Rightarrow LnTB^{+}$	1	2.66	0.44	14.29	9.62	7.32
$LnRex^{+} \not\Rightarrow LnTB^{-}$	2	1.71	0.42	7.47	3.87	2.60
$LnRex^{-} \not\Rightarrow LnTB^{+}$	2	2.74	0.25	11.03	6.58	5.04
$LnRex^{-} \not\Rightarrow LnTB^{-}$	3	0.11	0.73	7.25	4.03	2.70
$LnTB+ \not\Rightarrow LnRex+$	1	5.61	0.13	12.56	8.82	6.73
$LnTB+ \not\Rightarrow LnRex-$	2	0.82	0.66	10.15	6.34	4.74
$LnTB- \not\Rightarrow LnRex+$	2	0.84	0.35	8.63	4.13	2.70
$LnTB- \not\Rightarrow LnRex-$	2	2.74	0.25	11.03	6.58	5.04

Saudi Arabia						
$LnRex^{+}$≠> $LnTB^{+}$	1	4.24**	0.03	7.70	4.49	2.84
$LnRex^{+}$≠> $LnTB^{-}$	3	0.84	0.35	8.28	4.30	2.68
$LnRex^{-}$≠> $LnTB^{+}$	1	1.16	0.28	9.79	4.74	3.03
$LnRex^{-}$≠> $LnTB^{-}$	1	0.31	0.57	10.80	4.68	3.08
LnTB+≠> LnRex+	3	0.91	0.34	7.65	4.82	3.03
LnTB+≠> LnRex-	2	2.83*	0.09	8.92	3.87	2.80
LnTB-≠> LnRex+	2	0.28	0.59	7.21	4.12	3.03
LnTB-≠> LnRex-	1	0.17	0.68	10.65	4.68	2.71
UAE						
$LnRex^{+}$≠> $LnTB^{+}$		5.44**	0.02	9.66	4.93	3.16
$LnRex^{+}$≠> $LnTB^{-}$	1	0.97	0.61	10.16	6.67	4.95
$LnRex^{-}$≠> $LnTB^{+}$	1	0.23	0.65	7.82	3.99	2.74
$LnRex^{-}$≠> $LnTB^{-}$	1	0.17	0.67	8.16	3.92	3.06
LnTB+≠> LnRex+	3	0.10	0.74	8.57	3.80	2.87
LnTB+≠> LnRex-	1	0.39	0.52	7.89	4.34	2.86
LnTB-≠> LnRex+	2	0.07	0.79	7.67	4.22	2.78
LnTB-≠> LnRex-	2	0.35	0.55	7.34	4.19	2.86

*Note: ***, **, and * indicate the null hypothesis to be rejected at 1%, 5%, or 10% significance level, respectively.*

The results of the MWALD test based on the leverage bootstrap distribution indicate different findings. At first sight, we reject the null hypothesis in favour of the alternative one and find evidence for asymmetric causality in either direction except for Ukraine and China. In this manner, we have supported the cointegration results in the non-linear model for India, the USA, and the UAE. For instance, in the case of India, there is a causal linkage between positive shocks to the exchange rate and those to the trade balance, indicating bidirectional causality. It can also be seen from Table 3 in the non-linear model that the LnRexPos (appreciation in domestic currency) variable positively affects the external balance between Türkiye and India in the long run. Likewise, the test results for the UAE implicate the rejection of the null hypothesis of Granger non-causality between the positive shocks of exchange rates and the external balance of Türkiye. Therefore, positive shocks in exchange rates cause positive shocks to the trade balance with these partners. In Table 8, the LnRexPos variable positively affects the external balance between Türkiye and the UAE in the long run for the non-linear model. For the USA, the null hypothesis of non-Granger causality from negative shocks of the exchange rate variable to positive shocks of the trade balance variable is rejected at a 5% significance level. Similarly, as seen from Table 5, the LnRexNeg (depreciation in currency) variable in the non-linear model positively affects the external balance between Türkiye and the USA in the long run.

5. Conclusion

This paper investigates the short-run and long-run responses of the trade balance to currency movements (the J-curve hypothesis) for the Turkish economy from Q1 2000 to Q4 2022, using both the linear (ARDL) and nonlinear autoregressive distributed lag (NARDL) approaches as well as asymmetric Toda-Yamamoto causality analysis under bootstrap leverage. For this purpose, we employ the bilateral trade balance model proposed by Rose & Yellen (1989), using bilateral data from Türkiye and seven of her largest non-EU trading partners.

Using the linear ARDL approach for error correction and cointegration analysis, we observed a specific pattern that supports the J-curve phenomenon only for Russia and the

UAE. When we applied the non-linear ARDL approach, we found supportive evidence for both the asymmetrical exchange rate effect and the J-curve hypothesis in three (India, USA, and UAE) out of seven in the long term. This indicates that currency appreciations impact the trade balance differently than currency depreciations. We also observed that the magnitude of the coefficients is higher in the long term than in the short term. Additionally, lira depreciation improves Türkiye's trade balance with India, the USA, and the UAE in the short run. However, in the long run, the trade balance is affected "positively" by lira appreciation in the cases of India and the UAE and depreciation in the case of the USA. In other words, lira depreciation has affected the trade balance "negatively" in the cases of India and the UAE, and lira appreciation has affected the case of the USA. Third, according to the error correction coefficients, the error correction mechanism in the non-linear model adjusts the long-run equilibrium faster than the linear model.

The findings of this study differ somewhat from those of previous studies in terms of the short- and long-term dynamics of the trade balance response to changes in the exchange rate concerning different partners. Although the non-linear approach provided more evidence for our case, we only found evidence for the J-curve pattern in 2 out of 7 partners in the linear models and three trading partners in the non-linear models. Therefore, the ML condition was found to hold only for a small group of countries in this study. Thus, we can conclude that exchange rate movements have a limited effect on the Turkish economy.

In the case of Türkiye, the effects of exchange rate movements on the trade balance have been limited by structural reasons. First of all, the Turkish economy, like many other emerging markets, heavily depends on imported inputs and intermediate goods for domestic production, and any depreciation in the Turkish Lira leads to an increase in the cost of production. The rise in exchange rates also makes importing advanced technology, know-how and capital goods more expensive. Furthermore, any depreciation increases the price of imported goods and services, making them costlier for consumers. Another factor that reduces the impact of exchange rates is the pricing behaviour in countries with persistent inflation. In such cases, expectations also play a role in diminishing the effect of exchange rates. Furthermore, an increase in dollarisation can cause exchange rate movements to be more volatile, leading to a cycle of exchange rate inflation. As a result, these factors reinforce the exchange rate pass-through mechanism, making the devaluation of domestic currencies ineffective in achieving the desired outcomes, particularly regarding trade balance, in the long run.

In this regard, the Turkish economy has struggled with a persistent trade deficit for many years, and devaluations of the TL have been employed as a solution at various times, such as in 1980, 1994, and 2001. More recently, the New Economy Model (NEM) was initialised in December 2021 to turn the country's chronic current account deficits into a surplus by artificially lowering interest rates and weakening the Turkish lira. However, as of June 2023, the current account deficit has increased almost sevenfold to $60 billion since the launch of the NEM. According to recent data, the Turkish economy recorded a trade deficit of 45.2 billion dollars for 2023. To address the persistent trade deficit issue, policymakers should consider promoting the development of medium and high-tech industries, implementing comprehensive structural reforms in the economy, attracting foreign direct investment, reducing reliance on imported inputs, enhancing export competitiveness, and pursuing complementary macroeconomic policies.

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