

Revisiting the J-Curve Hypothesis in Turkey: A Nonlinear Autoregressive Distributed Lag Approach with Asymmetric Exchange Rate Effects

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Received: February 21, 2026 | Review began: February 24, 2026 | Review ended: April 29, 2026 | Published: June 17, 2026

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Abstract

This study empirically investigates the validity of the J-curve hypothesis for Turkey over the period 1975-2024 by employing the Nonlinear Autoregressive Distributed Lag (NARDL) framework. The model incorporates trade balance (TB), Gross Domestic Product (GDP), foreign direct investment (FDI), and the official exchange rate to capture both short- and long-run asymmetries in Turkey's external adjustment process. Unit root and Brock-Dechert-Scheinkman tests confirm the presence of mixed integration orders and nonlinear dependence among the variables, justifying the use of a nonlinear model. The results indicate a stable long-run cointegration relationship, with the Wald tests validating significant asymmetries in both the short and long run. Specifically, exchange rate depreciations improve Turkey's TB, whereas appreciations have a stronger deteriorating impact, supporting the asymmetric J-curve hypothesis. GDP and FDI exert negative long-run effects on TB, reflecting import-led growth dynamics and investment-driven import demand. Diagnostic and stability tests confirm the robustness of the estimated NARDL model.

Categories: Trade and economic development, International financial markets and institutions, International monetary system

Keywords: trade balance, j-curve hypothesis, exchange rate asymmetry, nardl, fdi

Introduction

Understanding the dynamics between exchange rate (EXCH) movements and the trade balance (TB) remains central to open-economy macroeconomics, especially for emerging economies characterized by structural import dependence and recurrent currency volatility. Turkey represents a particularly relevant case, given its chronic trade deficits, episodes of sharp depreciation, and high sensitivity of domestic production to imported intermediate goods. Traditional theoretical frameworks - such as the elasticities approach, the Marshall-Lerner condition, and the J-curve hypothesis - predict that currency depreciation initially worsens TB before improving it as export and import volumes adjust ([Magee, 1973](#)) ([Krueger, 1983](#)). However, the empirical literature has demonstrated that these dynamics are frequently nonlinear and asymmetric, especially in developing and emerging markets where import content of exports is high and price pass-through is rapid ([Bussière et al., 2020](#)) ([Ghosh et al., 2015](#)).

Recent advances in nonlinear econometric modeling have shown that TBs often react differently to appreciations versus depreciations, challenging the assumption of symmetric adjustment embedded in linear models. The nonlinear ARDL (NARDL) framework introduced by Shin et al. ([Shin et al., 2014](#)) enables the separate identification of positive and negative exchange-rate shocks and has been widely applied to detect asymmetric J-curve behavior ([Bahmani-Oskooee](#)

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and Fariditavana, 2015). For Turkey, previous studies emphasize that exchange-rate appreciations tend to be far more harmful to TB than depreciations are beneficial, reflecting structural constraints in the export sector and strong import dependence (Bahmani-Oskooee and Halicioğlu, 2017) (Ali et al., 2019).

This study contributes to the literature by analyzing Turkey's TB over the period 1975-2024 using a NARDL framework, complemented by the Local Projections (LP) method of Jordà (Jordà, 2005) to obtain asymmetric impulse responses. By including Gross Domestic Product (GDP) and foreign direct investment (FDI) as structural determinants, the analysis captures both income-driven import demand and the import-intensive nature of investment activity - two factors shown to be highly relevant in emerging markets (Alfaro et al., 2004) (Herzer, 2012). The results highlight pronounced asymmetries: appreciations cause strong and persistent deterioration in the TB, whereas depreciations produce only moderate and delayed improvements. FDI shocks also display nonlinearities, with negative shocks exerting a much stronger adverse effect on external balances than positive inflows improve them.

Building on the theoretical and empirical gaps identified above, this study addresses the following research questions:

RQ1. Does the J-curve hypothesis hold for Turkey when asymmetric exchange rate movements are modeled within a NARDL framework?

RQ2. Do currency depreciations and appreciations exert asymmetric short-run and long-run effects on Turkey's trade balance?

RQ3. What roles do GDP and FDI play in shaping Turkey's trade balance dynamics, and are these effects consistent with import-demand and absorption theories?

RQ4. Do dynamic multiplier and local projection methods reveal nonlinear and persistent responses of the trade balance to exchange rate shocks?

The research questions are linked to a set of well-defined research objectives. First, the study aims to examine the validity of the J-curve hypothesis in Turkey over the period 1975-2024 within a nonlinear framework, thereby assessing whether exchange rate movements generate the expected dynamic adjustment pattern in the trade balance. Second, the analysis seeks to evaluate whether exchange rate appreciations and depreciations exert asymmetric effects on the trade balance in both the short and long run, with particular attention to the magnitude and persistence of these effects. Third, the study aims to investigate the role of key macroeconomic fundamentals, namely GDP and FDI, in shaping TB dynamics, with a focus on identifying whether economic growth and investment are associated with increased import dependence. Finally, the study aims to analyze the dynamic adjustment path of the trade balance following exchange rate shocks by employing nonlinear econometric techniques, in order to capture potential asymmetries and persistence in the response of external balances.

The combined use of NARDL and Local Projections provides a comprehensive depiction of short- and long-run adjustment paths, reinforcing the importance of nonlinear modeling in capturing Turkey's external sector dynamics.

This study contributes to the existing literature in several important ways. First, it provides a long time-span analyses of the J-curve hypothesis for Turkey, covering the period 1975-2024, thereby capturing multiple structural regimes, crises, and exchange rate policy shifts. Second, this paper combines NARDL with the LP method, allowing for a more flexible and direct estimation of asymmetric impulse responses without imposing dynamic restrictions. Third, the analysis integrates structural determinants such as GDP and FDI, linking exchange rate dynamics to the absorption approach and import-dependent growth mechanisms. Fourth, the study provides strong empirical evidence of asymmetric adjustment, showing that exchange rate appreciations have a substantially larger and more persistent adverse effect on the trade balance than the improvement generated by depreciations.

Literature review

The J-curve hypothesis has its origins in the contributions of Magee (Magee, 1973), who first formalized the idea that a currency depreciation initially worsens the TB before leading to an improvement as quantities adjust. Early theoretical refinements by Krueger (Krueger, 1983) and Arndt and Dorrance (Arndt and Dorrance, 1987) emphasized the role of pre-

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existing contracts, slow price pass-through, and delayed volume responses, which jointly generate the dynamic adjustment path characteristic of the “J” shape. At the empirical level, Rose and Yellen ([Rose and Yellen, 1989](#)) pioneered the use of bilateral U.S. data to test the hypothesis, although they found no robust evidence of either a J-curve or a stable long-run link between EXCH and TB. Their findings underscored the difficulty of detecting the J-curve using aggregate data and linear econometric models.

A comprehensive survey by Bahmani-Oskooee and Ratha ([Bahmani-Oskooee and Ratha, 2004](#)) provided one of the earliest systematic reviews, concluding that inconclusive empirical results often reflect methodological heterogeneity and the masking effects of aggregated trade data. Because aggregate trade flows may improve with some partners while deteriorating with others, bilateral data are considered essential for reducing aggregation bias - a point reinforced by Bahmani-Oskooee and Brooks ([Bahmani-Oskooee and Brooks, 1999](#)). Subsequent research identified substantial heterogeneity across countries. For instance, Bahmani-Oskooee and Goswami ([Bahmani-Oskooee and Goswami, 2003](#)) found limited J-curve evidence for Japan, while Wilson ([Wilson, 2001](#)) detected no J-curve effect for Singapore, Korea, or Malaysia except in isolated cases. Similarly, Narayan ([Narayan, 2006](#)) observed some positive impacts of currency depreciation for China but no clear J-curve pattern. Using a NARDL framework for eight major African economies over 1970-2019, Mesagan et al. ([Mesagan et al., 2022](#)) find pronounced exchange-rate asymmetries. They show that while currency depreciation tends to stimulate trade and output growth in the short run, both appreciation and depreciation exert negative effects on long-run TB and growth across most countries. Using a large panel of 185 countries over 1980-2023, Afonso et al. ([Afonso et al., 2025](#)) show that geopolitical risk and global uncertainty drive energy price inflation, with markedly stronger effects under flexible exchange rate regimes, particularly in oil-exporting and emerging economies. Herley et al. ([Herley et al., 2023](#)) show that equity return-exchange rate linkages are asymmetric and state-dependent, with strong shock transmission emerging only during high-volatility regimes identified by VIX-based SETAR and Markov-switching models.

Evidence for Turkey

Empirical work on Turkey reveals mixed results, depending largely on data frequency, partner countries, and methodological choices. The early pioneering work of Halicioglu ([Halicioglu, 2008a](#)) applied an ARDL model to Turkey's aggregate data and found support for both the long-run effect of depreciation and for a conventional J-curve pattern. However, other aggregate-data studies such as Kale ([Kale, 2001](#)), Akbostanci ([Akbostanci, 2004](#)), and Cergibozan and Ari ([Cergibozan and Ari, 2018](#)) did not detect a consistent J-curve effect, reinforcing the view that aggregate Turkish data may obscure underlying bilateral dynamics.

Turkey-specific bilateral studies represent an important step forward. Halicioglu ([Halicioglu, 2008b](#)) examined Turkey's bilateral J-curve with 13 major trading partners and found that while no short-run J-curve exists, long-run depreciation improves the TB for several partners. Çelik and Kaya ([Çelik and Kaya, 2010](#)) extended this line of research to seven partners and showed that the impact of devaluation is highly country-specific, with reverse J-curve or even S-curve patterns in some cases. A later contribution by Bahmani-Oskooee and Halicioglu ([Bahmani-Oskooee and Halicioglu, 2017](#)), using both linear and nonlinear ARDL models for Turkey and 11 OECD partners, revealed strong asymmetric effects: real depreciation improves Turkey's TB with countries such as France, Germany, Italy, Portugal, and the UK, while appreciation has disproportionately large adverse impacts.

Nonlinear approaches and asymmetric adjustment

Recent literature emphasizes nonlinear and asymmetric dynamics in the EXCH-TB nexus. Bahmani-Oskooee and Fariditavana ([Bahmani-Oskooee and Fariditavana, 2016](#)) introduced the NARDL approach to J-curve testing and proved that many earlier studies failed to uncover J-curve dynamics because linear models implicitly assume symmetric adjustment. Their findings show that TBs often respond more strongly to currency appreciations than to depreciations. This asymmetry is consistent with import dependence, contract rigidities, and differing adjustment speeds in exports and imports. For Turkey, nonlinear studies such as Bahmani-Oskooee and Fariditavana ([Bahmani-Oskooee and Fariditavana, 2016](#)) and Bahmani-Oskooee and Halicioglu ([Bahmani-Oskooee and Halicioglu, 2017](#)) confirmed that incorporating asymmetry reveals previously hidden evidence of the J-curve.

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Using linear and nonlinear ARDL models for Turkey's bilateral trade (2000-2015), Karamelikli ([Karamelikli, 2016](#)) finds no short-run J-curve for the United States and France, symmetric evidence for Germany, and asymmetric effects for the United Kingdom, while long-run EXCH-TB relationships appear mixed and partner-specific.

Ali et al. ([Ali et al., 2019](#)) show that nonlinear ARDL techniques reveal much stronger evidence of the J-curve for Turkey's bilateral trade with EU partners than linear models, highlighting the dominant role of asymmetry in Turkey's exchange-rate adjustment process.

Bahmani-Oskooee and Karamelikli ([Bahmani-Oskooee and Karamelikli, 2021](#)) show that disaggregating Turkey-U.S. trade into 45 industries reveals pronounced short-run and, in some sectors, long-run asymmetric responses to lira-dollar movements - patterns that remain hidden in traditional linear models.

The study by Yildirim and Saraç ([Yildirim and Saraç, 2022](#)) finds that real exchange rate changes positively affect Turkey-Germany bilateral trade during expansion periods - supporting the J-curve hypothesis - while showing no significant effect during contraction phases.

Kilinc-Ata and Çamkaya ([Kilinc-Ata and Çamkaya, 2026](#)) highlight the critical role of technological advancement in the clean energy transition, showing that improvements in the Green Energy Mix Quality Index significantly contribute to reducing CO₂ emissions across EU countries. Kilinc-Ata et al. ([Kilinc-Ata et al., 2026](#)) show that while the European Union has achieved absolute decoupling of economic growth from CO₂ emissions, Gulf Cooperation Council countries exhibit only partial decoupling, reflecting the influence of structural factors such as fossil-fuel dependence, population growth, and varying progress in renewable energy adoption. Kilinc-Ata ([Kilinc-Ata, 2022](#)) finds that while economic growth and R&D expenditures contribute to reducing carbon emissions in Turkey, energy consumption increases emissions, and the overall relationship among the variables is largely symmetric despite the use of nonlinear ARDL techniques.

The existing literature indicates that (i) early theoretical models predict a delayed improvement in the TB following depreciation, (ii) empirical findings are mixed when using aggregate and linear models, and (iii) Turkey exhibits strong asymmetric and bilateral-specific responses, with appreciations harming TB far more than depreciations improve it. Given Turkey's persistent trade deficits, high import dependence, and recurrent episodes of exchange-rate instability, this country provides an important case for revisiting the J-curve hypothesis using nonlinear econometric techniques such as the NARDL framework.

This study examines Turkey's aggregate TB during 1975-2024 using a NARDL framework with both positive and negative exchange-rate shocks, including GDP and FDI as structural determinants and confirming nonlinearity through Brock-Dechert-Scheinkman (BDS) tests. By integrating asymmetric exchange-rate movements, income effects, and investment dynamics within a nonlinear cointegration setting, this study fills the gap by providing a comprehensive long-run assessment of Turkey's external adjustment process that captures both directional asymmetries and structural factors.

Research Method

Theoretical framework of the J-curve hypothesis

The J-curve hypothesis, originally proposed by Magee ([Magee, 1973](#)), describes the dynamic response of a country's TB to movements in EXCH. When a currency depreciates, the value of imports initially rises faster than the value of exports (because import prices increase in domestic currency), causing a temporary deterioration in TB. Over time, as quantities of exports and imports adjust to new relative prices, export revenues expand and import expenditures contract, leading to a subsequent improvement in TB. This adjustment path traces the shape of the letter "J." According to Krueger ([Krueger, 1983](#)), this phenomenon emerges because short-term trade dynamics are shaped by existing contracts and shipments negotiated at pre-depreciation prices, which continue to influence trade flows and postpone any rapid adjustment. By Arndt and Dorrance ([Arndt and Dorrance, 1987](#)), when a country devalues its currency to fix a balance of payments problem, the situation may first worsen because export prices adjust slowly while import costs rise. The deficit gets larger before trade volumes improve and TB begins to recover. This is called the J-curve effect. The Marshall-Lerner condition represents a cornerstone of international trade theory, determining the circumstances under which a currency

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depreciation improves a country's TB.

Formally, the condition asserts that a depreciation will have a positive effect on the TB if the sum of the absolute values of the price elasticities of demand for exports and imports exceeds unity (Marshall, 1923) (Lerner, 1944).

In the short run, due to contracts, habit formation, and adjustment costs, elasticities tend to be low, causing a temporary worsening of the TB. Over time, as consumers and firms adjust, elasticities increase, and TB may improve - a dynamic adjustment process that underlies the J-curve phenomenon (Bahmani-Oskooee and Ratha, 2004) (Krugman and Obstfeld, 2009).

Figure 7 illustrates the Marshall-Lerner condition in the elasticity space defined by the import and export elasticities of demand. The dynamic adjustment from inelastic to elastic regions over time reflects the theoretical mechanism of the J-curve, as trade volumes gradually respond to new relative prices.

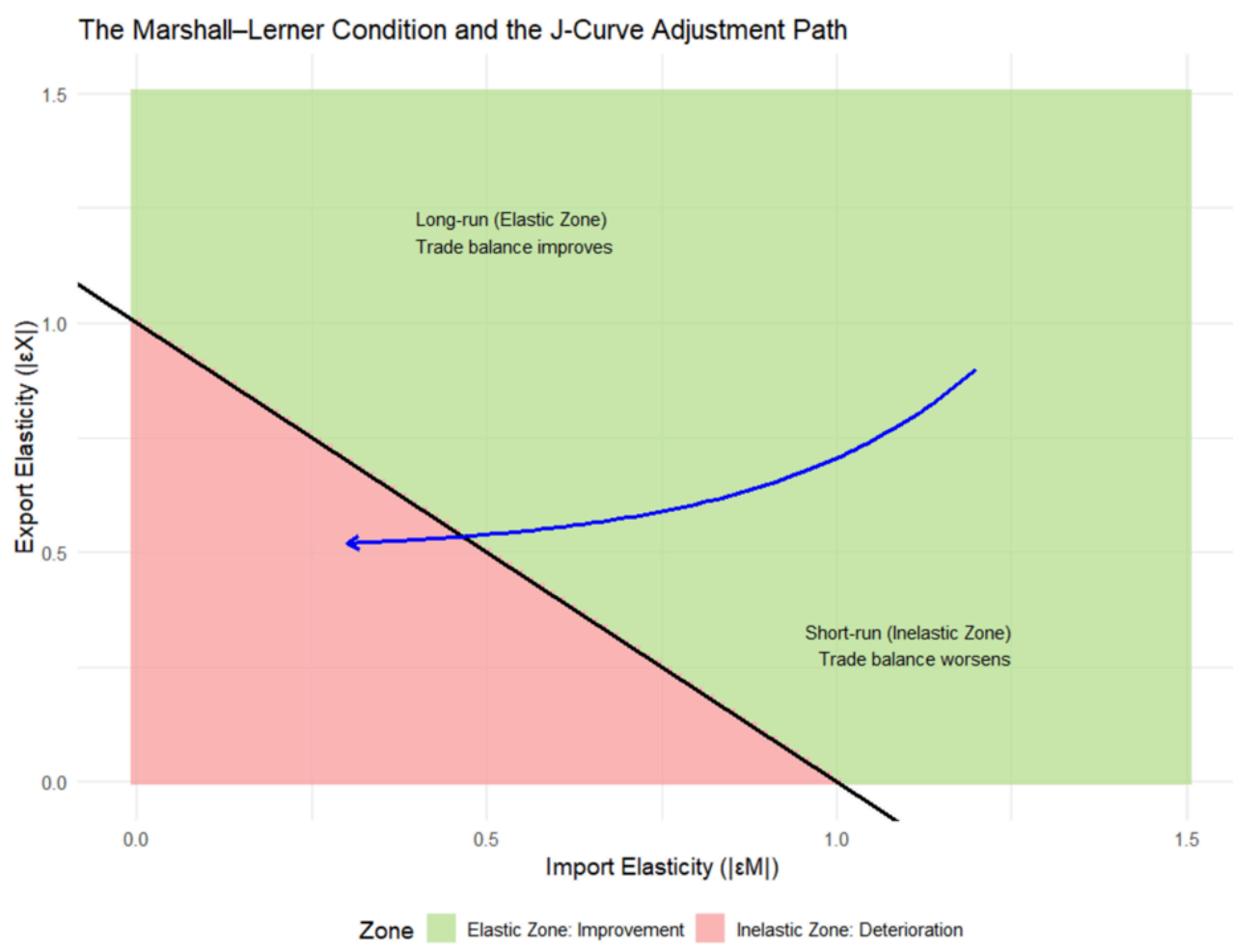


FIGURE 1: The Marshall-Lerner condition and the J-curve adjustment path

Source: Author.

Beyond the traditional elasticities framework and the Marshall-Lerner condition, alternative theoretical perspectives explain how income and expenditure dynamics affect TB. Two of the most influential are the absorption approach and the import-demand hypothesis, both of which complement the J-curve mechanism by emphasizing real income effects rather than relative price adjustments.

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The absorption approach, initially developed by Alexander (Alexander, 1952), argues that a country's TB depends on the gap between national output and total domestic expenditure (absorption). According to this framework, a depreciation improves the TB only if it raises output more than absorption. If expansionary fiscal or monetary policies increase domestic demand faster than production, TB deteriorates despite a weaker currency. This mechanism has been widely discussed in open-economy macroeconomics (Krugman and Obstfeld, 2009). In Turkey's case, periods of rapid GDP growth have often coincided with higher import demand, reflecting strong domestic absorption that offsets any competitiveness gains from EXCH depreciation (see Figure 2).

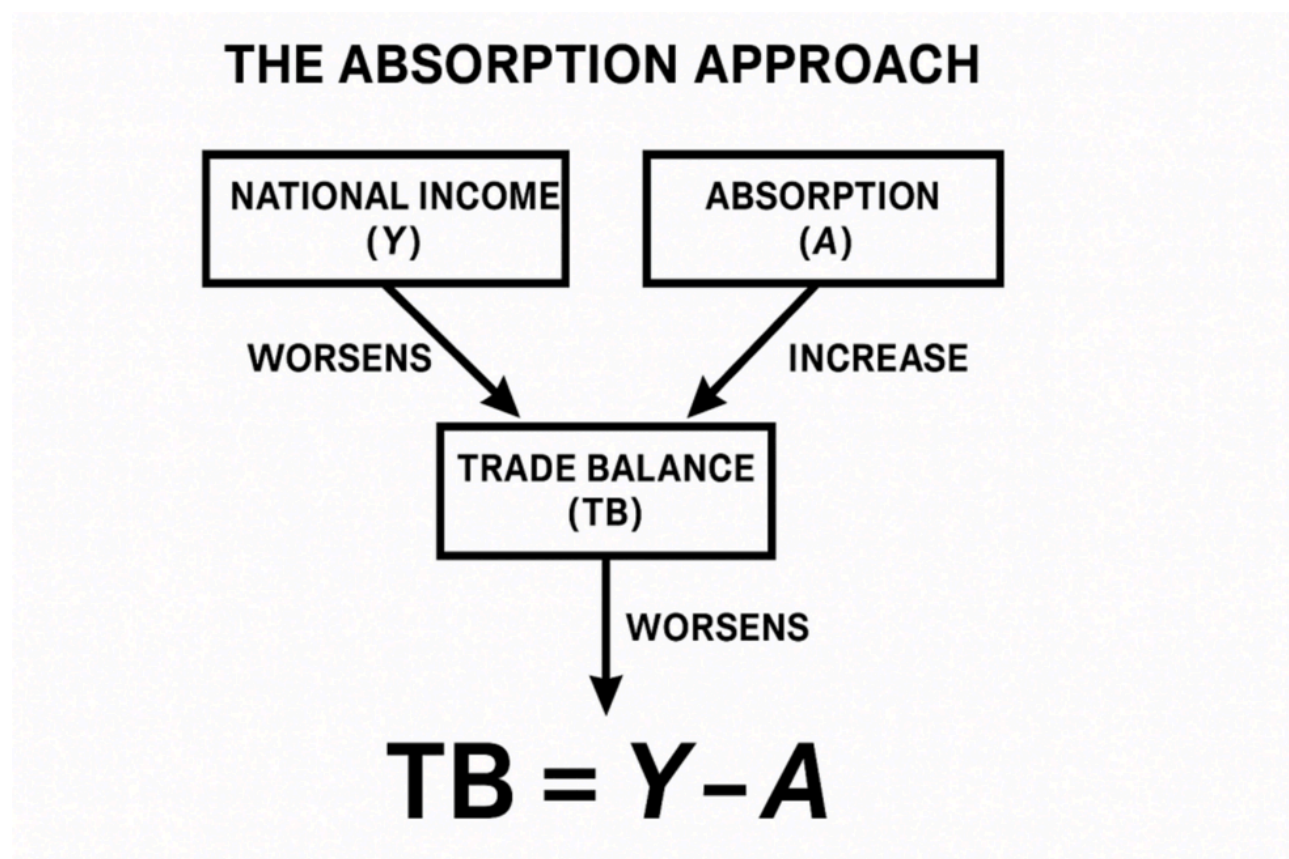


FIGURE 2: The absorption approach

Source: Author.

The import-demand hypothesis provides a complementary explanation. Rooted in the work of Houthakker and Magee (Houthakker and Magee, 1969) and Goldstein and Khan (Goldstein and Khan, 1985), it emphasizes the responsiveness of imports to income and relative prices. This hypothesis posits that higher income levels lead to greater demand for imported goods - particularly intermediate and capital goods used in production - while the relative price elasticity of imports determines the magnitude of this effect. In developing and emerging economies, where production structures depend heavily on imported inputs, economic expansion usually worsens the TB in the short run. Empirical studies such as Arize et al. (Arize et al., 2000), Halicioglu (Halicioglu, 2008a), and Bahmani-Oskooee and Kutan (Bahmani-Oskooee and Kutan, 2008) confirm that for Turkey, increases in GDP tend to stimulate imports more than exports, consistent with this hypothesis.

Table 1 summarizes the variables, collected for Turkey from various sources for the period 1975-2024 from World Bank (World Development Indicators, 2025). Following the World Bank (WDI) definition, net trade in goods and services (% of GDP) is used as a proxy for the trade balance, consistent with standard practice in empirical J-curve studies.

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TB is expressed as a function of GDP, EXCH, and FDI. The inclusion of GDP as a determinant of TB is justified in the literature, as it reflects the domestic income level that influences import demand. Higher GDP increases the capacity of an economy to import goods, potentially worsening TB in the short run (Bahmani-Oskooee and Ratha, 2004) (Arize et al., 2017). In the long run, rising income may also enhance export capacity through productivity improvements and investment in tradable sectors, leading to a possible J-curve adjustment effect.

The official EXCH (LCU per US\$, period average) was used instead of RER owing to its longer and more consistent data coverage, and to capture the direct effect of nominal currency movements on TB without the distortions introduced by price adjustments or trade-weighted indices.

FDI is included as it has a dual impact on TB. FDI inflows can stimulate export-oriented industries and technology transfer, improving TB; on the other hand, they may increase imports of intermediate and capital goods, leading to a short-term deterioration (Tang, 2003).

The econometric modeling will be performed using logarithmic transformations of the variables (Lütkepohl, 2005). By taking into account both short- and long-term asymmetries in the relationship between variables, the NARDL model provides flexibility by enabling the separate effects of positive and negative shocks within a single cointegration framework. NARDL allows mixed orders of integration, similar to ARDL. Equation (1) provides the asymmetric long-run form of EXCH, which is divided into positive and negative changes.

$$TB_t = \delta_0 + \delta_{EXCH}^+ EXCH_t^+ + \delta_{EXCH}^- EXCH_t^- + \delta_{GDP} GDP_t + \delta_{FDI} FDI_t + \varepsilon_t \quad (1)$$

The NARDL-ECM equation is:

$$\Delta TB_t = \lambda ECT_{t-1} + \sum \delta \Delta TB + \sum (\delta^+ \Delta EXCH^+ + \delta^- \Delta EXCH^-) + \sum \delta \Delta GDP + \sum \delta \Delta FDI + \varepsilon_t \quad (2)$$

Equation (3) represents the error correction term (ECT) from the NARDL-ECM specification, capturing the long-run equilibrium relationship among the variables (TB, EXCH, GDP, and FDI):

$$ECT_{t-1} = TB_{t-1} - \gamma_1 EXCH_{t-1}^+ - \gamma_2 EXCH_{t-1}^- - \gamma_3 GDP_{t-1} - \gamma_4 FDI_{t-1} \quad (3)$$

To account for asymmetric effects in the short and long term, the NARDL model separates the positive and negative partial sums of changes in EXCH.

$$EXCH^+ = \sum_{i=1}^t \Delta EXCH_i^+ = \sum_{i=1}^t \max(\Delta EXCH_i, 0) \quad (4)$$

$$EXCH^- = \sum_{i=1}^t \Delta EXCH_i^- = \sum_{i=1}^t \min(\Delta EXCH_i, 0) \quad (5)$$

Dynamic multipliers illustrate the adjustment path from the initial equilibrium to the new long-run equilibrium following a shock. They capture the asymmetric responses of the dependent variable TB to both positive and negative changes in the exchange rate. The cumulative dynamic multipliers describe how the dependent variable responds over time to these respective positive and negative shocks. LPs estimate impulse responses directly through horizon-specific regressions, avoiding Vector Autoregression (VAR) restrictions (Jordà, 2005). This allows to capture nonlinear short-run dynamics without specifying a full system.

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Variable	Acronym	Measurement unit	Source
Trade balance = Net trade in goods and services	TB	BoP, current US\$	World Bank
GDP per capita	GDP	constant 2015 US\$	World Bank
Foreign Direct Investments	FDI	% of GDP	World Bank
Official exchange rate	EXCH	LCU per US\$, period average	World Bank

TABLE 1: Variables and sources

Results And Discussion

Input data and analysis

Figure 3 illustrates the evolution of Turkey’s macroeconomic indicators during 1975-2024. Figure 3 reveals strong GDP growth alongside a persistent depreciation of the Turkish lira, volatile FDI inflows, and recurring trade deficits, reflecting the structural and external dynamics of the Turkish economy. EXCH shows a sharp upward trend, especially after 2000, indicating a persistent depreciation of the Turkish lira amid inflationary pressures and financial instability. FDI rose in the early 2000s due to structural reforms and EU accession efforts but became volatile after 2008, reflecting sensitivity to global and domestic shocks. GDP exhibits a steady long-term increase, with brief slowdowns during crises, confirming Turkey’s sustained economic growth despite cyclical fluctuations. TB fluctuates widely and remains mostly negative, showing that Turkey’s economic expansion has been accompanied by persistent trade deficits.

Table 2 summarizes the descriptive statistics of the logarithmic variables, indicating overall stability and near-normal distributions. Only EXCH shows mild volatility and deviation from normality. TB exhibits a stable pattern over time, with values distributed symmetrically around the mean, indicating relative consistency in Turkey’s external position. GDP reflects sustained economic expansion, characterized by low variability and a mildly right-skewed distribution consistent with long-term growth dynamics. EXCH displays the highest degree of variability, capturing pronounced fluctuations in the Turkish lira’s value that mirror periods of macroeconomic and financial instability. FDI shows moderate dispersion and slight left skewness, suggesting that while investment inflows were uneven, they remained broadly stable throughout the analyzed period.

The scatterplots in Figure 4 show positive linear relationships between TB and explanatory variables. The positive slope in each case suggests that increases in economic output, EXCH (indicating depreciation), and FDI are associated with higher TB levels. This implies that economic growth, currency movements, and external investment may have reinforcing effects on Turkey’s trade performance when viewed in logarithmic terms.

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	TB	GDP	EXCH	FDI
Mean	22.466	8.808	-2.815	-0.681
Median	22.164	8.733	-0.670	-0.629
Maximum	24.956	9.597	3.491	1.287
Minimum	18.903	8.231	-11.145	-3.941
Std. Dev.	1.311	0.416	4.538	1.286
Skewness	-0.040	0.333	-0.512	-0.685
Kurtosis	2.623	1.825	1.817	2.739
Jarque-Bera	0.309	3.803	5.104	4.056
Probability	0.857	0.149	0.078	0.132

TABLE 2: Descriptive statistics (in logarithms)

TB, trade balance; FDI, foreign direct investment; EXCH, official exchange rate; GDP, Gross Domestic Product

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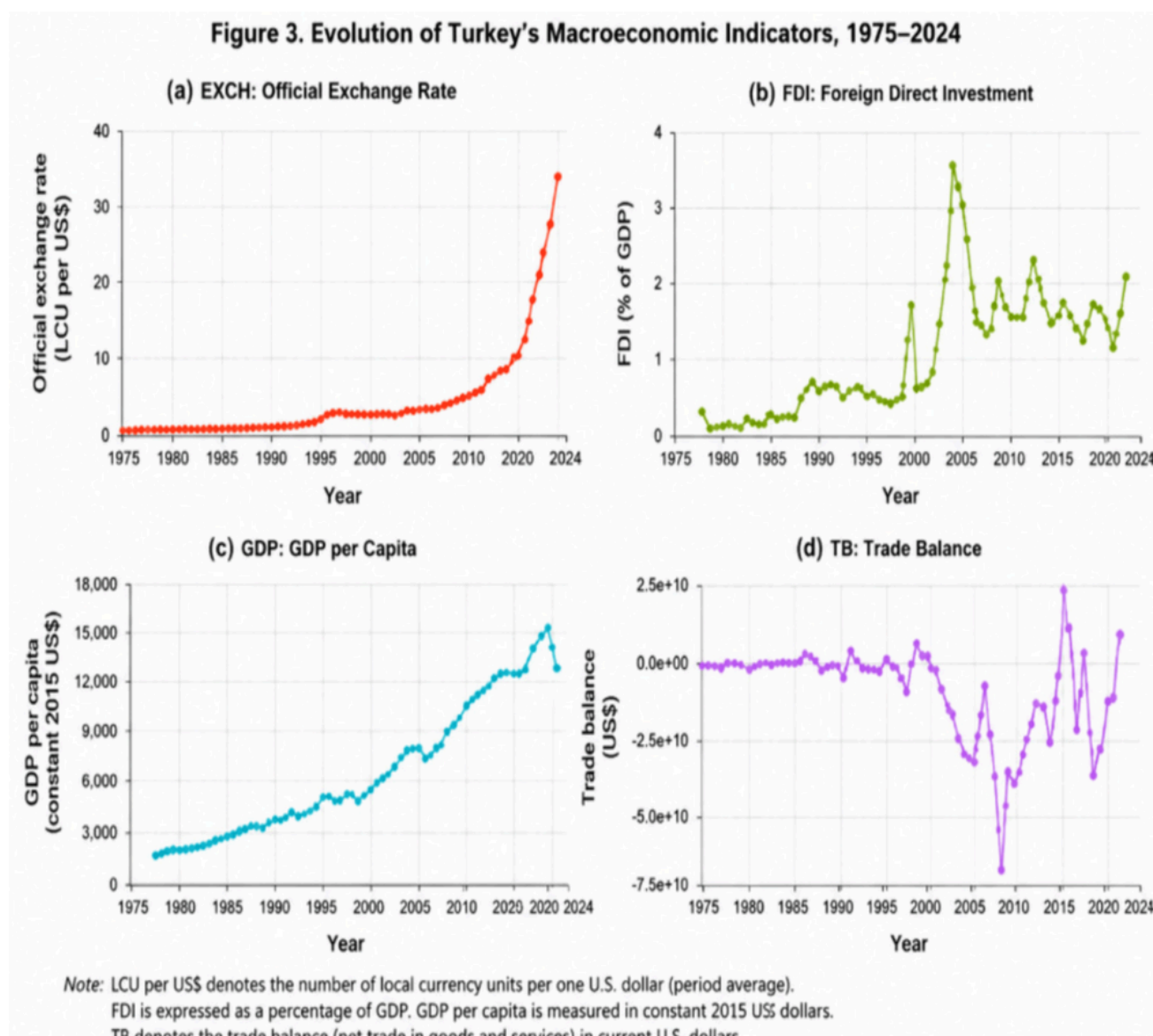


FIGURE 3: The evolution of selected variables for Turkey (1975-2024) - raw variables

Source: Author. TB, trade balance; FDI, foreign direct investment; EXCH, official exchange rate; GDP, Gross Domestic Product

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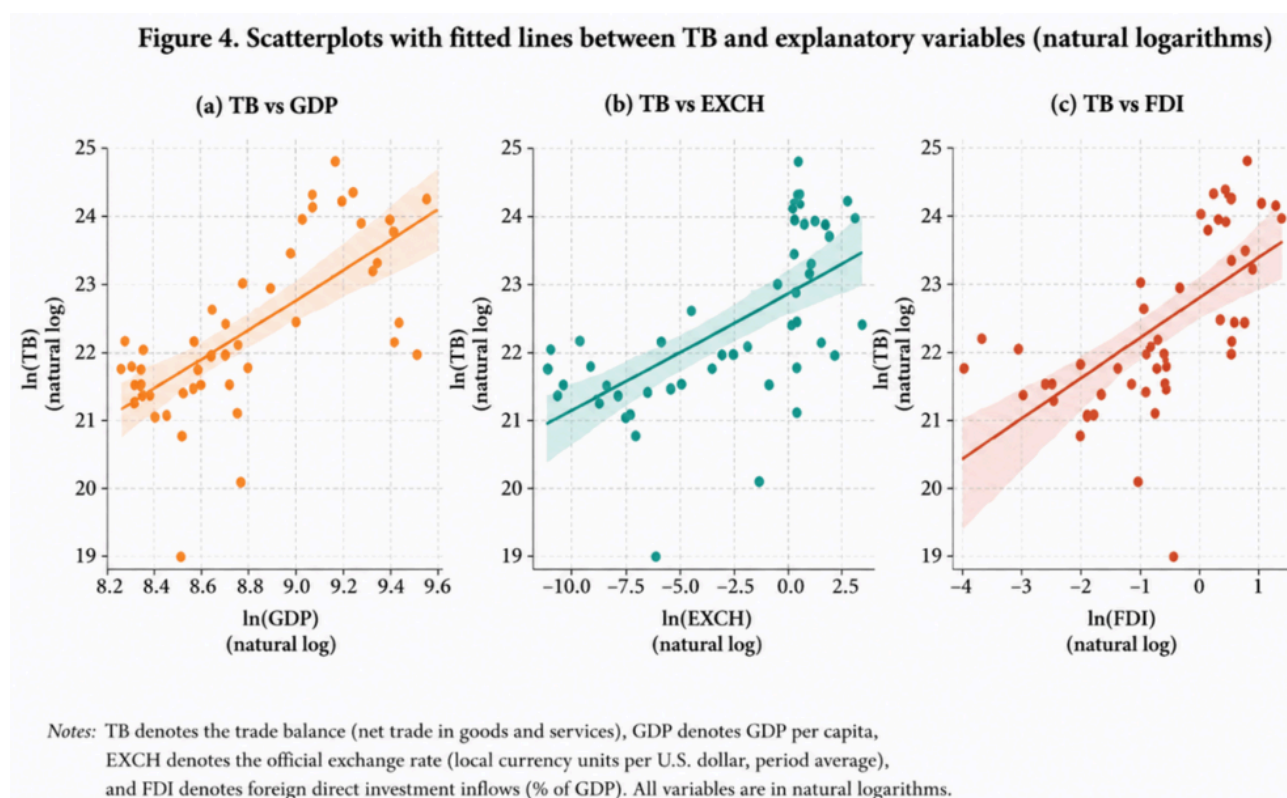


FIGURE 4: Scatterplots with fitted lines between TB and explanatory variables (in logarithms)

Source: Author. TB, trade balance; FDI, foreign direct investment; EXCH, official exchange rate; GDP, Gross Domestic Product

It should be noted that the relationships depicted in Figure 4 represent unconditional bivariate associations and do not control for the influence of other explanatory variables or dynamic adjustment mechanisms. In contrast, the NARDL model estimates conditional long-run effects after accounting for exchange rate movements, FDI, and the underlying dynamic structure of the data. Consequently, GDP may exhibit a positive simple correlation with the trade balance in the scatterplots while exerting a negative long-run effect within the multivariate framework. This result reflects Turkey's import-dependent growth structure, whereby economic expansion increases import demand more rapidly than export capacity over the long run.

NARDL framework

To assess the stationarity characteristics of the series, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips-Perron (PP) test (Phillips and Perron, 1988) are applied, both testing the null hypothesis of a unit root. The outcomes reported in Table 3 reveal that the variables are integrated of mixed orders, $I(0)$ and $I(1)$, thereby supporting the use of the NARDL approach for empirical estimation.

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Variables	ADF		PP	
	Level	First difference	Level	First difference
	T-statistics	T-statistics	T-statistics	T-statistics
TB	-1.18 (0.673)	-9.20*** (0.000)	-3.28*** (0.020)	-13.43*** (0.000)
EXCH	-1.84 (0.355)	-3.63*** (0.008)	-1.56 (0.494)	-3.62*** (0.008)
GDP	-0.26 (0.922)	-5.80*** (0.000)	-0.13 (0.939)	-5.48*** (0.000)
FDI	-1.76 (0.395)	-11.70*** (0.000)	-1.43 (0.559)	-13.88*** (0.000)

TABLE 3: Unit root test

Source: Author. ADF, Augmented Dickey-Fuller; PP, Phillips-Perron; TB, trade balance; FDI, foreign direct investment; EXCH, official exchange rate; GDP, Gross Domestic Product

The BDS test results in Table 4 (Brock et al., 1996) reject the null hypothesis of independence for all variables at all embedding dimensions, as all p-values are below 0.01. This indicates the presence of nonlinear dependence in the TB, EXCH, GDP, and FDI series, suggesting that linear models may be inadequate and that nonlinear modeling approaches are more appropriate for capturing the underlying dynamics.

BDS statistic	Dim 2	Dim 3	Dim 4	Dim 5	Dim 6
TB	0.05(0.000)	0.09(0.000)	0.11(0.000)	0.13(0.000)	0.13(0.000)
EXCH	0.16(0.000)	0.24(0.000)	0.28(0.000)	0.28(0.000)	0.25(0.000)
GDP	0.18(0.000)	0.30(0.000)	0.37(0.000)	0.42(0.000)	0.46(0.000)
FDI	0.12(0.000)	0.24(0.000)	0.33(0.000)	0.36(0.000)	0.39(0.000)

TABLE 4: BDS independence test

TB, trade balance; FDI, foreign direct investment; EXCH, official exchange rate; GDP, Gross Domestic Product; BDS, Brock-Dechert-Scheinkman

Table 5 reports the results of the VAR lag order selection. The majority of selection criteria favor lag 3.

How to cite this article:

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Lag	LogL	LR	FPE	AIC	SC	HQ
0	-212.41	NA	0.14	9.40	9.56	9.46
1	-2.90	373.47	3.19e-05	0.99	1.79*	1.29*
2	14.85	29.56	3.01e-05	0.91	2.35	1.45
3	36.10	30.49*	2.50e-05*	0.69*	2.75	1.46
4	48.41	15.51	3.19e-05	0.85	3.55	1.86

TABLE 5: VAR Lag order selection criteria

VAR, Vector Autoregression; FPE, Final Prediction Error; LR, Likelihood Ratio; AIC, Akaike Information Criterion; SC, Schwarz Criterion; HQ, Hannan–Quinn Criterion

The NARDL approach uses the F-test (Pesaran et al., 2001) to check for cointegration, with the null hypothesis of no cointegration. The calculated F-statistic of 9.04 exceeds the upper critical value for I(1) in Table 6, indicating a long-run asymmetric relationship among the variables.

Test statistic	Value	K (number of regressors)
F-statistic	9.04	4
Critical value bounds		
Significance	I(0)	I(1)
10%	2.37	3.32
5%	2.82	3.87
1%	3.84	5.15

TABLE 6: Results of NARDL cointegration bounds test

NARDL, Nonlinear Autoregressive Distributed Lag

We estimate next both the long-run and short-run coefficients of the NARDL model in Tables 7 and 8. A 1% increase in GDP deteriorates the TB by approximately 2.64% in the long run. This negative elasticity suggests that economic expansion in the domestic economy stimulates import demand more strongly than it promotes export growth. As income rises, consumers and firms tend to increase their purchases of imported goods, leading to a widening trade deficit. This finding is consistent with the absorption approach and the import-demand hypothesis, both of which

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highlight that output growth initially worsens the external balance in developing and emerging economies. Similar evidence was reported for Turkey by Bahmani-Oskooee and Kutan ([Bahmani-Oskooee and Kutan, 2008](#)) and Halicioglu ([Halicioglu, 2008a](#)), who found that higher GDP levels tend to exert pressure on TB through import-led growth patterns.

A 1% increase in FDI inflows worsens TB by 0.15% in the long run. This finding indicates that FDI inflows, while contributing to capital formation and technology transfer, are initially import-intensive and may not translate into immediate export gains. In many emerging economies, foreign investors rely on imported machinery, technology, and intermediate inputs during the setup phase, which raises import expenditure. Consequently, the expansion of export capacity usually occurs with a lag. These findings are consistent with the studies of Bozoklu and Yilanci ([Bozoklu and Yilanci, 2013](#)) for Turkey and Dash and Parida ([Dash and Parida, 2013](#)) for India, who observed that FDI inflows often deteriorate TB when investment projects depend heavily on imported capital goods and inputs.

A 1% increase in EXCH_POS, representing a 1% depreciation of the domestic currency (since the EXCH is measured in local currency units per U.S. dollar), improves TB by 0.19% in the long run. This elasticity implies that a weaker domestic currency enhances export competitiveness by reducing the foreign-currency prices of domestic goods while making imports more expensive. Consequently, exports expand and imports contract, leading to a gradual improvement in TB. This finding is consistent with the Marshall-Lerner condition, which predicts that real depreciation strengthens the TB when the combined elasticity of export and import demand exceeds unity. The positive long-run effect of depreciation also supports the J-curve hypothesis, according to which TB initially worsens but subsequently improves as trade flows adjust to new relative prices. Empirical studies for Turkey by Bahmani-Oskooee and Fariditavana ([Bahmani-Oskooee and Fariditavana, 2016](#)) and Truong and Vo ([Truong and Vo, 2023](#)) similarly confirm that exchange-rate depreciation exerts a positive and asymmetric effect on TB in the long run.

A 1% increase in EXCH_NEG, representing a 1% appreciation of the domestic currency (since EXCH is measured in local currency units per U.S. dollar), worsens TB by 14.05% in the long run. This high elasticity indicates that TB reacts far more strongly to appreciation than to depreciation, reflecting the structural rigidity of the export sector, import dependence, and limited substitutability between domestic and foreign goods. Currency appreciation reduces the competitiveness of domestic exports while making imports relatively cheaper, which collectively deteriorates TB. The pronounced magnitude of this effect highlights the asymmetric nature of EXCH dynamics, where appreciations have a much larger adverse impact than the improvement generated by depreciations. This result supports the nonlinear J-curve hypothesis, suggesting that EXCH movements influence the TB in an asymmetric and path-dependent manner. Bahmani-Oskooee and Fariditavana ([Bahmani-Oskooee and Fariditavana, 2016](#)) and Truong and Vo ([Truong and Vo, 2023](#)) provide similar evidence that exchange-rate appreciations (EXCH_NEG) tend to exert negative effects on the TB in the long run, reflecting asymmetric adjustment patterns consistent with the nonlinear J-curve hypothesis.

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Variable	Coefficient	t-Statistic	Prob.
GDP	-2.64	-1.87	0.068*
FDI	-0.15	-0.73	0.046**
EXCH_POS	0.19	2.11	0.041**
EXCH_NEG	-14.05	-4.29	0.000***
C	42.06	3.66	0.000***

TABLE 7: NARDL(1,1,0,1,2) long-run form

NARDL, Nonlinear Autoregressive Distributed Lag; FDI, foreign direct investment; GDP, Gross Domestic Product

Table 8 presents the short-run dynamics of the NARDL model. A 1% increase in GDP improves TB by 4.00% in the short run. This finding contrasts with the negative long-run coefficient, suggesting that during temporary economic expansions, export volumes may rise faster than imports due to increased production capacity and external demand. However, the long-run deterioration observed earlier implies that this improvement is only transitory. Such a reversal between short- and long-run effects is consistent with the dynamic adjustment pattern often associated with the J-curve phenomenon (Bahmani-Oskooee and Kutan, 2008).

A 1% increase in EXCH_POS, representing a 1% depreciation of the domestic currency, immediately improves TB by 1.53% in the short run. This strong positive elasticity indicates that the responsiveness of trade flows to depreciation occurs rapidly, likely due to improved export competitiveness and greater import-substitution capacity. The positive sign is consistent with the Marshall-Lerner condition, suggesting that depreciation enhances net exports when the combined elasticities of import and export demand exceed unity. This short-run improvement also supports the early phase of the J-curve hypothesis, according to which currency depreciation yields an immediate beneficial adjustment in TB before the long-run equilibrium is reached (Bahmani-Oskooee and Fariditavana, 2016).

A 1% appreciation of the domestic currency worsens TB by 22.48% in the current period and by 16.43% in the following period. The persistence of negative effects over two periods reveals a strong asymmetric response, where appreciation shocks have both immediate and lagged adverse impacts. This finding corroborates the nonlinear J-curve hypothesis, suggesting that appreciations deteriorate TB much more severely than depreciations improve it. Comparable short-run asymmetries were identified by Truong and Vo (Truong and Vo, 2023) for Vietnam and Bahmani-Oskooee and Fariditavana (Bahmani-Oskooee and Fariditavana, 2016) for Turkey.

ECT is negative and highly significant, confirming the existence of a stable long-run equilibrium relationship among the variables. Its magnitude greater than one indicates a fast speed of adjustment, meaning that more than 100% of any short-run disequilibrium in TB is corrected within a year.

The model explains about 60% of the short-run variations in TB, which is satisfactory for a macroeconomic time-series model.

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Variable	Coefficient	t-Statistic	Prob.
D(GDP)	4.00	1.40	0.063*
D(EXCH_POS)	1.53	4.22	0.000***
D(EXCH_NEG)	-22.48	-3.37	0.001***
D(EXCH_NEG(-1))	-16.43	-2.56	0.014***
CointEq(-1)*	-1.10	-7.84	0***
R-squared	0.64		
Adjusted R-squared	0.60		

TABLE 8: NARDL short-run form

NARDL, Nonlinear Autoregressive Distributed Lag

The null hypothesis of the short-run Wald test assumes that the short-run effects of EXCH depreciations and appreciations on TB are equal. In other words, it posits that TB reacts symmetrically to both positive and negative changes in EXCH.

Rejecting this hypothesis implies that short-term responses differ in magnitude or direction, confirming the existence of short-run asymmetry.

Test Statistic	Value	Degrees of Freedom	Probability
t-statistic	3.5978	37	0.0009
F-statistic	12.945	(1, 37)	0.0009
Chi-square	12.945	1	0.0003

TABLE 9: Short-run Wald test for EXCH asymmetry

EXCH, official exchange rate

The null hypothesis of the long-run Wald test states that the long-run effects of EXCH depreciations and appreciations on TB are identical. It assumes that over time, TB converges symmetrically to equilibrium regardless of whether the currency appreciates or depreciates.

Rejection of this hypothesis indicates long-run asymmetry, suggesting that the long-term improvement or deterioration of TB depends on the direction of EXCH movement.

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Test Statistic	Value	Degrees of Freedom	Probability
t-statistic	2.902724	37	0.0062
F-statistic	8.425806	(1, 37)	0.0062
Chi-square	8.425806	1	0.0037

TABLE 10: Long-run Wald test for EXCH asymmetry

EXCH, official exchange rate

The Wald test results reported in Tables 9 and 10 reject the null hypotheses of both short-run and long-run symmetry at the 1% level. These findings indicate that TB responds asymmetrically to EXCH movements in both the short and long run, thereby validating the nonlinear specification of the NARDL model and supporting the asymmetric J-curve hypothesis.

Table 11 summarizes the diagnostic test results (Jarque-Bera normality, Breusch-Godfrey serial correlation, ARCH heteroscedasticity, and Ramsey RESET tests), confirming the NARDL model's validity at the 5% significance level.

Test	H ₀	Decision Statistics [p-value]
SC*	There is no serial correlation in the residuals	Accept H ₀ 0.49[0.614]
HE**	There is no autoregressive conditional heteroscedasticity (ARCH)	Accept H ₀ 0.64[0.425]
NO***	Normal distribution	Accept H ₀ 0.86[0.648]
RR****	Absence of model misspecification	Accept H ₀ 0.26[0.793]

TABLE 11: Results of NARDL diagnostic and stability tests

NARDL, Nonlinear Autoregressive Distributed Lag

Figure 5 illustrates the cumulative dynamic multiplier responses of TB in Turkey to both positive (EXCH⁺) and negative (EXCH⁻) exchange rate over a 15-period horizon. Depreciations (EXCH⁺) lead to a gradual improvement, while appreciations (EXCH⁻) cause a sharp and immediate deterioration. The asymmetry band indicates that these effects differ significantly over several periods. In the short run, TB reacts strongly to appreciations due to Turkey's high import dependence, whereas the positive impact of depreciations emerges slowly as exports adjust. Over time, both effects stabilize, but the persistence of asymmetry confirms that EXCH changes influence TB in a nonlinear, direction-dependent way. This pattern supports the asymmetric J-curve hypothesis for Turkey.

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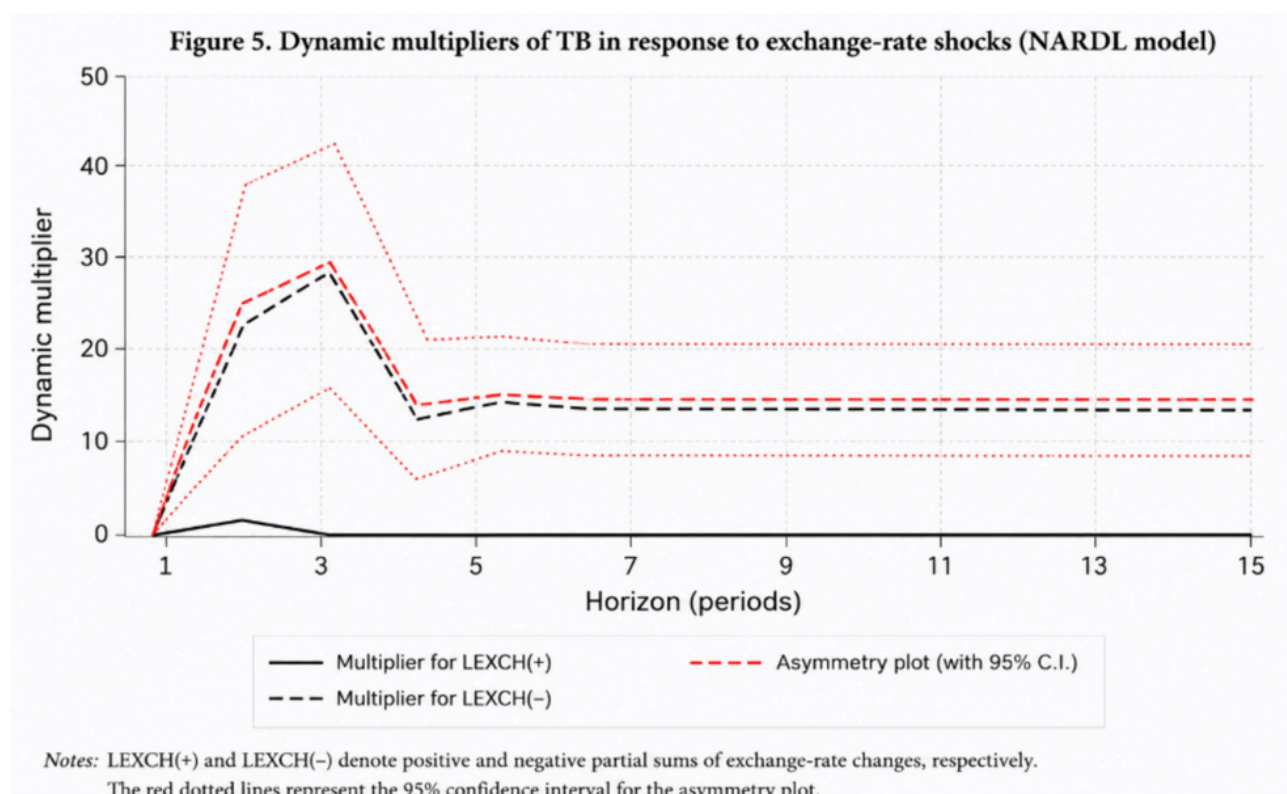


FIGURE 5: Dynamic multiplier effects of EXCH shocks ($EXCH^+$ and $EXCH^-$) on TB

Source: Author. EXCH, official exchange rate; TB, trade balance; NARDL, Nonlinear Autoregressive Distributed Lag

Figure 6 displays the outcomes of the CUSUM test to assess the parameter stability of the NARDL model. The test statistics remains within the 5% critical bounds, marked by the red dotted lines, indicating that the model is structurally stable.

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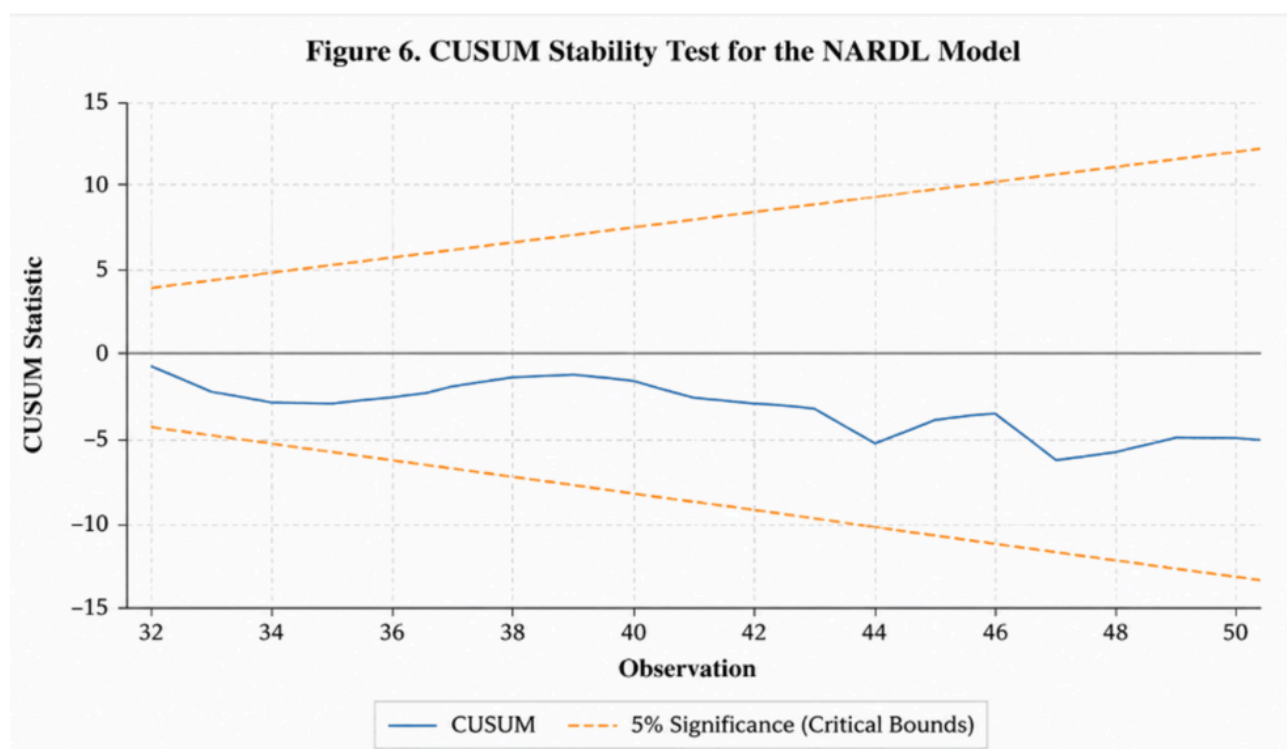


FIGURE 6: NARDL CUSUM plot

Source: Author. NARDL, Nonlinear Autoregressive Distributed Lag

Figure 7 presents the impulse response functions of Turkey's TB to two structural shocks - positive and negative movements in the exchange rate (EXCH_POS, EXCH_NEG) - estimated using the LP method of Jordà (Jordà, 2005). The results reveal nonlinearities and asymmetric adjustment patterns, reinforcing Turkey's structural sensitivity to external shocks.

A depreciation shock (EXCH_POS) generates a moderate short-run improvement in TB, which strengthens across horizons. This is consistent with the J-curve argument that export and import volumes adjust gradually. This pattern accords with evidence that Turkey's export sector responds positively to currency weakness, though with delays due to high import content in production (Ghosh et al., 2015).

In stark contrast, an appreciation shock (EXCH_NEG) causes a large, immediate, and persistent deterioration of TB. The magnitude of this negative effect far exceeds the improvement observed after depreciation, indicating strong asymmetric trade responsiveness. This pattern is consistent with the literature emphasizing that appreciation episodes disproportionately harm emerging economies with high import dependence and limited capacity for rapid export substitution (Bussière et al., 2020).

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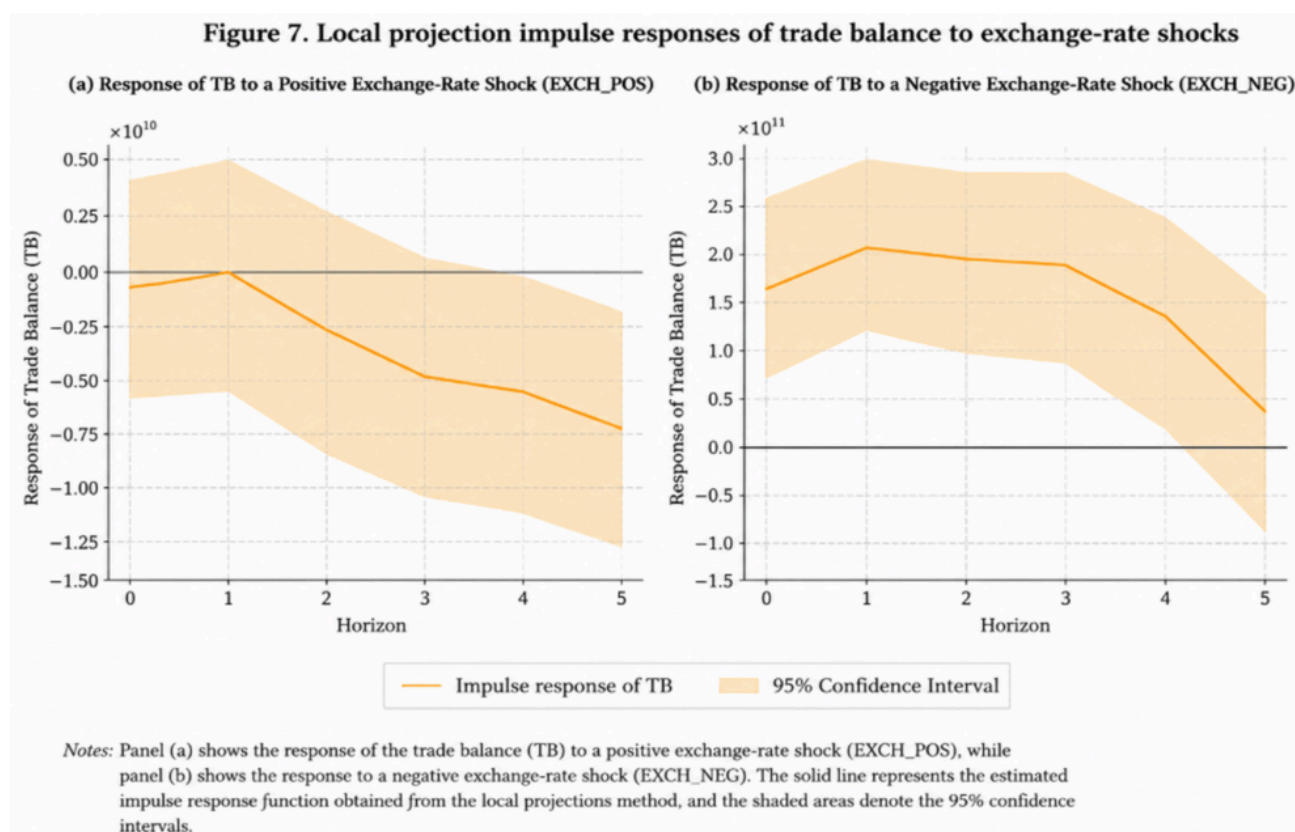


FIGURE 7: Dynamic responses of TB to EXCH shocks (local projections, 95% CIs)

Source: Author. TB, trade balance; EXCH, official exchange rate; CI, confidence interval

The findings of this study provide clear evidence in support of all four research questions. RQ1 is fulfilled, as the short-run NARDL results reveal that depreciations and appreciations have different effects on TB, with appreciations generating much stronger deterioration. RQ2 is fulfilled, because the long-run estimates show that depreciation improves TB, while appreciation worsens it, consistent with the Marshall-Lerner condition. RQ3 is fulfilled, given that the Wald tests reject symmetry in both the short and long run, confirming that Turkey's TB adjusts asymmetrically to exchange rate movements. Finally, RQ4 is fulfilled, as the dynamic multipliers and local projections show a gradual and persistent adjustment path that aligns with the theoretical J-curve pattern.

The asymmetry identified in this study also reflects the limited elasticity of exports in the short run, which constrains the ability of depreciation to generate immediate improvements in the trade balance. In economies such as Turkey, where production relies heavily on imported intermediate inputs, cost increases associated with depreciation can partially offset gains in export competitiveness. This structural feature weakens the traditional J-curve effect and explains why improvements in TB remain gradual and relatively small compared to the sharp deterioration caused by appreciation. The persistence of the negative effects following exchange rate appreciation suggests that adjustment processes are not only asymmetric but also path dependent. Once competitiveness is reached, recovery through export expansion requires time, investment, and structural adaptation. This delayed adjustment reinforces the idea that exchange rate shocks have lasting implications for external balance dynamics, particularly in economies with rigid production structures and high exposure to global value chains. These findings also highlight the role of global integration in shaping TB responses. As Turkey is deeply integrated into international trade and financial systems, exchange rate movements quickly translate

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into changes in import prices and external financing conditions. Consequently, appreciation episodes may coincide with increased capital inflows and consumption-driven imports, further exacerbating trade deficits. This interaction between exchange rate dynamics and external financing channels amplifies the observed asymmetry.

Conclusions

The results show clear nonlinear and asymmetric effects of EXCH shocks on Turkey's TB. Currency appreciations cause a sharp and persistent deterioration in the TB, while depreciations generate smaller and slower improvements. These patterns suggest that Turkey's external position is highly sensitive to adverse currency movements. The combination of NARDL and LP confirms that Turkey's TB adjusts differently depending on the direction of shocks, and that structural import dependence plays a central role in shaping these outcomes.

These findings provide robust empirical support for the asymmetric J-curve hypothesis in the case of Turkey, confirming that exchange rate movements do not affect TB in a linear or proportional manner. The magnitude of the estimated coefficients, particularly the substantially larger impact of appreciation compared to depreciation, suggests that traditional symmetric models would significantly underestimate the risks associated with currency overvaluation. This asymmetry reflects structural rigidities in the Turkish economy, including high import dependence, limited short-run export elasticity, and strong pass-through effects from exchange rate movements to domestic prices.

The findings imply that excessive exchange-rate appreciation should be avoided, as it has a disproportionately negative effect on TB. Reducing reliance on imported intermediate goods through industrial and technological development would help mitigate sensitivity to currency movements. FDI policies should encourage investments that generate exports or reduce import requirements, as typical inflows tend to be initially import-intensive. Finally, growth episodes in Turkey tend to increase imports; therefore, macroeconomic and trade policies should be coordinated to ensure that expansions do not exacerbate external imbalances.

This study relies on aggregate TB data, which may hide sector-specific or partner-specific patterns. The use of nominal EXCH, rather than a real effective measure, may also limit interpretation. Future research could examine bilateral trade flows, sectoral differences, or structural breaks in Turkey's EXCH regime. Incorporating financial variables or using RER data would also allow a deeper understanding of Turkey's external adjustment mechanisms.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Irina Georgescu, Jani Kinnunen

Acquisition, analysis, or interpretation of data: Irina Georgescu, Jani Kinnunen

Drafting of the manuscript: Irina Georgescu, Jani Kinnunen

Critical review of the manuscript for important intellectual content: Irina Georgescu, Jani Kinnunen

Supervision: Irina Georgescu, Jani Kinnunen

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial**

How to cite this article:

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relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Data Availability Statements

The datasets (and/or code) supporting this study are available from the corresponding author upon reasonable request.

References

1. Afonso A, Alves J, Jalles J, Monteiro S: [Energy price dynamics in the face of uncertainty shocks and the role of exchange rate regimes: A global cross-country analysis](#). The Journal of Economic Asymmetries. 2025, 32:e00425. [10.1016/j.jeca.2025.e00425](#)
2. Alexander S: [Effects of devaluation on a trade balance](#). IMF Staff Papers. 1952, 2:263-278.
3. Alfaro L, Chanda A, Kalemli-Ozcan S, Sayek S: [FDI and economic growth: the role of local financial markets](#). Journal of International Economics. 2004, 64:89-112.
4. Ali AA, Cergibozan R, Cevik E: [J-curve in Turkish bilateral trade: A nonlinear approach](#). The International Trade Journal. 2019, 33:31-53. [10.1080/08853908.2018.1521316](#)
5. Akbostanci E: [Dynamics of the trade balance: The Turkish J-curve](#). Emerging Markets Finance and Trade. 2004, 40:57-73. [10.1080/1540496x.2004.11052584](#)
6. Arize AC, Malindretos J, Igwe EU: [Do exchange rate changes improve the trade balance: An asymmetric nonlinear cointegration approach](#). International Review of Economics & Finance. 2017, 49:313-326. [10.1016/j.iref.2017.02.007](#)
7. Arize AC, Osang T, Slottje DJ: [Exchange-rate volatility and foreign trade: Evidence from thirteen LDCs](#). Journal of Business & Economic Statistics. 2000, 18:10-17.
8. Arndt HW, Dorrance G: [The J-curve](#). Australian Economic Review. 1987, 20:9-19. [10.1111/j.1467-8462.1987.tb00653.x](#)
9. Bahmani-Oskooee M, Brooks TJ: [Bilateral J-curve between US and her trading partners](#). Weltwirtschaftliches Archiv. 1999, 135:156-165. [10.1007/bf02708163](#)
10. Bahmani-Oskooee M, Fariditavana H: [Nonlinear ARDL approach and the J-Curve phenomenon](#). Open Economies Review. 2016, 27:51-70. [10.1007/s11079-015-9369-5](#)
11. Bahmani-Oskooee M, Fariditavana H: [Nonlinear ARDL approach, asymmetric effects and the J-curve](#). Journal of Economic Studies. 2015, 42:519-530. [10.1108/jes-03-2015-0042](#)
12. Bahmani-Oskooee MM, Goswami GG: [A disaggregated approach to test the J-Curve phenomenon: Japan versus her major trading partners](#). Journal of Economics and Finance. 2003, 27:102-113. [10.1007/bf02751593](#)
13. Bahmani-Oskooee M, Halicioglu F: [Asymmetric effects of exchange rate changes on Turkish bilateral trade balances](#). Economic Systems. 2017, 41:279-296. [10.1016/j.ecosys.2016.07.001](#)
14. Bahmani-Oskooee M, Karamelikli H: [The Turkey-US commodity trade and the asymmetric J-curve](#). Economic Change and Restructuring. 2021, 54:943-973. [10.1007/s10644-020-09298-1](#)
15. Bahmani-Oskooee M, Ratha A: [The J-Curve: a literature review](#). Applied Economics. 2004, 36:1377-1398. [10.1080/0003684042000201794](#)
16. Bahmani-Oskooee M, Kutan AM: [Are devaluations contractionary in emerging economies of Eastern Europe?](#). Economic Change and Restructuring. 2008, 41:61-74. [10.1007/s10644-008-9041-9](#)
17. Bozoklu Ş, Yılandı V: [Finansal Gelişme ve İktisadi Büyüme Arasındaki Nedensellik İlişkisi: Gelişmekte Olan Ekonomiler İçin Analiz](#). Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi. 2013, 28:161-187.
18. Brock WA, Scheinkman JA, Dechert WD, LeBaron B: [A test for independence based on the correlation dimension](#). Econometric Reviews. 1996, 15:197-235. [10.1080/07474939608800353](#)
19. Bussière M, Gaulier G, Steingress W: [Global trade flows: Revisiting the exchange rate elasticities](#). Open Economies Review. 2020, 31:25-78. [10.1007/s11079-019-09573-3](#)

How to cite this article:

Georgescu I, Kinnunen J (June 17, 2026) Revisiting the J-Curve Hypothesis in Turkey: A Nonlinear Autoregressive Distributed Lag Approach with Asymmetric Exchange Rate Effects. Cureus J Bus Econ 3 : es44404-026-00123-y. DOI <https://doi.org/10.7759/s44404-026-00123-y>

20. Cergibozan R, Ari A: [The exchange regime and trade balance in Turkey](#). The International Trade Journal. 2018, 32:363-387.
21. Çelik S, Kaya H: [Real exchange rates and bilateral trade dynamics of Turkey: panel cointegration approach](#). Applied Economics Letters. 2010, 17:791-795.
22. Dash RK, Parida PC: [FDI, services trade and economic growth in India: empirical evidence on causal links](#). Empirical Economics. 2013, 45:217-238. [10.1007/s00181-012-0621-1](#)
23. Dickey DA, Fuller WA: [Distribution of the estimator for autoregressive time series with a unit root](#). Journal of the American Statistical Association. 1979, 74:427-431. [10.2307/2286348](#)
24. Goldstein M, Khan MS: [Income and price effects in foreign trade](#). Handbook of International Economics. Jones RW, Kenen PB (ed): Elsevier, 1985. 2:1041-1105.
25. Ghosh AR, Ostry JD, Qureshi MS: [Exchange rate management and crisis susceptibility: A reassessment](#). IMF Economic Review. 2015, 63:238-276.
26. Halicioglu F: [The J-curve dynamics of Turkey: an application of ARDL model](#). Applied Economics. 2008a, 40:2423-2429. [10.1080/00036840600949496](#)
27. Halicioglu F: [The bilateral J-curve: Turkey versus her 13 trading partners](#). Journal of Asian Economics. 2008b, 19:236-243. [10.1016/j.asieco.2008.02.006](#)
28. Herley MD, Orlowski LT, Ritter MA: [Asymmetric responses of equity returns to changes in exchange rates at different market volatility levels](#). The Journal of Economic Asymmetries. 2023, 28:e00336. [10.1016/j.jeca.2023.e00336](#)
29. Herzer D: [How does foreign direct investment really affect developing countries' growth?](#). Review of International Economics. 2012, 20:396-414. [10.1111/j.1467-9396.2012.01029.x](#)
30. Houthakker HS, Magee SP: [Income and price elasticities in world trade](#). Review of Economics and Statistics. 1969, 51:111-125.
31. Jordà O: [Estimation and inference of impulse responses by local projections](#). American Economic Review. 2005, 95:161-182.
32. Kale P: [Turkey's trade balance in the short and the long run: An error correction modelling and cointegration](#). The International Trade Journal. 2001, 15:27-56. [10.1080/088539001300005440](#)
33. Karamelikli H: [Linear and nonlinear dynamics of the Turkish trade balance](#). International Journal of Economics and Finance. 2016, 8:70-80. [10.5539/ijef.v8n2p70](#)
34. Kilinc-Ata N: [The asymmetric impact of economic growth, energy consumption, population, and R&D on carbon emission in Turkey: Evidence from ARDL and non-linear ARDL](#). Handbook of Research on Sustainable Development Goals, Climate Change, and Digitalization. Castrillón RA (ed): IGI Global Scientific Publishing, 2022. 200-215. [10.4018/978-1-7998-8482-8.ch013](#)
35. Kilinc-Ata N, Çamkaya S: [Assessing the impact of technology on the EU clean energy transition: evidence from the Green Energy Mix Quality Index](#). International Journal of Energy Sector Management. 2026, 20:1068-1087. [10.1108/ijesm-03-2025-0041](#)
36. Kilinc-Ata N, Xavier B, Bhat MA: [Decoupling economic growth and CO2 emissions: a geopolitical comparison of the EU and GCC energy transitions](#). Quality & Quantity. 2026, 60:7377-7406. [10.1007/s11135-026-02572-w](#)
37. Krueger AO: [Exchange Rate Determination](#). Cambridge University Press, 1983.
38. Krugman PR, Obstfeld M: [International Economics: Theory and Policy](#). Pearson Education India, 2009.
39. Lerner AP: [The Economics of Control: Principles of Welfare Economics](#). Macmillan, 1944.
40. Lütkepohl H: [New Introduction to Multiple Time Series Analysis](#). Springer, Berlin; 2005. [10.1007/978-3-540-27752-1](#)
41. Magee SP: [Currency contracts, pass-through, and devaluation](#). Brookings Papers on Economic Activity. 1973, 303-325. [10.2307/2534091](#)
42. Marshall A: [Money, Credit and Commerce](#). Macmillan, 1923.
43. Mesagan EP, Alimi OY, Vo XV: [The asymmetric effects of exchange rate on trade balance and output growth](#). The Journal of Economic Asymmetries. 2022, 26:e00272. [10.1016/j.jeca.2022.e00272](#)
44. Narayan PK: [Examining the relationship between trade balance and exchange rate: the case of China's trade with the USA](#). Applied Economics Letters. 2006, 13:507-510. [10.1080/13504850500400488](#)
45. Phillips PCB, Perron P: [Testing for a unit root in time series regression](#). Biometrika. 1988, 75:335-346. [10.1093/biomet/75.2.335](#)

How to cite this article:

Georgescu I, Kinnunen J (June 17, 2026) Revisiting the J-Curve Hypothesis in Turkey: A Nonlinear Autoregressive Distributed Lag Approach with Asymmetric Exchange Rate Effects. Cureus J Bus Econ 3 : es44404-026-00123-y. DOI <https://doi.org/10.7759/s44404-026-00123-y>

46. Pesaran MH, Shin Y, Smith RJ: [Bounds testing approaches to the analysis of level relationships](#). Journal of Applied Econometrics. 2001, 16:289-326. [10.1002/jae.616](#)
47. Rose AK, Yellen JL: [Is there a J-curve?](#). Journal of Monetary Economics. 1989, 24:53-68.
48. Shin Y, Yu B, Greenwood-Nimmo M: [Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework](#). Festschrift in Honor of Peter Schmidt, W.C. Horrace and R.C. Sickles. Springer, 2014. 281-314.
49. Tang TC: [Japanese aggregate import demand function: reassessment from the 'bounds' testing approach](#). Japan and the World Economy. 2003, 15:419-436. [10.1016/s0922-1425\(02\)00051-8](#)
50. Truong LD, Vo DV: [The asymmetric effects of exchange rate on trade balance of Vietnam](#). Heliyon. 2023, 9:e14455. [10.1016/j.heliyon.2023.e14455](#)
51. Wilson P: [Exchange rates and the trade balance for dynamic Asian economies-Does the J-curve exist for Singapore, Malaysia, and Korea?](#). Open Economies Review. 2001, 12:389-413. [10.1023/a:1017982901034](#)
52. [World Development Indicators](#). (2025). <https://databank.worldbank.org/source/world-development-indicators..>
53. Yildirim AE, Saraç TB: [Exchange rate volatility and Turkey-Germany bilateral trade: An asymmetry analysis](#). The Journal of International Trade & Economic Development. 2022, 31:783-797. [10.1080/09638199.2021.2022742](#)

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