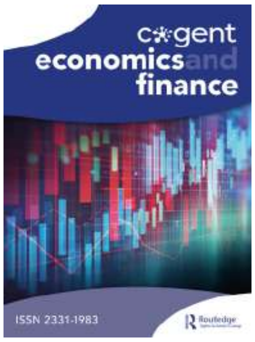

Cogent Economics & Finance

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/oaef20

An asymmetric NARDL approach to the J-curve phenomenon and export competitiveness in India-US trade

Sayed Gulzar Ganai & Javid Ahmad Khan

To cite this article: Sayed Gulzar Ganai & Javid Ahmad Khan (2025) An asymmetric NARDL approach to the J-curve phenomenon and export competitiveness in India-US trade, Cogent Economics & Finance, 13:1, 2483866, DOI: 10.1080/23322039.2025.2483866

To link to this article: https://doi.org/10.1080/23322039.2025.2483866

Published online: 10 Apr 2025.

COGENT ECONOMICS & FINANCE
2025, VOL. 13, NO. 1, 2483866
https://doi.org/10.1080/23322039.2025.2483866

GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE
OPEN ACCESS
Check for updates

An asymmetric NARDL approach to the J-curve phenomenon and export competitiveness in India-US trade

Sayed Gulzar Ganai[a] and Javid Ahmad Khan[b]

[a]SCMS, Symbiosis International University, Pune, India; [b]Department of Economics, Islamic University of Science and Technology, J&K, India

ABSTRACT
This study explores the asymmetric impact of export competitiveness on India's trade balance with the United States (US) and examines the presence of the J-curve phenomenon from 1980 to 2023. Using the Non-linear Autoregressive Distributed Lag (NARDL) model, impulse response functions, and other econometric techniques, the study investigates both short- and long-run dynamics. The results reveal that India's trade balance with the US is significantly influenced by the competitiveness of its manufactured exports and industrial production capacity. In the short run, a declining real exchange rate has a negative impact on the trade balance, which is consistent with the J-curve effect, while prior trade surpluses contribute to economic stability. In the long run, the analysis shows that a higher dollar-to-rupee exchange rate leads to an improvement in India's trade balance, whereas a stronger rupee poses risks to sustaining this surplus. The findings also highlight that increased export competitiveness has strengthened India's trade balance, even in the face of rising US industrial productivity, which typically boosts American exports to India. Conversely, reductions in US industrial output provide India with opportunities to capture a larger market share, further emphasizing the complex and dynamic relationship between export competitiveness, exchange rates, and trade balances. This research underscores the critical role of export competitiveness in shaping India's trade balance with the US.

IMPACT STATEMENT
This study explores the asymmetric impact of export competitiveness on India's trade balance with the United States from 1980 to 2023, offering new insights into the dynamics of international trade. By utilizing the Non-linear Autoregressive Distributed Lag (NARDL) model and other advanced econometric techniques, the research uncovers both short- and long-term effects of exchange rate fluctuations, industrial output, and export competitiveness on India's trade balance. The findings reveal the presence of the J-curve phenomenon and highlight the complex interplay between currency movements, export competitiveness, and the broader economic environment. This work is crucial for policymakers, as it underscores the importance of maintaining a competitive export sector to bolster India's trade balances and stabilize her economic growth. Moreover, the study provides valuable insights for businesses and economists seeking to understand the evolving relationship between India and the US in the context of changing geo-political cum economic conditions.

ARTICLE HISTORY
Received 27 September 2024
Revised 11 January 2025
Accepted 19 March 2025

KEYWORDS
India; US; NARDL; export competitiveness; J-Curve; exchange rate

SUBJECTS
Economics; Industry & Industrial Studies; Business, Management and Accounting

Introduction

The relationship between exchange rate fluctuations and trade balance has garnered significant attention from both scholars and policymakers since the introduction of floating exchange rates in the early 1970s. The exchange rate is vital in shaping trade volumes between countries, and the rise of globalization and free trade has intensified the need to understand this relationship. Policymakers aim to implement exchange rate policies that address both short-term and long-term trade and investment goals

CONTACT Sayed Gulzar Ganai sayed.ganai@scmspune.ac.in/saiedhusyn17@gmail.com SCMS, Symbiosis International University, Pune, India

with key trading partners globally (Bahmani-Oskooee & Aftab, 2017). Meanwhile, researchers have evaluated how sensitive trade flows are to exchange rate changes and the nature of this impact. Typically, exchange rate adjustments are used as a trade policy tool to address trade imbalances by influencing short-term export and import levels. In the long-term, export-driven strategies may involve competitive devaluation or depreciation to enhance exports and foster economic growth. However, the initial effects of such measures can be less favorable, potentially worsening the trade balance, a phenomenon known as the J-curve effect. Thus, exchange rates are crucial in both short- and long-term economic strategies. According to the J-Curve theory, after a currency depreciates, the trade balance initially worsens but improves over time. This occurs as foreign demand for cheaper exports increases and import demand decreases due to higher prices. The trade balance follows a J-shaped curve when plotted over time. The theory is based on the elasticity approach, which highlights the responsiveness of export and import volumes to price changes, and it considers time lags in economic adjustments, where the effects of currency depreciation on trade balances take time to materialize. This phenomenon is important for understanding how trade balances respond to exchange rate fluctuations and has significant implications for policymakers and businesses involved in international trade (Krugman, 1989; Magee, 1973).

On the other hand, export competitiveness can be understood as the ability of firms to endure and thrive in a competitive environment, which involves the capacity to offer products that satisfy market demands in terms of quantity, price, and quality, while also ensuring profitability (Latruffe, 2010). In particular, export competitiveness is shaped by both price and non-price factors. Price factors are driven by costs and profit margins, whereas non-price factors encompass aspects such as product quality, advertising, composition, and marketing (Sharma, 1992; Varghese, 1979). The relationship between a country's exporting manufacturers and international competitiveness is significant and, often determined by elements such as resource availability, cost efficiency, production quality, exchange rates, technological expertise, human capital, institutional frameworks, and economies of scale (Basin, 2005). Moreover, an increasing share of the global export market is crucial to a nation's export competitiveness. As new international trade agreements emerge and economies become more interconnected, nations gain access to foreign markets but also face heightened competition, as exports are promoted based on their competitive edge (Cockburn et al., 1999; Varghese, 1979). Therefore, the growth in a nation's exports or the scale of its trade balance often reflects its economic strength and competitive position. Countries such as Germany, Japan, South Korea, and other East Asian economies have successfully preserved their competitive edge and expanded their production in the global market. These nations have sustained their income levels and economic robustness through the adoption of open economic models. India is an ideal country to study as its exports have been on the rise in the United States (US) market and is one of the few economies with which India has shown Balance of Payments (BoP) surplus in recent years.

Graph 1 illustrates the evolving trade relationship between India and the U.S., with Indian exports to the U.S. (IN-US) consistently exceeding U.S. exports to India (US-IN), resulting in a steady trade surplus for India. Both export trends show growth, but the gap has widened significantly since 2010, with a

Graph 1. Evolving trade relationship between India and the U.S. *Source*: Developed by author from WITS data. *Note*. IN-US: Indian exports to US excluding Services, US-IN: US exports to India excluding services and BoT indicates Balance of Trade between India and US.

notable surge in Indian exports after 2020. This reflects India's growing role in global trade and its competitive strengths in various sectors. However, the persistent trade imbalance highlights the importance of addressing market access and trade barriers to foster more balanced and mutually beneficial economic ties.

This analysis is crucial for India, given its reliance on its export market and significant trade with the US. It could also provide valuable insights for policymakers on how the Balance of Trade (BoT) reacts to exchange rate changes, showing the validation or otherwise of the J-curve. In addition, this study has included a new variable of export competitiveness that would give a new insight to the existing literature and would be an exclusive study that empirically tests the competitive strength of Indian manufacturing product lines along with the J-curve effects in the US economy.

Theoretical framework

The essence of J-curve theory explains how currency depreciation initially worsens a country's trade balance before improving it over time, creating a 'J'-shaped pattern. In the short run, trade balance deteriorates as imports become more expensive and exports cheaper, but trade volumes remain inelastic due to contractual and adjustment lags (Magee, 1973). Over the long term, as export volumes increase and import volumes decrease due to price elasticity, the trade balance improves, satisfying the Marshall-Lerner condition if the combined elasticities of exports and imports exceed one. The absorption approach also suggests that depreciation improves the trade balance if national output grows faster than domestic consumption (Bahmani-Oskooee & Ratha, 2004). While the J-curve is supported in many cases, its validity depends on factors like trade structure and elasticities, with mixed evidence in some economies (Rose & Yellen, 1989).

Despite the theoretical appeal of the J-curve effect, empirical support is limited. Previous research often relied on simple econometric methods and aggregated data, which may have hindered comprehensive findings. Several studies, such as Bahmani-Oskooee and Ratha (2004) and Bahmani-Oskooee and Hegerty (2010), offer a detailed examination of these issues. However, studies addressing non-linearity in exchange rates and trade balance modeling are scarce. Shin et al. (2014) recently introduced a non-linear autoregressive distributed lag (NARDL) method, to enhance the ability to model trade balance responses to exchange rate fluctuations in both short and long terms. Bahmani-Oskooee and Fariditavana (2015, 2016) applied this method to explore non-linear patterns in exchange rates and trade flows. Our aim is to apply this approach to the manufacturing product lines trade balance between India and the US, India's largest export market for manufactured products.

While theoretical research in international macroeconomics suggests a predictable link between exchange rates and trade balances, earlier empirical studies have produced mixed results regarding this connection. These earlier studies investigated how fluctuations in exchange rates affect trade balances and specifically explored the underlying causes of trade deficits. For example, Krugman et al. (1987) argued that the appreciation of the dollar was a key factor behind the U.S. trade deficits in the 1980s. This perspective was contested by Mundell (1987), who proposed that trade balance is influenced by differences in national savings and investments, thereby questioning the significance of exchange rates in determining a country's trade balance. Conversely, Feldstein (1987) and Hutchinson and Piggot (1984) attributed the deterioration in the U.S. trade balance primarily to increasing U.S. budget deficits. On the flip side, Backus (1993) utilized a vector autoregressive model to establish a short-term relationship between the real exchange rate and real trade balance for Japan. Similarly, Demirden and Pastine (1995) confirmed a short-term relationship between exchange rates and the U.S. trade balance using the same model. Arize et al. (2017) explored the relationship between import-to-export ratios and the real effective exchange rate for several countries using a vector error correction model. Their findings indicated a short-term relationship but revealed little evidence of a long-term connection between real effective exchange rates and trade balances. The divergent findings on the link between exchange rates and trade balances highlight the need for additional research in this domain. Earlier studies faced criticism due to issues such as non-stationarity in several variables within the trade balance model. Consequently, the parameter estimates derived from ordinary least squares regressions may be unreliable, as this can lead to incorrect rejection of the null hypothesis (Engel & Granger, 1987).

Tiwari and Shahbaz (2011) examine the relationship between India's exchange rate with the US dollar and its trade balance from 1965 to 2008 using the ARDL bounds testing approach for cointegration, along with impulse response functions (IRFs) and variance decompositions (VDs) for dynamic analysis. Their results show a long-term cointegrating relationship between the exchange rate and trade balance, with a depreciation of the Indian rupee positively impacting the trade balance by increasing exports. The study also highlights the lasting effects of past trade policies on the trade balance. In the short term, however, an increase in the money supply and economic growth negatively affects the trade balance, likely due to higher imports driven by increased domestic demand. Additionally, the study supports the J-curve phenomenon, demonstrating that India's trade balance worsens initially after a currency depreciation before improving in the long term. These findings emphasize the complex interactions between exchange rates, trade policies, and economic factors, considering both short-term and long-term influences on India's trade balance with the US.

Virmani and Hashim (2011) examines Indian productivity and growth and find that estimates of Indian manufacturing productivity indicate a slowdown during the 1990s, which has perplexed analysts considering the more extensive and profound reforms of that decade compared to the 1980s, which had previously boosted the Indian economy's growth rate by 2 percentage points The study also examined the hypothesis of a J-curve on productivity and growth following significant liberalization and found it broadly supported by the data.

Islam et al. (2016) use the Bickerdike-Robinson-Metzler (BRM) model to analyze the impact of the Indian Rupee's exchange rate against the US dollar on India's trade balance. Applying the elasticity of absorption approach, the study explores the relationship between macroeconomic variables and the trade balance, while also investigating the presence of the J-curve effect. The authors analyze data from 1965 to 2008, a period of significant global political and economic changes, which may have led to structural breaks in the data. Their findings include cointegration, a positive impact of the depreciation of the rupee on India's trade balance, and confirmation of the J-curve phenomenon. These results provide valuable insights for policymakers in India and its neighboring countries.

Iqbal et al. (2017) emphasize the crucial role of foreign trade in India's economic growth over the past two decades, highlighting increased competitiveness and expanded domestic business opportunities. The study points out that the removal of trade barriers facilitated smoother export-import processes between India and the United States. After the 1991 economic reforms, India saw significant changes in its bilateral trade dynamics with the US, resulting in a sharp increase in trade volume in recent years. Using a 30-year dataset and multiple regression analysis, the authors found a positive relationship between bilateral trade and economic growth for both countries.

Arize et al. (2017) analyze the effect of the real effective exchange rate on the trade balance of eight countries using several non-linear techniques, particularly the non-linear auto-regressive distributed lag (NARDL) model. The NARDL approach offers more efficient estimates for both short- and long-run coefficients, and accommodates asymmetric dynamics through its single common cointegrating vector. Their findings from the long-run co-integration analysis and short-run assessments indicate that these factors significantly affect the trade balance in an asymmetric context.

Das and Biswas (2021) investigate discrepancies in the bilateral trade statistics between India and the United States, noting that India's export data is consistently under-reported, while import data shows periodic fluctuations of both over- and under-mis-invoicing. The authors analyze the determinants of this data fabrication through empirical exercises, developing an econometric model that incorporates various macroeconomic policy variables. Their findings suggest that relative interest rates play a key role in influencing export and import mis-invoicing, followed by spot and forward exchange rates. The study also identifies a uni-directional causal relationship, where import mis-invoicing in one period affects export mis-invoicing in the subsequent period.

Bhat and Bhat (2021) use an asymmetric model and find no evidence of the J-curve effect in the context of India in the global market. In the short term, currency appreciation worsens the trade balance, while currency depreciation enhances it. A similar pattern is observed in the long term, although only the effect of currency depreciation is statistically significant.

Parray et al. (2023) investigated the J-curve effect in the BRICS countries (Brazil, Russia, India, China, and South Africa) using both symmetric and asymmetric pooled mean group estimators. Analyzing quarterly data from 2000Q1 to 2020Q2, the study found no evidence of the J-curve phenomenon. However, the asymmetric model revealed that currency appreciation worsened the trade balance more than depreciation, which had an insignificant effect. Additionally, domestic demand negatively impacted the trade balance, while foreign demand had a positive effect, consistent across both linear and non-linear models. These results offer new insights into exchange rate and demand dynamics in emerging economies.

Based on previous studies, the question remains open regarding the Indian economy, particularly since India has maintained a trade surplus with the U.S. from years. This raises the possibility of observing a J-curve effect. Additionally, incorporating an export competitiveness variable would contribute a unique perspective to the existing literature. The existing literature on the relationship between exchange rates and trade balances often overlooks the crucial role of export competitiveness in shaping this dynamic. While studies have focused on the direct effects of exchange rate fluctuations, the impact of a country's export competitiveness, driven by factors such as productivity, innovation, and market access remains underexplored. Given the growing significance of India's export sector, particularly in the context of its evolving trade relations with major partners, integrating export competitiveness into the analysis could provide deeper insights into the true drivers of trade balance adjustments. Understanding how export competitiveness interacts with exchange rate movements could offer a more nuanced perspective on the long-term and short-term effects of currency fluctuations on trade balances with India's one of the major trading partner, addressing a significant gap in the current literature.

Methodology

When analyzing trade balance, it is typical to consider the level of economic activity both domestically and abroad, as well as the real exchange rate, as key factors influencing trade. Following established research (e.g. Bahmani-Oskooee and Ratha 2004), we model the trade balance between India and the US for manufacturing sector in the dataset using the following function:

$$BoT = f(REX, IIPI, IIPUS, EC) \ldots\ldots \quad (1)$$

Where BoT represents the balance of trade between Indian and US manufactured products. REX denotes the real exchange rate between the Indian rupee and the US dollar, and IIPI and IIPUS represents the indices of industrial production of India and the US respectively taken at base year of 2010. EC represents the competitiveness of manufactured product lines exported from India to the US market and serves as the average revealed comparative advantage Index (RCA) for manufactured exports in this study over the study period.

The RCA index is shown by a formula as,

$$RCAci = \frac{X_{ci}/X_c}{X_{wi}/X_w}$$

Where; $RCAci$ = Revealed comparative advantage of country c in product i.

X_{ci} = exports of commodity i by country c; X_c = total exports of country c.

X_{Wi} = world exports of commodity i; X_w= total world exports.

Accordingly, country c exhibits revealed comparative advantage in the export of good i if $RCAci$ is greater than one. In this study, the export competitiveness of manufactured product line is captured by the average RCA of the exported items of India following (Ganai et al., 2023, 2024).

The dataset was collected for the period of 1980–2023. Table 1 gives the brief description of variables and their data source.

Table 1. Variables used in the study.

Variable	Description	Data Source
Export Competitiveness of manufactured product lines	EC	UNCTAD, WITS
Real exchange rate	REX	RBI, UNIDO
Index of Industrial Production of India	IIPI	MoSPI, Government of India
Industrial Production index of US	IIPUS	IMF, World Bank
Balance of Trade	BoT	Calculated by Authors using data from WITS, World Bank and UNCTAD

The estimated equation from the above function 1 is presented as below:

$$BoT_t = \alpha_0 + \alpha_{01}REX_t + \alpha_{02}IIPI_t + \alpha_{04}IIPUS_t + \alpha_{05}EC_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

This study converted all series into logarithms to obtain reliable and efficient empirical evidence. The log linear specification reduces sharpness in the time series data and provides better results with controllable variance as compared to a simple specification. The log-linear specification of our empirical equation is as follows.

$$BoT_t = \alpha_0 + \alpha_{01}InREX_t + \alpha_{02}InIIPI_t + \alpha_{04}InIIPUS_t + \alpha_{05}InEC_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where; t is the time period from 1980 to 2023, α_o is the intercept, balance of trade (BoT) represents the dependent variable, and the other sample variables are independent variables.

Unit root test

Augmented Dickey Fuller (ADF) and Phillip Perron (PP) unit root tests were used to examine the stationary properties of the long-run relationships of time series variables. Augmented Dickey Fuller (ADF) test is based on the following equation:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum\nolimits_{j-1}^{k} d_j \Delta Y_{tj} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where ε_t is the pure white noise error term, Δ is the difference operator, Y_t is the time series $, \alpha_0,$ is a constant, and k is the optimum number of lags of the dependent variable. The Augmented Dickey Fuller (ADF) test determines whether the estimates of the coefficients are equal to zero. The ADF test provides the cumulative distribution of ADF Statistics. The variable is said to be stationary, if the value of coefficient δ is less than the critical values from the Fuller table. The PP unit root test equation is as follows:

$$\Delta Y_t == \alpha + p^* Y_{t-1} + \varepsilon_t \quad (5)$$

The Phillip and Perron unit root test is also based on t-statistics associated with the estimated coefficients of p^*.

ARDL bound testing

To investigate the long- and short-run dynamics between the variables, this study incorporates the ARDL bounds developed by Pesaran (1997) and Pesaran et al. (2001). The empirical ARDL equation was formulated as follows:

$$\Delta \boldsymbol{BoT}_t = \alpha_0 \boldsymbol{BoT} + \sum_{i=1}^{p} \alpha_{1j} \Delta \boldsymbol{BoT}_{t-j} + \sum_{i=0}^{q1} \alpha_{2j} \Delta REX_{t-j} + \sum_{i=0}^{q2} \alpha_{3j} \Delta IIPI_{t-j} + \sum_{i=0}^{q2} \alpha_{4j} \Delta IIPUS_{t-j} + \sum_{i=0}^{q2} \alpha_{5j} \Delta EC_{t-j}$$
$$+ \theta_1 \boldsymbol{BoT}_{t-1} + \theta_2 REX_{t-1} + \theta_3 IIPI_{t-1} + \theta_4 IIPUS_{t-1} + \theta_5 EC_{t-1} + \varepsilon_{1t} \ldots\ldots\ldots \quad (5)$$

Where Δ indicates the first difference, α_o is a constant, ε is the residual, α_1 , α_2 , α_3 , $and \alpha_{5,}$ are the error correction terms, and $\theta_1, \theta_2, \theta_3, \theta_4$, θ_5 are the long-run coefficients. We estimate the long-run relationship between the variables by testing the null hypothesis of no co-integration $H_O = \theta_{1=}\theta_{2=}\theta_{3=}\theta_{4=}\theta_5$ against the alternative hypothesis $H_1 = \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5$. The F-statistic value was used to determine co-integration. The critical values given by Pesaran et al. (2001) indicate whether the null hypothesis is accepted or rejected. If the F-statistic values lie within the critical values, the result will be inconclusive, whereas if the F-statistic lies above the critical values, the result will be considered conclusive, but lower than the critical value means no co-integration. This study used the Akaik information criterion (AIC) for lag length selection.

For the long-run relationship between BoT, IIPI, IIPUS, REX and EC, this study uses the following equation to estimate the long-run coefficients:

$$\Delta \boldsymbol{BoT} = \delta_0 + \delta_1 \sum_{i=1}^{0} \boldsymbol{BoT}_{t-1} + \delta_2 \sum_{i=1}^{0} REX_{t-1} + \delta_3 \sum_{i=1}^{0} IIPI_{t-1} + \delta_4 \sum_{i=1}^{0} IIPUS_{t-1} + \delta_5 \sum_{i=1}^{0} EC_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

If this study finds evidence of a long-run relationship between the sample variables, then estimate the short-run coefficients using the model equation will be employed.

$$\Delta \boldsymbol{BoT} = \varphi_0 + \varphi_1 \sum_{i=1}^{0} \Delta \boldsymbol{BoT}_{t-1} + \varphi_2 \sum_{i=1}^{0} \Delta REX_{t-1} + \varphi_3 \sum_{i=1}^{0} \Delta IIPI_{t-1} + \varphi_4 \sum_{i=1}^{0} \Delta IIPUS_{t-1} + \varphi_5 \sum_{i=1}^{0} \Delta EC_{t-1} + \text{n} ECT_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

The error correction model (ECT) shows the speed of adjustment needed to restore long-run equilibrium following a short-run shock. '*n*' is the coefficient of the error correction term in the model, which indicates the speed of the adjustments.

Non-linear ARDL technique

The ARDL method does not consider the probability of an asymmetric connection between variables. The positive and negative variations of the decomposed series have the same effect on the dependent variable, which is not an appropriate approach for studying the degree of association between BoT and EC because there could be asymmetric links between these variables. Therefore, we favor the NARDL model. The foremost advantage of this framework is that it permits testing for hidden co-integration, which helps differentiate between linear co-integration, non-linear co-integration, and a lack of co-integration. Thus, we apply a non-linear version of the ARDL approach, which allows for asymmetric relationships. The NARDL model was assembled for a subsequent long-run asymmetric association.

However, the real world includes various fluctuations that have occurred in trade balances, export competitiveness and other economic activities that can have divergent influences on the BoT of India. To, overcome this drawback, this study used the non-linear ARDL following (Shin et al., 2014) to evaluate the asymmetrical effects of independent variables on BoT of India with US. This study uses equation (7) to transform it into a non-linear ARDL model as follows:

$$\begin{aligned}\Delta ln\boldsymbol{BoT}_t = {} & \alpha_1 + \sum_{i=1}^{p} \delta_{ij} \Delta ln\boldsymbol{BoT}_{t-1} + \sum_{i=0}^{q1+} \sigma_{ij}^{+} \Delta lnREX_{t-i} + \sum_{i=0}^{q1-} \sigma_{ij}^{+} \Delta lnREX_{t-i} + \sum_{i=0}^{q2+} \gamma_{ij}^{+} \Delta lnIIPI^{+}{}_{t-i} \\ & + \sum_{i=0}^{q2-} \gamma_{ij}^{-} \Delta lnIIPI^{-}{}_{t-i} + \sum_{i=0}^{q2+} \varphi_{ij}^{+} \Delta lnIIPUS^{+}{}_{t-i} + \sum_{i=0}^{q2-} \varphi_{ij}^{-} \Delta lnIIPUS^{-}{}_{t-i} + \sum_{i=0}^{q2+} \psi_{ij}^{+} \Delta lnEC^{+}{}_{t-i} \\ & + \sum_{i=0}^{q2-} \psi_{ij}^{-} \Delta lnEC^{-}{}_{t-i} + \theta_1 ln\boldsymbol{BoT}_{t-1} + \theta_2^{+} lnREX^{+}{}_{t-1} + \theta_2^{-} lnREX^{-}{}_{t-1} + \theta_3^{+} lnIIPI^{+}{}_{t-1} + \theta_3^{-} lnIIPI^{-}{}_{t-1} \\ & + \theta_4^{+} lnIIPUS^{+}{}_{t-1} + \theta_4^{-} lnIIPUS^{-}{}_{t-1} + \theta_5^{+} lnEC^{+}{}_{t-1} + \theta_5^{-} lnEC^{-}{}_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots \end{aligned} \quad (9)$$

The independent variable export competitiveness is separated into partial positive and negative sum processes, as follows:

$$lnEC_t^{+} = \left\{ \sum_{i=1}^{q} \Delta lnEC_i^{+} = \sum_{i=1}^{q} \max(\Delta lnEC_i; 0) \right\}$$

$$lnEC_t^{-} = \left\{ \sum_{i=1}^{q} \Delta lnEC_i^{-} = \sum_{i=1}^{q} \min(\Delta lnEC_i; 0) \right\}$$

$$lnREX_t^{+} = \left\{ \sum_{i=1}^{q} \Delta lnREX_i^{+} = \sum_{i=1}^{q} \max(\Delta lnREX_i; 0) \right\}$$

$$lnREX_t^- = \left\{ \sum_{i=1}^{q} \Delta lnREX_i^- = \sum_{i=1}^{q} \min(\Delta lnREX_i; 0) \right\}$$

If the long-run relationship between sample variables exist and the results confirm the existence of a long-run relationship between the variables, the following equation is used to estimate the long-run coefficients using the non-ARDL technique:

$$\Delta \boldsymbol{BoT} = \delta_0 + \delta_1 \sum_{i=1}^{p} \boldsymbol{BoT}_{t-1} + \delta_2 \sum_{i=0}^{q1+} REX_{t-1} + \delta_3 \sum_{i=0}^{q2+} IIPI^{+}{}_{t-i} + \sum_{i=0}^{q2-} IIPI^{-}{}_{t-i} + \delta_4 \sum_{i=0}^{q2+} IIPUS^{+}{}_{t-i} + \sum_{i=0}^{q2-} IIPUS^{-}{}_{t-i} + \delta_5 \sum_{i=0}^{q2+} EC^{+}{}_{t-i} + \sum_{i=0}^{q2-} EC^{-}{}_{t-i} + \mu_t \ldots\ldots\ldots\ldots\ldots \quad (10)$$

If a long relationship is evidenced in the non-linear ARDL long-run model, the following equation is utilized to estimate the short-run relationship using this criterion:

$$\Delta \boldsymbol{BoT} = £_0 + £_1 \sum_{i=1}^{p} \Delta \boldsymbol{BoT}_{t-1} + £_2 \sum_{i=0}^{q1+} \Delta REX_{t-1} + £_3 \sum_{i=0}^{q2+} \Delta IIPI^{+}{}_{t-i} + \sum_{i=0}^{q2-} \Delta IIPI^{-}{}_{t-i} + £_4 \sum_{i=0}^{q2+} \Delta IIPUS^{+}{}_{t-i} + \sum_{i=0}^{q2-} \Delta IIPUS^{-}{}_{t-i} + £_5 \sum_{i=0}^{q2+} \Delta EC^{+}{}_{t-i} + \sum_{i=0}^{q2-} \Delta EC^{-}{}_{t-i} + nECT_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots \quad (11)$$

The error correction model shows the speed adjustment required to restore the long-run equilibrium following a short-run shock. 'n' is the coefficient of the error correction term in the equation that indicates the speed of adjustment.

Granger causality

Additionally, the Granger causality test was employed to assess whether one-time series could help predict another. A time series X is considered Granger-cause Y if the lagged values of X contain significant information regarding the future values of Y. The test was conducted under the assumption that the information was relevant for predicting the respective sample variables. The existence of a significant relationship in the first difference of the variables provides evidence of short-run causality.

Results and discussions

In the first stage of the empirical investigation, the bound test for *F* statistics was used to check the co-integration or long-run relationship between the balance of trade and other sample variables, as shown in Table 2. This indicates that F value is higher than the upper bound critical value, which detects the long-run relationship between the sample variables.

Moreover, the evidence of the diagnostic tests revealed that there is no statistical problem with the empirical results for the sample variables for the Indian economy. The null hypothesis is also given in the tables that have been tested through various diagnostic tests, as shown in Table 3(a–c).

Before conducting the empirical investigation, it was essential to perform unit root tests to assess the stationarity of data. Augmented Dicky Fuller (ADF) and Philips-Peron (PP) unit root tests were utilized for

Table 2. Bound test.

F-bounds test		Null Hypothesis: No levels relationship		
Test statistic	Value	Significance	I(0)	I(1)
			Asymptotic: $n = 1000$	
F-statistic	4.57	10%	2.20	3.09
k	4	5%	2.56	3.49
		2.50%	2.88	3.87
		1%	3.29	4.37

Source: Authors calculation.

Table 3. Results of diagonistic tests.

(a) Godfrey Serial correlation LM Test (Ho: No serial Correlation)			
F-statistic	5.09	Prob.*F*(2,29)	0.127
Obs*R-squared	9.88	Prob.chi-square (2)	0.076
(b) Heteroskedasticity test:Breusch-pagan-godfrey (Ho: Homoskedasticity)			
F-statistic	4.68	Prob.F(6,31)	0.34
Obs*R squared	18.08	Prob.chi-square (6)	0.32
Scaled explained SS	61.62	Prob.chi-square (6)	0.074
(c) Normal Distribution			
Jarque-Bera		133.42	
Probability		0.00005	

Source: Author's Calculation, Ho is null hypothesis for the repective tests.

Table 4. Unit root tests.

		ADF		PP	
Variables	Order	*t*- stat	*p*-Value	Adj. *t*-stat	*p*-Value
BoT	Level	2.55	1.000	2.94	0.98
	First difference	−5.06	0.002*	−5.13	0.0002*
IIPI	Level	0.49	0.98	0.52	0.98
	First difference	−6.18	0.001**	−6.17	0.0001**
IIPUS	Level	−2.21	0.20	−2.15	0.22
	First difference	−4.83	0.0004**	−4.86	0.003**
REX	Level	0.21	0.96	0.15	0.97
	First difference	−5.20	0.0001*	−5.18	0.0001*
EC	Level	−1.64	0.44	−1.81	0.36
	First difference	−5.76	0.00**	−5.81	0.0001**

Source: Author's calculation.
Note. '**' and '*' represents significance at level 1% and 5% respectively.

Table 5. Asymmetric short-run NARDL estimation.

Variable	Coefficient	*p*-Value
$\Delta lnREX_t^+$	−2.12	0.032
$\Delta lnREX_t^-$	−1.01	0.132
$\Delta lnBoT_{t-1}^+$	0.33	0.021
$\Delta lnEC_t^+$	0.37	0.022
$\Delta lnEC_t^-$	−0.66	0.013
$\Delta lnEC_{t-1}^+$	−2.19	0.020
$\Delta lnIIPI_t^+$	0.34	0.047
$\Delta lnIIPI_t^-$	−0.94	0.035
$\Delta lnIIPUS_t^+$	2.38	0.051
$\Delta lnIIPUS_t^-$	1.82	0.025
EC_{t-1}	−0.43	0.002
Constant	1.82	0.69
Adj. *R*-square	0.89	–

Source: Authors Calculation.

this purpose as shown in Table 4. The null hypothesis for the test is that variables have a unit root, that must be rejected at least for the first difference. The results show that all the variables are integrated at I (1). The findings indicated that the variables were non-stationary at their initial levels but attained stationarity after computing the first differences. This suggests that there may be a long-term relationship between these variables.

The short-run estimations of the non-linear ARDL model are presented in Table 5. The results indicate that the real exchange rate (REX) has a significant negative effect on the balance of trade (BoT) between India and the US, while its negative value exhibits an insignificant *p*-value. Additionally, the lagged positive value of the BoT has a significant impact on improving the trade balance for the Indian economy relative to that of the US. This suggests that, in the short-run, a declining exchange rate adversely affected India's BoT with the US, illustrating the J-curve phenomenon.

The other variables showed a mixed impact on BoT. Notably, the export competitiveness of manufactured products (EC+) positively contributes to the trade balance, alongside the industrial production indices of both the US (IIPUS−) and India (IIPI+). In contrast, the positive counterparts of IIPUS and IIPI negatively impact India's BoT, as does the variable (EC−). Therefore, increasing export competitiveness is beneficial for improving India's trade balance with the US, as it enhances production.

Table 6. Asymmetric long run estimates of NARDL model.

Variable	Coefficient	*p*-Value
$lnREX_t^+$	2.07	0.045
$lnREX_t^-$	−1.50	0.013
$lnBoT_{t-1}^+$	0.31	0.022
$lnEC_t^+$	2.37	0.032
$lnEC_t^-$	−2.19	0.019
$lnIIPI_t^+$	3.38	0.006
$lnIIPI_t^-$	−4.85	0.007
$lnIIPUS_t^+$	−3.45	0.008
$lnIIPUS_t^-$	2.35	0.007
Constant	−1.45	0.701

Source: Authors calculation.

The negative effects of EC − and IIPI indicate that declines in the competitive strength of manufactured products and industrial production in India weaken the BoT, while their positive counterparts have the opposite effect. This highlights the importance of export competitiveness in the short-run to strengthen India's BoT against the US. Similarly, both the positive and negative aspects of IIPUS influence India's trade balance in the short term, suggesting that higher productivity can foster increased trade between the two economies.

The error correction term (EC_{t-1}) reveals the speed of adjustment from the short-term to long-term. An error correction term (ECT) of −0.43 indicates a strong and significant adjustment process towards the long-run equilibrium monotonically. Specifically, this means that for every unit deviation from the long-run equilibrium, approximately 43% of that deviation is corrected in the next period. This high value suggests rapid adjustment, implying that the system is responsive and quickly returns to equilibrium after any short-term shocks or disturbances.

The long-run estimates of the NARDL model are presented in Table 6. The positive and negative counterparts of the sample variables exhibit mixed effects on India's balance of trade with the US, influencing it in both beneficial and detrimental ways. Notably, the positive counterpart of the exchange rate between India and the US shows a significant long-run effect of 2.07. This suggests that an increasing dollar-to-rupee rate is advantageous for India, enabling it to maintain a trade surplus with the US.

Conversely, the negative counterpart has an adverse effect, indicating that any appreciation or overvaluation of the Indian rupee in the long run would likely deteriorate India's trade balance with the US. Thus, the long-run results further support the J-curve phenomenon for the Indian economy in the US market.

Similarly, the lagged value of BoT has also proved to be beneficial for the Indian economy, as it positively impacts the trade balance both in the short- and long-run, as shown in Tables 4 and 5.

The primary factor influencing India's trade balance is the export competitiveness of its manufactured goods, along with the country's industrial production capacity. The coefficient values presented in the accompanying table highlight the significance of these variables in the long-term health of the Indian economy.

The growing competitiveness of Indian manufactured products in the U.S. market has positively impacted trade balances over time. However, the increased industrial productivity in the U.S. has a negative effect on India's balance of trade, as it may lead to a surge in U.S. exports to India, potentially undermining the surplus India has achieved. Conversely, lower industrial production in the U.S. is beneficial for India, as indicated by a coefficient value of 2.35 in Table 6, in which Indian exports would benefit from entering the US market because of the reduced output potential of the US economy.

As a result, India has sustained its trade surplus with the U.S., primarily because of its robust industrial productivity, the rising competitiveness of its manufactured exports, and its market-driven exchange rate. These factors have collectively contributed to a favorable trade balance with the US in the long term.

Additionally, the J-curve phenomenon has been endorsed, with export competitiveness also exhibiting a J-curve phenomenon relative to the balance of trade, as illustrated in the impulse graphs as well and shown in Figures 1 and 2. These graphs demonstrate that as export competitiveness increases, India's balance of trade also follows a similar J-curve trend.

The findings of this study align with studies by Bahmani-Oskooee and Fariditavana (2015, 2016), Tiwari and Shahbaz (2011), Arize et al. (2017), Iqbal et al. (2017), Virmani and Hashim (2011) and Islam et al. (2016), which confirm the J-curve phenomenon, asymmetric effects of exchange rate fluctuations,

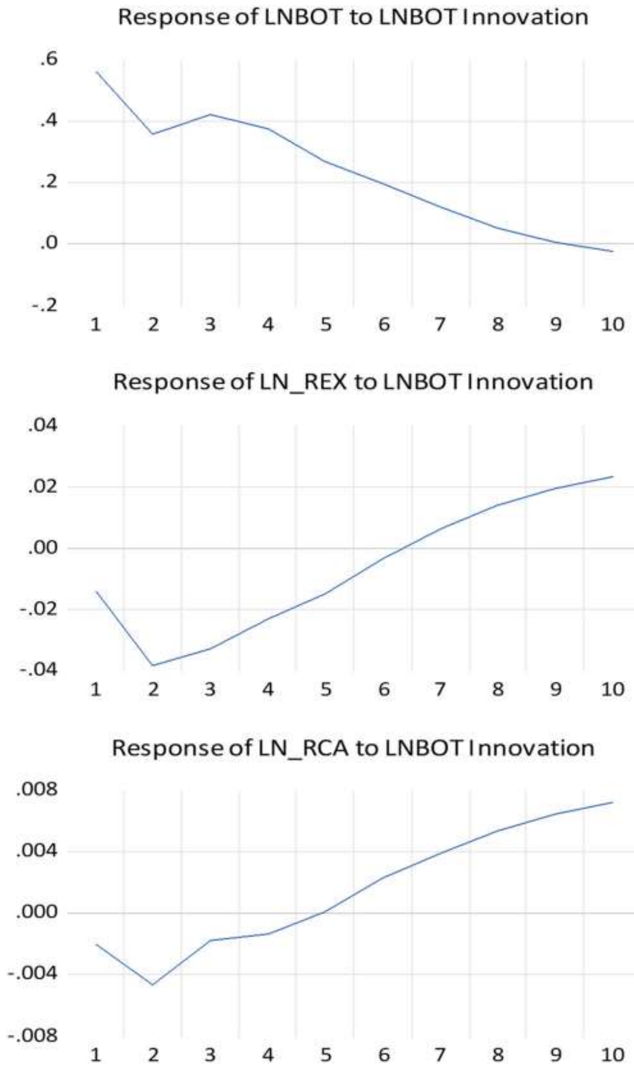

Figure 1. Effects of a shock to *LnBOT* on itself, *LnREX*, and *LnRCA*, highlighting a declining self-impact, rising exchange rate response, and delayed positive adjustment in competitive advantage.
Source: Authors' calculation.

and the critical role of export competitiveness and industrial productivity in driving trade balance. These studies support the notion that exchange rate depreciation initially worsens the balance of trade (BoT) but improves it in the long run, consistent with our results. Conversely, studies such as Bhat and Bhat (2021), Parray et al. (2023), Rose and Yellen (1989), and Das and Biswas (2021) contradict our findings by either rejecting the J-curve phenomenon, finding insignificant effects of exchange rate fluctuations, or attributing trade imbalances to factors like mis-invoicing and external shocks. These contrasting results highlight the contextual and methodological differences in analyzing trade dynamics across different economies and timeframes.

Furthermore, the stability of the estimates in both the short- and long-run was assessed using CUSUM and CUSUMSQ tests, following the methodology outlined by Pesaran et al. (2001). At the 5 percent significance level, both CUSUM and CUSUMSQ remain within the critical bounds, confirming the stability of the estimated results, as illustrated in Figures 3 and 4. The findings of these stability tests fall within acceptable limits, providing strong evidence that the estimated results are stable and reliable.

Granger causality

The results of the Granger causality test are shown in Table 7. For India, REX does not Granger-cause BoT initially, as the significant probability value leads us to reject the null hypothesis, which suggests

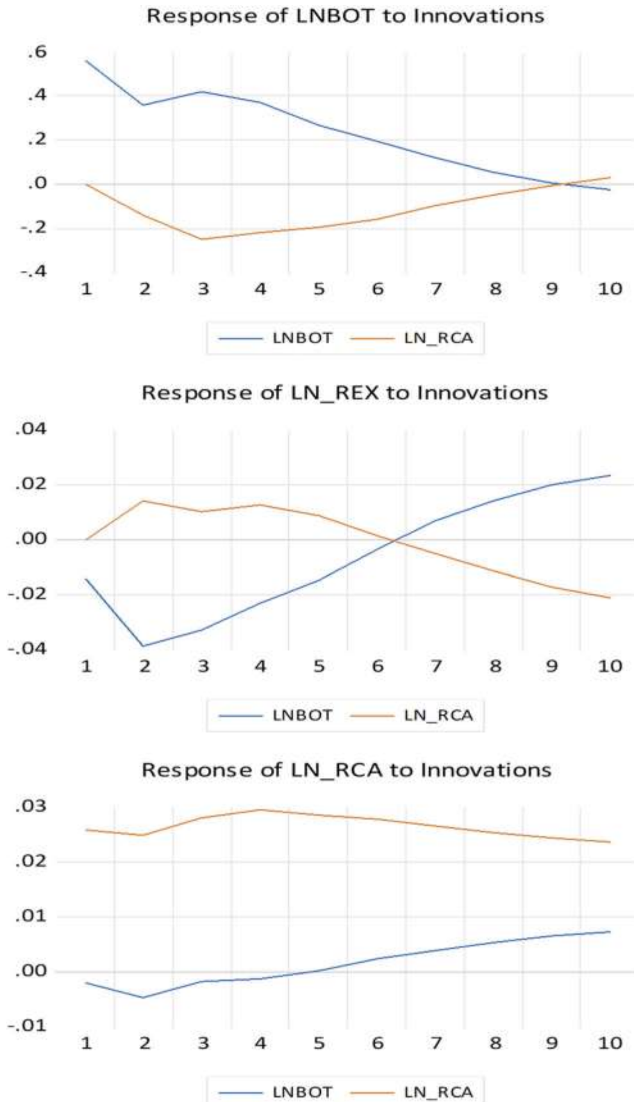

Figure 2. Dynamic effects of *LnBOT* and *LnRCA* innovations on *LnBOT*, *LnREX*, and *LnRCA*. Results indicate a declining own-response of *LnBOT*, a positive exchange rate response to *LnBOT* shocks, and a gradual improvement in comparative advantage following *LnBOT* innovations.*Source:* Authors' calculation.

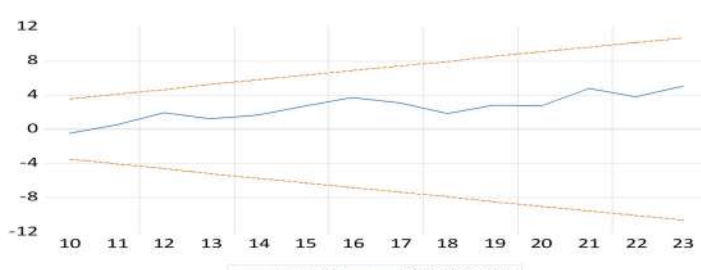

Figure 3. CUSUM.

that the exchange rate causes trade balances to occur in India. However, the BoT does not Granger-cause REX, with a *p*-value of 0.8453, suggesting that we accept the null hypothesis. This indicates a unidirectional relationship, in which only the exchange rate influences an increase in trade balance in India.

Similarly, other variables showing either no Granger-cause or unidirectional results for the sample variables are shown in Table 7.

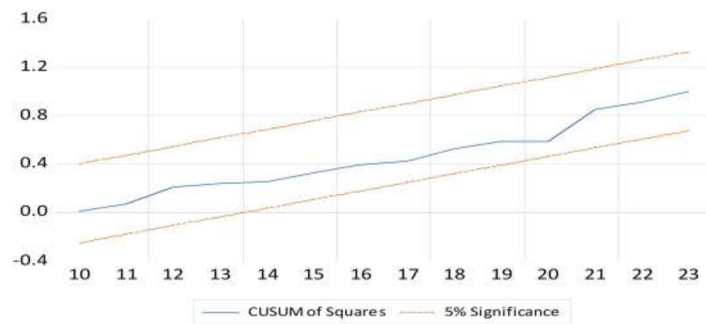

Figure 4. CUSUM of Squares. *Source*: Authors' calculation.

Table 7. Granger causality results.

Causality direction	*F*-Stat	*P*-value	Granger Cause
Ln REX → *Ln BoT*	8.35	0.0012	Yes (Unidirectional)
Ln BoT → *Ln REX*	0.16	0.8453	No
Ln EC → *Ln BoT*	0.06	0.0385	Yes (Unidirectional)
Ln BoT → *Ln EC*	0.22	0.7994	No
Ln IIPUS → *Ln BoT*	1.62	0.2134	No
Ln BoT → *Ln IIPUS*	1.05	0.3585	No
Ln IIPI → *Ln BoT*	5.03	0.0124	Yes (Unidirectional)
Ln BoT → *Ln IIPI*	0.77	0.4690	No
Ln EC → *Ln REX*	1.19	0.3154	No
Ln REX → *Ln EC*	1.05	0.0361	Yes (Unidirectional)
Ln IIPUS → *Ln REX*	1.34	0.2747	No
Ln REX → *Ln IIPUS*	2.36	0.1106	No
Ln IIPI → *Ln REX*	2.54	0.0495	Yes (Unidirectional)
Ln REX → *Ln IIPI*	0.97	0.3877	No
Ln IIPUS → *Ln EC*	0.19	0.8228	No
Ln EC → *Ln IIPUS*	0.23	0.7937	No
Ln IIPI → *Ln EC*	2.38	0.0185	Yes (Unidirectional)
Ln EC → *Ln IIPI*	3.01	0.0361	Yes (Unidirectional)
Ln IIPI → *Ln IIPUS*	1.71	0.1957	No
Ln IIPUS → *Ln IIPI*	1.17	0.3227	No

Source: Author's Calculation, '→ ' denote the 'doesn't granger-cause'.

Conclusion and implications

The analysis of both the short- and long-run NARDL models indicates that India's balance of trade with the United States is significantly influenced by the export competitiveness of manufactured goods and capacity for industrial production. In the short term, a declining real exchange rate adversely affects trade, which aligns with the J-curve phenomenon, while lagged trade surpluses contribute to stability along with positive counterparts of industrial production. In the long run, a higher dollar-to-rupee exchange rate is advantageous for India's trade balance; however, a strengthened rupee could jeopardize this surplus. The increasing competitiveness of Indian exports has improved the trade balance, although increasing industrial productivity in the US poses challenges by boosting American exports to India. Conversely, a decline in US industrial output allows India to gain market share, highlighting the dynamic nature of these relationships.

Moreover, the study's findings suggest several critical policy implications for improving India's trade balance with the US. Effective exchange rate management is essential, as a gradual depreciation of the Indian rupee can enhance the trade balance in the long run, though short-term adverse effects require mitigation through targeted interventions, such as financial support for vulnerable sectors. So, it is crucial to implement strategies to stabilize exchange rates, as fluctuations can significantly impact trade performance. To sustain and enhance its trade surplus with the US, India should prioritize further improving export competitiveness by investing in innovation and quality enhancements within the manufacturing sector. Enhancing export competitiveness should be a priority, necessitating increased investments in research and development, adoption of advanced technologies, and streamlining trade facilitation processes to reduce costs and improve efficiency. Industrial growth policies focusing on boosting manufacturing capabilities and infrastructure development can further strengthen India's export performance. Additionally, strengthening industrial capacity should be a focus, alongside policies that promote domestic productivity and the exploration of new export markets to reduce dependence on the US. Besides, India must adopt a proactive approach that aligns domestic production capabilities with international market demands. By implementing these strategies, India can enhance its trade relations not only with the United States but also with other regions worldwide, fostering long-term economic growth while sustaining its trade surplus.

Furthermore, robust trade monitoring mechanisms are needed to address challenges posed by rising US productivity, including strategic trade agreements and initiatives to ensure better market access for Indian products. Finally, diversifying trade partnerships by exploring and strengthening ties with other global markets can reduce over-reliance on the US and create a more resilient trade framework for India.

Limitations and future research

The study has certain limitations, including its focus on India-US trade, which may not fully capture the broader implications of exchange rate fluctuations and trade dynamics in other bilateral or multilateral contexts. Additionally, the analysis relies on specific variables like export competitiveness and industrial production indices, potentially overlooking other critical factors such as trade policies, geopolitical influences, and sectoral differences within manufacturing. The data constraints, such as limited timeframes or potential structural breaks, may also affect the robustness of the results. Future research could expand the scope by incorporating other trading partners, exploring sector-specific impacts, like high-tech, engineering, resource-based and other processing manufactures and analyzing the role of non-tariff barriers along with the technological advancements.

Author’s contributions

Ganai, S. G.: Responsible for conceptualization, literature review, methodology development, data management and analysis, as well as writing and discussion. **Khan, J. A.:** Contributed to validation and provided feedback on earlier versions of the manuscript. The authors have read and approved the final version of the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

About the authors

Dr. Sayed Gulzar Ganai is an Assistant Professor at Symbiosis Centre for Management Studies (SCMS), Symbiosis International University, Pune, India. He earned his Ph.D. in 2022 from the Islamic University of Science and Technology, focusing his research on the export competitiveness of India and China in manufacturing commodities. Dr. Ganai’s research interests encompass international economics, export competitiveness, and developmental economics. He has contributed to various scholarly articles, including studies on the dynamics of export competitiveness between India and China.

Dr. Javid Ahmad Khan is an Assistant Professor in the Department of Economics at the Islamic University of Science and Technology (IUST) in Awantipora, Jammu and Kashmir. His research interests include international economics, export competitiveness, and developmental economics. Dr. Khan has supervised multiple Ph.D. scholars at IUST, focusing on topics export competitiveness, digital financial inclusion, and human capital’s impact on economic growth. Institute Website: https://www.iust.ac.in/faculty-details.aspx?deptcode=DOECON&empId=1844

ORCID

Sayed Gulzar Ganai http://orcid.org/0000-0002-3552-0589
Javid Ahmad Khan http://orcid.org/0000-0002-8495-4121

Data availability statement

The data for this study were obtained from publicly available sources and can be provided upon request by the corresponding author, S G Ganai.

References

Abdi, A. H., Zaidi, M. A. S., Halane, D. R., & Warsame, A. A. (2024). Asymmetric effects of foreign direct investment and trade openness on economic growth in Somalia: Evidence from a non-linear ARDL approach. *Cogent Economics & Finance*, *12*(1). https://doi.org/10.1080/23322039.2024.2305010

Arize, A. C., Malindretos, J., & Igwe, E. U. (2017). Do exchange rate changes improve the trade balance: An asymmetric non-linear co-integration approach. *International Review of Economics & Finance*, *49*(C), 313–326. https://doi.org/10.1016/j.iref.2017.02.007

Backus, D. K. (1993). *The Japanese trade balance: Recent history and future prospects, paper prepared for trade policy and competition*. National Bureau of Economic Research.

Bahmani-Oskooee, M., & Aftab, M. (2017). Asymmetric effects of exchange rate changes on the Malaysia-EU trade: Evidence from industry data. *Empirica*, *44*(2), 339–365. https://doi.org/10.1007/s10663-016-9324-8

Bahmani-Oskooee, M., & Fariditavana, H. (2015). Non-linear ARDL approach, asymmetric effects and the J-curve. *Journal of Economic Studies*, *42*(3), 519–530. https://doi.org/10.1108/JES-03-2015-0042

Bahmani-Oskooee, M., & Fariditavana, H. (2016). Non-linear ARDL approach and the J-curve phenomenon. *Open Economies Review*, *27*(1), 51–70. https://doi.org/10.1007/s11079-015-9369-5

Bahmani-Oskooee, M., & Hegerty, S. W. (2010). The J-and S-curves: A survey of the recent literature. *Journal of Economic Studies*, *37*(6), 580–596. https://doi.org/10.1108/01443581011086639

Bahmani-Oskooee, M., & Ratha, A. (2004). The J-curve: A literature review. *Applied Economics*, *36*(13), 1377–1398. https://doi.org/10.1080/0003684042000201794

Basin, N. (2005). *External sector reforms in India: 1991–2005*. New Century Publications.

Bhat, S. A., & Bhat, J. A. (2021). Impact of exchange rate changes on the trade balance of India: An asymmetric nonlinear co-integration approach. *Foreign Trade Review*, *56*(1), 71–88. https://doi.org/10.1177/0015732520961328

Cockburn, J., Siggel, E., Coulibaly, M., & Vézina, S. (1999). Measuring competitiveness and its sources: The case of Mali's manufacturing sector. *Canadian Journal of Development Studies / Revue canadienne d'études du développement*, *20*(3), 491–519. https://doi.org/10.1080/02255189.1999.9669852

Das, S., & Biswas, A. K. (2021). Trade mis-invoicing between India & USA: An empirical exercise. *Foreign Trade Review*, *56*(1), 7–30. https://doi.org/10.1177/0015732520961344

Demirden, T., & Pastine, I. (1995). Flexible exchange rates and the J-curve. *Economic Letters*, *48*(3-4), 373–377. https://doi.org/10.1016/0165-1765(94)00634-E

Engel, R. F., & Granger, C. W. J. (1987). Co-integration and error correction representation estimation and testing. *Econometrics*, *55*, 251–276.

Feldstein, M. (1987). Correcting the trade deficit. *Foreign Affairs*, *65*(4), 795. https://doi.org/10.2307/20043094

Ganai, S. G., Khan, J. A., & Bhat, S. A. (2023). Dynamics of export competitiveness of India and China: A study of HS 6-digit manufacturing exports. *Competitiveness Review: An International Business Journal*, *33*(5), 889–938. https://doi.org/10.1108/CR-10-2021-0139

Ganai, S. G., Mir, A. H., Bhat, S. A., & Khan, J. A. (2024). Impacting instruments for export competitiveness: Evidence from India and China in the global manufacturing market. *Global Journal of Emerging Market Economies*, *16*(1), 130–142. https://doi.org/10.1177/09749101221146423

Hutchinson, M., & Piggot, C. (1984). Budget deficits, exchange rates, and the current account: Theory and U. S. Evidence. *Federal Reserve Bank of San Francisco Economic Review*, *Fall 5*(25), 145–148.

Iqbal, B. A., Turray, A. M., & Sami, S. (2017). Impact of Indo–US trade on India's economic growth: An empirical analysis. *Transnational Corporations Review*, *9*(1), 8–15. https://doi.org/10.1080/19186444.2017.1290918

Islam, M., Aviral Kumar Tiwari, A. K., & Shahbaz, M. (2016). *Indo-US bilateral trade: An empirical analysis of India's trade balance.* https://www.researchgate.net/publication/304661526_Indo-US_Bilateral_Trade_An_Empirical_Analysis_of_India's_Trade_Balance

Krugman, P. (1989). The J-curve, the fire sale, and the hard landing. *The American Economic Review*, *79*(2), 31–35. http://www.jstor.org/stable/1827725

Krugman, P. R., Baldwin, R. E., Bosworth, B., & Hooper, P. (1987). The persistence of the U. S. trade deficit. *Brookings Papers on Economic Activity*, *1987*(1), 1–58. https://doi.org/10.2307/2534513

Latruffe, L. (2010). *Competitiveness, productivity and efficiency in the agricultural and agri-food sectors, OECD Food, Agriculture and Fisheries Papers 30*. OECD Publishing.

Magee, S. P. (1973). Currency contracts, pass-through, and devaluation. *Brookings Papers on Economic Activity*, *1973*(1), 303–325. https://doi.org/10.2307/2534091

Mundell, R. A. (1987, January 29–30). A new deal on exchange rates [Paper presentation]. *At Japan-United States Symposium on Exchange Rates and Macroeconomics,* Tokyo, Japan.

Parray, W. A., Bhat, J. A., Yasmin, E., & Bhat, S. A. (2023). Exchange rate changes and the J-curve effect: Asymmetric evidence from a panel of five emerging market economies. *Foreign Trade Review*, *58*(4), 524–543. https://doi.org/10.1177/00157325221145432

Pesaran, M. H. (1997). The Role of Economic Theory in Modelling The Long Run. *The Economic Journal*, *107*(440), 178–191. https://doi.org/10.1111/1468-0297.00151

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, *16*, 289–326. https://doi.org/10.1002/jae.616

Rose, A. K., & Yellen, J. L. (1989). Is there a J-curve? *Journal of Monetary Economics*, *24*(1), 53–68. https://doi.org/10.1016/0304-3932(89)90016-0

Sharma, O. P. (1992). Export competitiveness: Some conceptual issues. *Foreign Trade Review*, *27*(2), 159–176. https://doi.org/10.1177/0015732515920204

Shin, Y., Yu, B. C., & Greenwood-Nimmo, M. (2014). Modelling asymmetric co-integration and dynamic multipliers in a non-linear ARDL framework. In R. Sickels & W. Horrace (Eds.), *Festschrift in Honor of Peter Schmidt: Econometric methods and applications* (pp 281–314). Springer.

Tiwari, A., & Shahbaz, M. (2011). *India's trade with USA and her trade balance: An empirical analysis (MPRA Paper No. 29023)*. University Library of Munich. https://mpra.ub.uni-muenchen.de/29023/

Verghese, S. K. (1979). Development in international competitiveness of India in 1970s. *Economic and Political Weekly*, *14*(40), 1718–1726.

Virmani, A., & Hashim, D., A. (2011). J-curve of productivity and growth: Indian manufacturing post-liberalization. *IMF Working Papers*, *11*(163), 1. https://doi.org/10.5089/9781455298730.001