ASYMMETRIC EXCHANGE RATE PASS-THROUGH AND THE J-CURVE: EVIDENCE FROM SRI LANKA'S TRADE BALANCE

Sri Lanka Journal of
Economic Research
Volume 13(2) June 2026
SLJER 13.02.04: pp. 69-91
Sri Lanka Forum of
University Economists
DOI: https://doi.org/10.4038/sljer.v13i2.262

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Abstract

The study empirically evaluates the effectiveness of exchange rate flexibility in facilitating Sri Lanka's external adjustment. Using monthly data from January 2003 to December 2024, the analysis employs both the linear Autoregressive Distributed Lag (ARDL) and Nonlinear Autoregressive Distributed Lag (NARDL) frameworks, focusing on the aggregate trade balance and the separate export and import channels. The NARDL model identifies a long-run asymmetric relationship between exchange rate fluctuations and the import-export ratio (M/X), defined as imports relative to exports, where a decline in the ratio indicates an improvement in external balance. The results show that currency depreciation reduces the import-export ratio, implying an improvement in external balance, while appreciation remains statistically insignificant, providing no evidence of a symmetric J-curve pattern. The observed asymmetry reflects export inertia (hysteresis) and asymmetric import responses associated with Sri Lanka's structural dependence on imported goods. The potential gains from appreciation are absorbed by foreign suppliers through asymmetric pricing-to-market behaviour (foreign suppliers adjusting prices differently for currency appreciations versus depreciations). Higher demand for foreign goods worsens the trade balance because exports rely heavily on imported inputs. Taken together, the results suggest that exchange-rate adjustments alone may be insufficient to correct Sri Lanka's trade disequilibrium. Policymakers should implement measures to reduce import dependency, strengthen backward linkages by supporting local suppliers, and diversify exports.

JEL: *C22, F14, F31, F41.*

Keywords: *Sri Lanka, Trade Balance, Asymmetric Cointegration, NARDL, J-Curve, Exchange Rate Pass-Through*

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INTRODUCTION

External sector stability is critical for the macroeconomic sustainability of small open economies such as Sri Lanka, where deep integration with global trade and capital flows amplifies exposure to external shocks (Yildirim & Ivrendi, 2016). Despite a transition toward a more flexible exchange-rate regime, Sri Lanka has experienced persistent trade deficits and recurring balance-of-payments pressures (Sumanaratne, 2023). These imbalances are structural: imports are dominated by essential goods, particularly energy, while exports remain highly concentrated in a narrow set of products and markets. This configuration limits the scope for expenditure switching and raises fundamental questions about the effectiveness of exchange-rate–based adjustment.

The central problem addressed in this study is whether exchange-rate depreciations can correct external imbalances in an economy characterised by high import dependence and limited export responsiveness. Standard elasticity-based theory predicts that currency depreciation improves external balance when the price elasticities of exports and imports satisfy the Marshall–Lerner condition (Houthakker & Magee, 1969; Goldstein & Khan, 1978). However, empirical evidence for Sri Lanka remains mixed, with several studies reporting weak, insignificant, or unstable trade responses to exchange-rate movements (Lakmal & Perera, 2015; Weerasinghe & Perera, 2019). The divergence between theoretical expectation and observed outcomes raises a key question: do exchange-rate movements generate symmetric and corrective adjustments, or do structural rigidities produce asymmetric and potentially adverse effects?

Existing empirical evidence for Sri Lanka provides no clear consensus on the relationship between exchange rate movements and the import-export ratio. Findings differ substantially across studies due to variations in data frequency, model specification, exchange-rate measures, and the definition of external balance indicators. Much of the earlier literature relies on annual or quarterly data and linear frameworks, which may obscure short-run adjustment dynamics and asymmetric responses to depreciations and appreciations (Weliwita et al., 1999; Keembiyahetti & Naranpanawa, 2015). In addition, several studies focus primarily on bilateral trade relationships or aggregate trade outcomes without separately identifying the export and import channels through which exchange-rate changes operate (Lakmal & Perera, 2015). More recent evidence also suggests that the effects of currency depreciation remain context-specific and empirically inconclusive across developing and Asian economies, including Sri Lanka (Mohammed et al., 2020; Alemu & Lee, 2014).

This study addresses these gaps by examining the asymmetric effects of real exchange-rate movements on Sri Lanka's trade balance using a unified empirical framework. It seeks to answer three questions: (i) whether exchange rate depreciations and appreciations exert symmetric or asymmetric effects on the trade balance; (ii) how these effects differ across short-run and long-run horizons; and (iii) whether observed dynamics are driven primarily by export responses or import adjustments.

The contribution of the study is fourfold. First, it employs monthly data (2003–2024), enabling the identification of high-frequency valuation effects and short-run dynamics that are typically overlooked. Second, the study uses the import-export ratio (M/X) as a measure of external balance rather than the conventional trade balance definition of exports minus imports. This formulation has also been adopted in recent analysis by the Reserve Bank of India for examining exchange-rate adjustments and external balance dynamics, given that it provides higher-frequency data (Sardar et al., 2024). Under this specification, an increase in the import-export ratio indicates deterioration in external balance, while a decline reflects improvement. Third, it applies a nonlinear autoregressive distributed lag (NARDL) framework to explicitly model asymmetric responses to depreciations and appreciations in both the short run and the long run. Fourth, it estimates separate models for the import-export ratio, exports, and imports, providing direct evidence on the channels through which exchange-rate movements operate. This empirical design enables a comprehensive assessment of asymmetric adjustment mechanisms in an import-dependent economy.

The remainder of the paper is structured as follows. The next section reviews the theoretical and empirical literature. The following section outlines the data and econometric methodology. The empirical results and discussion are presented next. The final section concludes with policy implications.

LITERATURE REVIEW

Theoretical Foundations

The traditional relationship between exchange rates and the trade balance is grounded in the Marshall–Lerner condition, which predicts that currency depreciation improves the trade balance when demand elasticities are sufficiently large (Houthakker & Magee, 1969; Goldstein & Khan, 1978). The J-curve hypothesis (Magee, 1973) extends this framework by incorporating dynamic adjustment effects, whereby currency depreciation may initially worsen the import-export ratio as import prices rise immediately while export and import quantities adjust only gradually due to existing contracts, invoicing rigidities, and delayed demand responses. Over time, however, export volumes tend to increase and import demand moderates, leading to an eventual improvement in external balance as quantity adjustments begin to dominate the initial price effects.

However, these models generally rely on assumptions of symmetry and smooth adjustment, which have increasingly been challenged in the literature. Theoretical contributions by Baldwin and Krugman (1989) and Dixit (1989) highlight the role of hysteresis arising from sunk costs associated with export market entry and exit, implying that trade flows may not respond proportionately to exchange-rate reversals (Baldwin &

Krugman, 1989; Dixit, 1989). Similarly, pricing-to-market behaviour suggests that firms with market power may adjust markups rather than quantities in response to exchange-rate movements, thereby weakening exchange-rate pass-through and limiting expenditure-switching effects (Krugman, 1987). These mechanisms imply that exchange-rate adjustments can generate asymmetric and path-dependent outcomes, particularly in economies characterised by structural rigidities.

Econometric Advances

Early empirical studies testing the J-curve hypothesis primarily relied on linear frameworks such as the Vector Error Correction Model (VECM) and the autoregressive distributed lag (ARDL) model to capture cointegration and dynamic adjustment between exchange rates and external balance indicators (e.g. Bahmani-Oskooee, 1991; Buluswar et al., 1996; Singh, 2004). However, these approaches impose symmetry by construction, effectively averaging the effects of appreciations and depreciations. This restriction has increasingly been identified as a potential source of inconsistent empirical findings in the exchange-rate and external adjustment literature (Bahmani-Oskooee & Gelan, 2012; Marwah & Klein, 1996).

The nonlinear ARDL (NARDL) model developed by Shin et al. (2014) addresses this limitation by decomposing explanatory variables into positive and negative partial sums. This approach enables the estimation of distinct short-run and long-run effects for depreciations and appreciations, providing a direct test of asymmetry within a single framework. As such, NARDL aligns more closely with theoretical models of hysteresis and pricing-to-market, offering a more flexible and empirically relevant specification.

Evidence on Asymmetric Trade-Balance Responses

Empirical findings on the exchange-rate–trade balance relationship remain highly heterogeneous. Linear-model-based studies report mixed results, with some supporting the J-curve hypothesis (e.g. Bahmani-Oskooee, 1985), others finding insignificant effects of exchange-rate movements on external balance (e.g. Singh, 2004), and some reporting adverse or unstable responses following currency depreciation (e.g. Bahmani-Oskooee & Malixi, 1992). These inconsistencies are not merely empirical noise but reflect both structural differences across economies and methodological constraints.

Nonlinear approaches have helped reconcile part of this divergence. Studies such as Bahmani-Oskooee and Fariditavana (2015, 2016), using nonlinear ARDL models for U.S. bilateral trade relationships and Malaysia–Singapore commodity trade, respectively, show that once asymmetry is explicitly incorporated, the effects of exchange-rate movements on the import-export ratio differ significantly in both direction and magnitude between depreciations and appreciations. Evidence from developing economies indicates that depreciations often have stronger and more persistent effects than appreciations, while bilateral analyses reveal substantial heterogeneity across trading partners. For instance, Bhat and Bhat (2020) find that depreciation improves the trade balance in the long run in India, whereas appreciation has a limited impact, with no clear J-curve pattern highlighting that asymmetry may exist even in the absence of conventional dynamics.

The Sri Lankan literature reflects similar inconsistencies. Studies employing linear models generally report weak or insignificant relationships between exchange rates and the trade balance (e.g., Weerasinghe & Perera, 2019), while others find negative long-run effects of depreciation on external balance (e.g. Sumanaratne, 2023), due to high import dependence and relatively inelastic demand for essential imports, which causes the increase in import costs to outweigh gains from export expansion. Under such conditions, depreciation may raise the domestic currency value of imports substantially while export volumes adjust only gradually, leading to a deterioration in the import-export ratio over time. Evidence on short-run dynamics and the J-curve remains inconclusive.

Recent applications of the NARDL framework provide stronger evidence of asymmetry. For example, Ekanayake and Liyanage (2022) identify asymmetric exchange-rate effects across Sri Lanka's major trading partners and conclude that exchange-rate policy alone has limited effectiveness in improving the trade balance. However, their analysis is primarily based on quarterly bilateral trade data and focuses mainly on aggregate bilateral trade responses rather than separate import and export adjustment channels, leaving the dynamics of Sri Lanka's overall aggregate trade balance insufficiently explored.

Accordingly, the present study aims to capture high-frequency adjustments using monthly data to examine the overall import-export ratio dynamics alongside its export and import components and explicitly models asymmetric short-run and long-run effects within a unified framework.

DATA AND METHODOLOGY

Data

The empirical analysis uses monthly time-series data for Sri Lanka from January 2003 to December 2024. All variables are transformed into natural logarithms to stabilise variance and interpret coefficients as elasticities. Table 1 summarises the variables used along with the sources of data.

The trade balance (TB) is measured as the ratio of imports to exports (M/X), consistent with recent nonlinear trade-balance studies (Bahmani-Oskooee & Fariditavana, 2015, 2016). Under this definition, an increase in TB indicates a deterioration in trade performance (i.e., imports rising relative to exports), while a decrease implies an improvement.

Table 1: Variables used in analysis

Variable	Definition	Frequency	Source
Import-Export Ratio (M/X)	Ratio of Imports to Exports (M/X)	Monthly	CEIC Database
Real Effective Exchange Rate (REER)	Official Index (2017=100), Decline reflects a depreciation	Monthly	CEIC Database
Domestic Demand (YD)	Sri Lanka Industrial Production Index (Proxy)	Monthly	CEIC Database
Foreign Demand (YF)	OECD Industrial Production Index (Proxy)	Monthly	CEIC Database
Geopolitical Risk (GPR)	Caldara and Iacoviello (2022) Index[1]	Monthly	Caldara & Iacoviello (2022)

The real effective exchange rate (REER) is measured using the official 2017-base index published by the Central Bank of Sri Lanka, where an increase in REER denotes a real appreciation (loss of external competitiveness) and a decrease denotes a real depreciation (gain in competitiveness). Accordingly, a positive coefficient on REER implies that an appreciation increases the import-to-export ratio (trade deterioration), while a negative coefficient implies that a depreciation reduces the ratio (trade improvement). This directional consistency is maintained throughout the analysis.

Domestic economic activity (YD) is proxied by Sri Lanka's Industrial Production Index, capturing internal production conditions and import demand pressures. The inclusion of domestic activity is motivated by standard trade-demand frameworks, where higher domestic income or production tends to increase import demand and thereby influence the import-export ratio (Bhat & Bhat, 2021). Foreign demand (FD) is measured using the OECD Industrial Production Index as a proxy for global industrial activity and external demand conditions. Similar proxies for external demand have been widely employed in exchange-rate and trade-balance models to capture changes in trading-partner economic activity and export demand (Bhat & Bhat, 2021; Sardar et al., 2024).

Although the OECD index may not perfectly represent the demand conditions of Sri Lanka's specific trading partners, it provides a consistently high-frequency proxy for global demand and is commonly used in monthly and quarterly external-sector models where partner-level monthly demand data are limited. Geopolitical risk (GPR) is represented by the global Geopolitical Risk Index developed by Caldara and Iacoviello (2022). The inclusion of GPR is motivated by the growing literature showing that geopolitical tensions affect international trade flows, external uncertainty, investment

[1] The study uses the global Geopolitical Risk (GPR) Index developed by Caldara and Iacoviello (2022), rather than country-specific GPR measures.

decisions, and exchange-rate dynamics, thereby influencing external balance adjustments (Sardar et al., 2024).

Model Specification

To assess how the exchange rate affects Sri Lanka's external sector, three independent behavioural equations are estimated: an aggregate trade-balance model, an export demand model, and an import demand model. Disaggregation is essential because exports and imports respond to exchange-rate movements through distinct channels; analysing only the trade balance introduces aggregation bias and obscures short-run adjustment patterns.

The long-run relationship for the import-export ratio follows Rose and Yellen (1989):

$$LnMX_t = \alpha + \beta LnREER_t + \gamma LnYD_t + \delta LnYF_t + \theta LnGPR_t + e_t \tag{1}$$

Depreciation is represented by a reduction in $\ln REER_t$. For the Marshall–Lerner condition to hold, a depreciation must reduce the value of MX; therefore, a depreciation (fall in REER) should be associated with an improvement in trade balance (fall in MX). This implies an expected positive coefficient on REER ($\beta > 0$). Domestic demand is expected to increase import intensity and worsen TB ($\gamma > 0$), while higher foreign demand should stimulate Sri Lankan exports and improve TB ($\delta < 0$). The influence of geopolitical risk is theoretically ambiguous.

Export volumes follow the standard specification:

$$LnX_t = \alpha + \beta LnREER_t + \delta LnYF_t + \theta LnGPR_t + e_t \tag{2}$$

A depreciation should make Sri Lankan exports more price-competitive, implying $\beta < 0$. Higher foreign demand should raise export volumes ($\delta > 0$). The effect of geopolitical risk depends on whether uncertainty disrupts logistics, contracts, or global demand.

Import volumes are modelled as:

$$LnM_t = \alpha + \beta LnREER_t + \gamma LnYD_t + \theta LnGPR_t + e_t \tag{3}$$

A depreciation increases the domestic currency cost of imports, implying a reduction in import volumes when REER declines; thus, under the log-level specification, the expected sign is $\beta > 0$. Domestic demand is expected to increase imports ($\gamma > 0$).

Econometric Methodology

ARDL Error-Correction Framework

Equations (1) – (3) are first estimated using the Autoregressive Distributed Lag (ARDL) approach. ARDL models provide consistent short-run and long-run estimates and remain valid when regressors are a mixture of I(0) and I(1) processes (Pesaran et al., 2001). Prior to estimation, unit-root tests (ADF, PP, KPSS) and structural-break tests (Bai–Perron) are used to confirm that no series is integrated of order two. Optimal lag lengths are selected using the Akaike Information Criterion.

The ARDL models are expressed in error-correction form. The general ECM representation for the three models is given by:

$$\Delta LnMX_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1,i}\ \Delta LnMX_{t-i} + \sum_{i=0}^{n2} \beta_{4,i}\, \Delta LnREER_{t-i} + \sum_{i=0}^{n3} \beta_{2,i}\ \Delta LnYD_{t-i}^{SL} + \sum_{i=0}^{n4} \beta_{3,i}\, \Delta LnYF_{t-i}^{OCED} + \sum_{i=0}^{n4,5} \beta_{4,i}\, \Delta LnGPR_{t-i} + \gamma_0\ LnMX_{j,t-1} + \gamma_1\ LnREER_{t-1} + \gamma_2\ LnYD_{t-1}^{SL} + \gamma_3\ LnYF_{t-1}^{OCED} + \gamma_4\ LnGPR_{t-1} + \xi_t \quad (4)$$

$$\Delta LnX_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1,i}\ \Delta LnX_{t-i} + \sum_{i=0}^{n2} \beta_{2,i}\, \Delta LnREER_{t-i} + \sum_{i=0}^{n3} \beta_{3,i}\, \Delta LnYF_{t-i}^{OCED} + \sum_{i=0}^{n4} \beta_{4,i}\, \Delta LnGPR_{t-i} + \gamma_0\ LnX_{j,t-1} + \gamma_1\ LnREER_{t-1} + \gamma_2\ LnYF_{t-1}^{OCED} + \gamma_3\ LnGPR_{t-1} + \xi_t \quad (5)$$

$$\Delta LnM_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1,i}\ \Delta LnM_{t-i} + \sum_{i=0}^{n2} \beta_{2,i}\, \Delta LnREER_{t-i} + \sum_{i=0}^{n3} \beta_{3,i}\ \Delta LnYD_{t-i}^{SL} + \sum_{i=0}^{n4} \beta_{4,i}\, \Delta LnGPR_{t-i} + \gamma_0\ LnM_{j,t-1} + \gamma_1\ LnREER_{t-1} + \gamma_2\ LnYD_{t-1}^{SL} + \gamma_3\ LnGPR_{t-1} + \xi_t \quad (6)$$

where n_1, n_2, n_3, n_4, n_5 denote the optimal lag lengths associated with each explanatory variable in the ARDL specification.

Short-run effects are captured by the differenced coefficients, while long-run effects follow from the normalised coefficients on the lagged levels. Cointegration is established using the bounds test, and model adequacy is assessed with serial correlation, heteroskedasticity, normality, misspecification, and stability diagnostics.

Nonlinear ARDL (NARDL) Framework

To test whether depreciations and appreciations exert asymmetric effects, the analysis employs the Nonlinear ARDL model developed by Shin et al. (2014). This approach involves decomposing the REER series into its positive and negative partial sums, which reflect the Sri Lankan rupee's appreciation and depreciation, respectively. These partial sums are constructed as follows:

$$REER_t^{+} = \sum_{j=1}^{t} \Delta REER_j^{+} \ \textit{where}\ \Delta REER_j^{+} = max(\Delta REER_j, 0)$$
$$REER_t^{-} = \sum_{j=1}^{t} \Delta REER_j^{-} \ \textit{where}\ \Delta REER_j^{-} = min(\Delta REER_j, 0)$$

The NARDL model is specified for the import-export ratio as:

$$\Delta LnMX_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1,i}\ \Delta LnMX_{t-i} + \sum_{i=0}^{n2} \beta_{2,i}\, \Delta REER_t^{+} + \sum_{i=0}^{n3} \beta_{3,i}\, \Delta REER_t^{-} + \sum_{i=0}^{n4} \beta_{4,i}\ \Delta LnYD_{t-i}^{SL} + \sum_{i=0}^{n5} \beta_{5,i}\, \Delta LnYF_{t-i}^{OCED} + \sum_{i=0}^{n6} \beta_{6,i}\, \Delta LnGPR_{t-i} + \gamma_0\ LnMX_{j,t-1} + \gamma_1 LnYD_{t-1}^{SL} + \gamma_2 LnREER_{t-1}^{+} + \gamma_3 LnREER_{t-1}^{-} + \gamma_4 LnYD_{t-1}^{SL} + \gamma_5 LnYF_{t-1}^{OECD} + \gamma_6 LnGPR_{t-1} + \xi_t \quad (7)$$

For exports as:

$$\Delta LnX_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1,i}\ \Delta LnX_{t-i} + \sum_{i=0}^{n2}\beta_{2,i}\,\Delta REER_t^{+} + \sum_{i=0}^{n3}\beta_{3,i}\,\Delta REER_t^{-} + \sum_{i=0}^{n4}\beta_{4,i}\,\Delta LnYF_{t-i}^{OCED} + \sum_{i=0}^{n5}\beta_{5,i}\,\Delta LnGPR_{t-i} + \gamma_0\ LnX_{\,t-1} + \gamma_1 LnREER_{t-1}^{+} + \gamma_2 LnREER_{t-1}^{-} + \gamma_3 LnYF_{t-1}^{OECD} + \gamma_4 LnGPR_{t-1} + \xi_t \quad (8)$$

And for imports as:

$$\Delta LnM_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1,i}\ \Delta LnM_{t-i} + \sum_{i=0}^{n2}\beta_{2,i}\,\Delta REER_t^{+} + \sum_{i=0}^{n3}\beta_{3,i}\,\Delta REER_t^{-} + \sum_{i=0}^{n4}\beta_{4,i}\ \Delta LnYD_{t-i}^{SL} + \sum_{i=0}^{n5}\beta_{6,i}\,\Delta LnGPR_{t-i} + \gamma_0\ LnM_{,t-1} + \gamma_1 LnYD_{t-1}^{SL} + \gamma_2 LnREER_{t-1}^{+} + \gamma_3 LnREER_{t-1}^{-} + \gamma_4 LnYD_{t-1}^{SL} + \gamma_5 LnGPR_{t-1} + \xi_t \quad (9)$$

This framework allows for the simultaneous estimation of short-run and long-run asymmetric effects. The existence of a long-run relationship is formally tested using the bounds testing approach, while long-run asymmetry is examined using a standard Wald test on the null hypothesis that the coefficients associated with positive and negative exchange-rate changes are equal. The optimal lag structure of the model is selected using information criteria such as the Akaike Information Criterion (AIC). Finally, the stability of the estimated models is evaluated using standard diagnostic and stability tests, including the CUSUM and CUSUMSQ tests.

EMPIRICAL RESULTS AND DISCUSSION

This section presents the empirical findings in four stages. First, preliminary diagnostics establish the statistical properties of the data. Second, linear ARDL results provide a benchmark. Third, nonlinear NARDL estimates identify asymmetric effects. Finally, disaggregated export and import models clarify the transmission channels.

Preliminary Analysis

Descriptive statistics indicate non-normality across variables, with pronounced skewness and excess kurtosis, particularly for geopolitical risk and the trade balance (Table 2).

Table 2: Descriptive Statistics

Statistic	LnMX	LnREER	LnYD	LnYF	LnGPR
Mean	1.64	102.93	85.77	98.46	103.77
Median	1.64	98.98	90.38	99.55	93.11
Maximum	3.98	143.08	119.60	106.45	358.71
Minimum	0.98	62.10	45.82	82.89	58.42
Std. Dev.	0.31	19.97	18.71	5.69	35.57
Skewness	1.62	0.52	-0.47	-0.63	3.15
Kurtosis	13.58	2.51	1.97	2.58	18.67
Jarque-Bera	1348.18	14.35	21.56	19.23	3139.47

Note: Author’s estimates

Unit root tests (ADF and Phillips–Perron) confirm that all variables are integrated of order one (I(1)), satisfying the precondition for ARDL/NARDL estimation (Table 3).

Table 3: Unit Root Analysis (at first difference)

	p values			
	Intercept		Intercept & Trend	
Variable	**ADF Test**	**Phillips-Perron Test**	**ADF Test**	**Phillips-Perron Test**
ΔLnMX	0.000	0.000	0.000	0.000
ΔLnX	0.000	0.000	0.000	0.000
ΔLnM	0.000	0.000	0.000	0.000
ΔLnREER	0.001	0.000	0.000	0.000
ΔLnYD	0.000	0.000	0.000	0.000
ΔLnYF	0.000	0.000	0.000	0.000
ΔLnGPR	0.000	0.000	0.000	0.000

Source: Author's estimates

Structural stability is assessed using Bai–Perron multiple break tests, which identify breakpoints around 2011, 2015, and 2021. These correspond to economically meaningful periods: 2011: post-civil-war adjustment and import expansion phase, 2015: policy regime shifts and external financing changes and 2021–2022: severe balance-of-payments crisis. These findings suggest that the exchange rate–trade balance relationship may have evolved over different macroeconomic phases. The identified breakpoints therefore provide useful context for interpreting the estimated relationships over the full sample period.

Table 4: Bai–Perron Structural Break Tests (Monthly Data, 2003M01–2024M12)

Test	F-Statistic	Scaled F-Statistic	Critical Value (5%)
0 vs. 1 break	15.97996	79.89982	18.23
1 vs. 2 breaks	10.57968	52.89840	19.91
2 vs. 3 breaks	5.682255	28.41127	20.99

Source: Author's estimates.

Aggregate Trade Balance Model

The ARDL results reported in Table 5 confirm the existence of a long-run cointegrating relationship among the variables. The estimated long-run coefficient on REER is positive and statistically significant, implying that an appreciation of the Sri Lankan rupee increases the import-export ratio (M/X) and therefore worsens external balance. Conversely, a decline in REER, representing currency depreciation, reduces the import-export ratio and improves external balance, consistent with the Marshall–Lerner condition. Since the dependent variable is defined as the ratio of imports to exports (M/X), a fall in the ratio indicates an improvement in external balance, while an increase reflects deterioration.

Table 5: Results of Linear Specification (ARDL) for Import-Export Ratio

Short-run coefficient estimates				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**p-value**
D(LNMX(-1))	-0.35	0.09	-3.88	0.00***
D(LNMX(-2))	-0.23	0.09	-2.56	0.01**
D(LNMX(-3))	-0.06	0.09	-0.68	0.50
D(LNMX(-4))	-0.12	0.09	-1.35	0.18
D(LNMX(-5))	-0.10	0.08	-1.15	0.25
D(LNMX(-6))	-0.03	0.08	-0.42	0.68
D(LNMX(-7))	0.00	0.08	0.00	1.00
D(LNMX(-8))	-0.06	0.07	-0.85	0.40
D(LNMX(-9))	-0.10	0.07	-1.42	0.16
D(LNMX(-10))	-0.27	0.06	-4.27	0.00***
D(LNMX(-11))	-0.16	0.05	-2.84	0.00***
D(LNYD)	-0.52	0.13	-4.15	0.00***
D(LNYD(-1))	-0.61	0.15	-4.01	0.00***
D(LNYD(-2))	-0.25	0.13	-1.99	0.05*
D(LNYF)	-1.22	0.69	-1.76	0.08*
D(LNYF(-1))	0.53	0.73	0.73	0.47
D(LNYF(-2))	1.14	0.65	1.74	0.08*
Long-run coefficient estimates				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**p-value**
Constant	-2.57	1.23	-2.10	0.04**
Ln REER	0.52	0.15	3.48	0.00***
Ln YD	0.31	0.11	2.80	0.01**
Ln YF	0.61	0.56	1.09	0.28
Ln GPR	0.04	0.08	0.44	0.66

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Short-run coefficients are only reported for statistically significant variables for brevity. Full results are available on request.

Source: Author's estimates.

In the short run, the estimated REER coefficients also indicate that depreciation contributes to a reduction in the import-export ratio, although not statistically significant, reflecting gradual adjustment dynamics in trade flows. Domestic economic activity (YD) enters with a positive and statistically significant coefficient, suggesting that stronger domestic activity increases import demand relative to exports and thereby worsens the import-export ratio. By contrast, foreign demand (YF) and geopolitical risk (GPR) do not exhibit statistically robust effects within the estimated specification.

As shown in Table 6, the ARDL results confirm the presence of a long-run cointegrating relationship among the variables. Together with the results in Table 5, this suggests that exchange-rate depreciation contributes to external adjustment by reducing imports relative to exports over the long run. The error-correction term is negative and statistically significant, indicating convergence toward the long-run equilibrium following short-run deviations. However, the Ramsey RESET test is statistically significant, suggesting possible functional-form misspecification or omitted nonlinear adjustment dynamics. This is consistent with the Bai-Perron structural breaks, which indicate that the relationship evolves across distinct macroeconomic regimes and imply that the exchange rate effects are not constant over time. These findings indicate that exchange-rate effects may not remain constant over time, implying that linear models may mask important asymmetric responses. Accordingly, the analysis proceeds to the nonlinear ARDL specification.

Table 6: Diagnostic Statistics Associated with Linear ARDL Model

Diagnostic Test	Value	P-value
F-statistic	3.93	0.00***
ECM(-1)	-0.43	0.00***
LM Test	0.77	0.46
RESET Test	9.71	0.00***
CUSUM	Stable	
CUSUMSQ	Stable	
Adj. R^2	0.52	

Note: The F-statistic tests for the existence of a long-run cointegrating relationship among the variables under the ARDL bounds testing framework.

Source: Author's estimates.

As shown in Table 6, the ARDL results confirm the existence of a long-run cointegrating relationship among the variables. The error-correction term is negative and statistically significant, indicating convergence towards the long-run equilibrium following short-run deviations. The RESET test is statistically significant, suggesting that the estimated relationship may not fully capture all aspects of the underlying data-generating process. In addition, the Bai–Perron test indicates that the sample period spans several major macroeconomic episodes. Accordingly, the estimated coefficients should be interpreted as average relationships over the full sample period. The analysis therefore proceeds to the nonlinear ARDL specification to examine whether allowing for asymmetric adjustment improves the empirical results.

Table 7 presents the results of the NARDL model and provides evidence of long-run asymmetry in the response of the import-export ratio (M/X) to exchange-rate movements.

Table 7: Results of Non-Linear Specification (NARDL) for Import-Export Ratio

Short-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
D(LNMX(-2))	-0.13	0.09	-1.35	0.18
D(LNMX(-3))	0.02	0.09	0.26	0.79
D(LNMX(-4))	-0.03	0.09	-0.33	0.74
D(LNMX(-5))	-0.02	0.09	-0.17	0.86
D(LNMX(-6))	0.04	0.08	0.53	0.60
D(LNMX(-7))	0.07	0.08	0.92	0.36
D(LNMX(-8))	0.01	0.08	0.10	0.92
D(LNMX(-9))	-0.05	0.07	-0.65	0.51
D(LNMX(-10))	-0.23	0.06	-3.73	0.00***
D(LNMX(-11))	-0.16	0.05	-2.90	0.00***
D(LNREER_POS)	-0.72	0.42	-1.72	0.09*
D(LNYD)	-0.42	0.13	-3.37	0.00***
D(LNYD(-1))	-0.62	0.14	-4.49	0.00***
D(LNYD(-2))	-0.21	0.11	-1.89	0.06
D(LNYF)	-1.34	0.67	-2.01	0.05*

Long-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
LNREER_POS	0.22	0.15	1.45	0.15
LNREER_NEG	0.33	0.12	2.69	0.01**
LNYD	0.51	0.13	4.02	0.00***
LNYF	0.71	0.42	1.70	0.09*
LNGPR	0.02	0.06	0.40	0.69
C	-2.07	0.75	-2.78	0.01**

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. POS variable reflects periods of Sri Lankan rupee appreciation, while the NEG variable represents periods of its depreciation. Short-run coefficients are only reported for statistically significant variables for brevity. Full results are available on request.

Source: Author’s estimates.

The long-run coefficient on REER_NEG, which captures cumulative depreciations and takes negative values by construction, is positive and statistically significant, while the coefficient on REER_POS is statistically insignificant. This implies that larger currency depreciations, represented by more negative values of REER_NEG, reduce the import-export ratio and thereby improve external balance. In contrast, appreciations do not exert a statistically significant long-run effect. The findings therefore suggest that exchange-rate depreciation contributes to external adjustment in a manner consistent with the Marshall–Lerner condition rather than through adverse valuation effects.

The short-run results in Table 7 indicate significant persistence in the dynamics of the import-export ratio (M/X), particularly through the significant lagged dependent-variable terms. The coefficient on REER_POS is negative and weakly significant, implying that appreciation reduces the import-export ratio in the short run. Domestic economic activity (YD) exerts a negative and statistically significant short-run effect, while foreign demand (YF) also enters negatively and weakly significantly.

As shown in Table 8, the NARDL model marginally improves model fit and confirms cointegration. Although the increase in the adjusted R-square is limited, the nonlinear specification captures asymmetric exchange-rate effects that are not identified under the linear ARDL framework. The Wald test confirms long-run asymmetry, while short-run asymmetry is not statistically significant, indicating that asymmetry is primarily a long-run structural phenomenon.

Table 8: Diagnostic Statistics Associated with the NARDL Model

Diagnostic Test	Value	P-value
F-statistic	5.34	N/A
ECM(-1)	-0.59	0.00***
LM Test	1.42	0.24
RESET Test	8.21	0.01***
CUSUM	Stable	N/A
CUSUMSQ	Stable	N/A
Adj. R^2	0.53	N/A
Wald s	1.65	0.20
Wald l	4.22	0.04**

Note: The F-statistic tests for cointegration, the LM test detects serial correlation, the RESET test checks functional form misspecification, and the CUSUM and CUSUMSQ tests assess model stability.

Source: Author's estimates.

The diagnostic tests indicate no evidence of serial correlation, while the CUSUM and CUSUMSQ tests support parameter stability over the sample period. Although the RESET statistic remains significant, the Bai–Perron test also suggests that the sample includes periods of substantial macroeconomic change. Since the objective of this study is to examine asymmetric exchange-rate effects rather than estimate regime-specific relationships, these structural changes are acknowledged when interpreting the findings. The estimated coefficients should therefore be viewed as average effects over the sample period.

Dynamic multiplier plots reinforce the presence of long-run asymmetry visually (Figure 1). The cumulative response to a unit depreciation shock shows a persistent decline in the import-export ratio (M/X), indicating an improvement in external balance over time. By contrast, the multiplier associated with appreciation shocks displays only a limited and transitory response that gradually converges toward zero. The divergence between the two multiplier trajectories is consistent with the long-run Wald asymmetry results and indicates that currency depreciations exert a stronger and more persistent effect on Sri Lanka's external adjustment process than appreciations during the sample period.

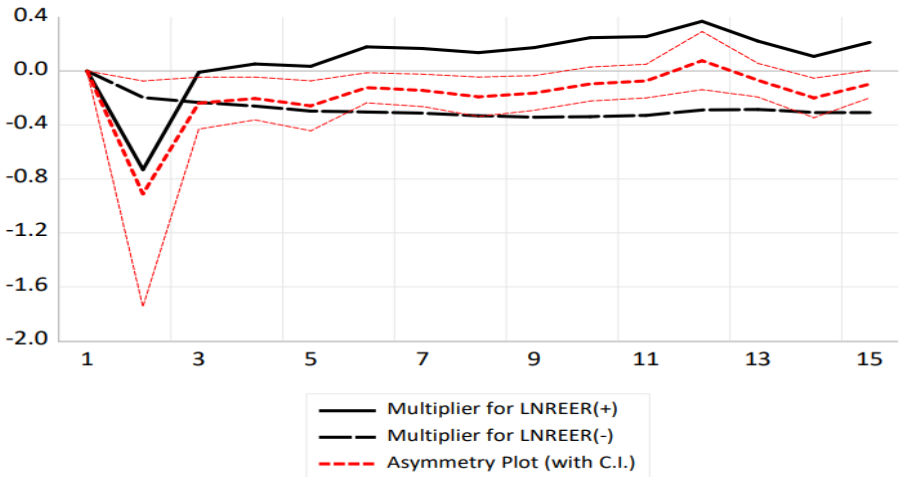

Figure 1: Cumulative Dynamic Multipliers for Appreciation and Depreciation Shocks

Source: Author's estimates.

Disaggregated Analysis: Export and Import Channels

To identify the source of asymmetry, the analysis is extended to separate export and import models. As shown in Table 9, for exports, the long-run coefficients associated with both appreciation and depreciation are individually insignificant. However, the long-run Wald test for asymmetry is statistically significant (Table 11). This indicates that export responses differ across exchange-rate directions in a joint sense, even though individual effects are weak or imprecisely estimated. A plausible explanation is export inertia, where firms face sunk costs and capacity constraints that limit responsiveness to exchange-rate changes. This is consistent with hysteresis-type behaviour, although not directly tested in the model. The short-run results for exports indicate strong persistence in export dynamics, with most lagged dependent-variable terms remaining negative and statistically significant. The short-run appreciation component, REER_POS, exhibits mixed effects across lags, with positive and statistically significant coefficients at the second and sixth lags. The depreciation component, REER_NEG, is also positive and weakly significant in the short run.

Table 9: Results of Non-Linear Specification (NARDL) for Exports

Short-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
D(LNEX(-1))	-0.53	0.08	-6.22	0.00***
D(LNEX(-2))	-0.32	0.08	-3.80	0.00***
D(LNEX(-3))	-0.08	0.08	-1.05	0.30
D(LNEX(-4))	-0.22	0.08	-2.87	0.00***
D(LNEX(-5))	-0.27	0.08	-3.54	0.00***
D(LNEX(-6))	-0.23	0.07	-3.23	0.00***
D(LNEX(-7))	-0.13	0.07	-1.87	0.06*
D(LNEX(-8))	-0.16	0.07	-2.30	0.02**
D(LNEX(-9))	-0.22	0.07	-3.12	0.00***
D(LNEX(-10))	-0.28	0.07	-4.22	0.00***
D(LNEX(-11))	-0.36	0.06	-6.50	0.00***
D(LNREER_POS)	0.00	0.36	0.00	1.00
D(LNREER_POS(-1))	0.44	0.35	1.25	0.21
D(LNREER_POS(-2))	0.62	0.35	1.78	0.08*
D(LNREER_POS(-3))	-0.40	0.35	-1.14	0.25
D(LNREER_POS(-4))	-0.30	0.35	-0.85	0.39
D(LNREER_POS(-5))	0.40	0.35	1.15	0.25
D(LNREER_POS(-6))	1.22	0.35	3.50	0.00***
D(LNREER_NEG)	0.28	0.17	1.66	0.10*

Long-run coefficient estimates

Variables	Coefficient	Std. Error	t-Statistic	p-value
LNREER_POS	0.07	0.27	0.26	0.80
LNREER_NEG	0.03	0.19	0.18	0.86
LNYF	1.90	0.79	2.41	0.02**
LNGPR	-0.09	0.10	-0.92	0.36
C	-2.62	1.52	-1.72	0.09*

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. POS variable reflects periods of Sri Lankan rupee appreciation, while the NEG variable represents periods of its depreciation.

Source: Author's estimates.

For imports, the results are presented in Table 10. The results for the NARDL model for imports are more pronounced than for exports. Both appreciation and depreciation components are positive and statistically significant in the long run, indicating that exchange-rate movements are associated with increases in imports. The coefficient on REER_POS is relatively larger, suggesting that appreciations exert a stronger expansionary effect on imports compared with depreciations. Domestic economic activity

(YD) also enters positively and significantly, reinforcing the structural dependence of Sri Lanka's economy on imported intermediate goods, energy, and consumption-related imports.

Table 10: Results of Non-Linear Specification (NARDL) for Imports

Short-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
D(LNIMPORTS(-1))	-0.37	0.07	-5.52	0.00***
D(LNIMPORTS(-2))	-0.26	0.06	-4.32	0.00***
D(LNREER_POS)	-0.54	0.35	-1.56	0.01***
D(LNREER_NEG)	0.57	0.19	3.04	0.05**
D(LNYD)	0.26	0.11	2.43	0.66
D(LNYD(-1))	-0.20	0.13	-1.52	0.00***
D(LNYD(-2))	-0.02	0.14	-0.18	0.39
D(LNYD(-3))	-0.37	0.13	-2.83	0.75
D(LNYD(-4))	-0.08	0.12	-0.67	0.76
D(LNYD(-5))	0.07	0.10	0.73	0.11
D(LNYD(-6))	0.01	0.10	0.13	0.69
D(LNYD(-7))	0.19	0.10	1.90	0.63
D(LNYD(-8))	-0.01	0.10	-0.09	0.00***
D(LNYD(-9))	0.04	0.09	0.46	0.02**
D(LNGPR)	-0.04	0.03	-1.18	0.42
D(LNGPR(-1))	-0.04	0.04	-1.13	0.11
D(LNGPR(-2))	0.04	0.04	0.96	0.34
D(LNGPR(-3))	-0.06	0.04	-1.61	0.11

Long-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
LNREER_POS	0.64	0.23	2.78	0.01***
LNREER_NEG	0.49	0.18	2.80	0.01***
LNYD	0.76	0.22	3.50	0.00***
LNGPR	0.09	0.13	0.71	0.48
C	-2.31	1.13	-2.05	0.04**

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. POS variable reflects periods of Sri Lankan rupee appreciation, while the NEG variable represents periods of depreciation.

Source: Author's estimates.

The short-run results reported in Table 10 indicate significant persistence in import dynamics, with the first and second lagged dependent-variable terms remaining negative and statistically significant. The short-run coefficient on REER_POS is negative and statistically significant, while REER_NEG is positive and statistically significant, indicating asymmetric short-run responses of imports to appreciation and depreciation shocks. Domestic economic activity (YD) exhibits mixed short-run effects across lags, whereas geopolitical risk (GPR) does not show statistically robust short-run effects.

The diagnostic statistics reported in Table 11 indicate that the nonlinear NARDL specifications for both exports and imports are generally stable and econometrically well-behaved. The error-correction terms are negative and statistically significant, confirming convergence toward the long-run equilibrium. The RESET tests do not indicate functional-form misspecification, while the CUSUM and CUSUMSQ tests confirm parameter stability over the sample period.

Table 11: Diagnostic Statistics Associated with Non-linear NARDL Model for Exports and Imports

	Exports		**Imports**	
Diagnostic Test	**Value**	**P-value**	**Value**	**P-value**
F-statistic	1.94		4.17	
ECM(-1)	-0.28	0.00	-0.32	0.00
LM Test	7.54	0.00	0.37	0.69
RESET Test	0.38	0.54	0.05	0.83
CUSUM	Stable		Stable	
CUSUMSQ	Stable		Stable	
Adj. R^2	0.73		0.49	
Wald s	0.10	0.76	3.72	0.05
Wald l	12.56	0.00	0.16	0.69

Note: The F-statistic tests for cointegration, the LM test detects serial correlation, the RESET test checks functional form misspecification, and the CUSUM and CUSUMSQ tests assess model stability.

Source: Author's estimates.

Taken together, the disaggregated results indicate that the observed asymmetry in the aggregate import-export ratio is driven predominantly by the import channel. The positive and statistically significant coefficient on REER_POS suggests that currency appreciation increases imports more strongly, likely reflecting greater purchasing power and lower domestic-currency prices of imported goods. Although currency depreciation effects are also statistically significant, their magnitude is comparatively smaller. This pattern indicates that import demand in Sri Lanka responds more strongly to currency appreciations than currency depreciations, reflecting the country's structural dependence on imported intermediate goods, fuel, and essential consumption items.

The relatively weaker export response further implies that exchange-rate adjustments do not translate proportionately into export expansion, thereby limiting the extent of external adjustment through the trade channel. These findings are consistent with recent nonlinear studies emphasising asymmetric exchange-rate effects. Similar to Bhat and Bhat (2020), the results suggest that exchange-rate adjustments do not generate a symmetric J-curve pattern, while appreciation and depreciation effects differ in both magnitude and persistence. The findings also align with Bahmani-Oskooee and Fariditavana (2015, 2016), who document asymmetric responses of trade flows to exchange-rate movements. In the Sri Lankan context, the present study extends earlier work by identifying the import channel as the primary source of asymmetry, thereby refining conclusions drawn in studies such as Sumanaratne (2023).

CONCLUSION

This study provides empirical evidence that exchange-rate adjustments in Sri Lanka generate asymmetric external balance outcomes. Using monthly data (2003–2024) within ARDL and NARDL frameworks, the results show that real depreciations systematically reduce the trade-balance ratio (M/X), indicating an improvement in external balance, while appreciations do not produce a statistically meaningful long-run effect. The disaggregated analysis demonstrates that this asymmetry is primarily import-driven: imports respond more strongly to exchange-rate movements, whereas exports exhibit weak and delayed responses to relative-price changes. Economically, this suggests that exchange-rate adjustments operate through uneven import and export responses, limiting the overall effectiveness of external adjustment through the trade channel.

Although depreciation contributes to an improvement in the import-export ratio, the results suggest that exchange-rate adjustment alone may not deliver sustainable external correction under existing structural conditions. This is especially relevant for a policy agenda that emphasises export-led growth and competitiveness, as exchange-rate movements do not automatically translate into strong export expansion.

Accordingly, policy responses must shift from price-based adjustment toward structural transformation. First, reducing dependence on imported energy and intermediate inputs is critical, given the strong responsiveness of imports to exchange-rate movements. Second, strengthening domestic production linkages, particularly in intermediate goods, can reduce the import intensity of exports and improve the effectiveness of competitiveness gains. Third, export diversification toward higher value-added and less import-dependent sectors is essential to enhance responsiveness to external demand. Without such structural changes, exchange-rate policy is likely to remain a limited instrument for external adjustment.

At the same time, several limitations should be acknowledged. The persistence of a significant RESET statistic indicates potential functional form misspecification or omitted nonlinearities, suggesting that the NARDL framework, while capturing asymmetry, does not fully account for all structural complexities. The Bai–Perron test identifies structural changes around 2011, 2015, and 2021, reflecting important macroeconomic developments during the sample period. As this study focuses on estimating the overall asymmetric relationship between exchange rates and the trade balance, these structural changes are acknowledged as a consideration when interpreting the results. In addition, potential endogeneity between exchange rates and trade flows is not fully addressed within the current framework. Finally, the use of proxy variables, such as the OECD industrial production index for foreign demand, may introduce measurement limitations.

Future research can extend this analysis along several dimensions. First, incorporating the dominant currency paradigm (DCP) by explicitly modelling invoicing currency effects—particularly the role of the U.S. dollar would provide deeper insight into exchange-rate pass-through mechanisms. Second, bilateral NARDL models could identify heterogeneity across trading partners and better capture country-specific demand conditions. Third, sectoral or commodity-level models would allow for a more precise identification of channels, especially in distinguishing between energy imports, intermediate goods, and export categories. Advances in micro-level pass-through estimation offer promising avenues for integrating these dimensions and refining the understanding of exchange-rate transmission in structurally constrained economies.

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