



The analysis of India's trade relations with its neighbors: implications of regional cooperation and development

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Abstract

This study conducts a detailed analysis of India's multilateral trade with its nine neighbors—Afghanistan, Bangladesh, Bhutan, Myanmar, Maldives, Nepal, China, Pakistan, and Sri Lanka—based on the gravity model of trade. This study adopts a quantitative research approach to analyze India's trade with its neighbors. It evaluates the significance of neighboring economies in India's overall trade structure and their integration with subregional economies. The study is based on key trade variables, including multilateral exports and imports with neighbors, total multilateral trade, the trade balance, and the shares of India's exports, imports, total trade, and the trade balance in total trade. The analysis uses secondary data from official statistics published by the Ministry of Commerce, Government of India. Data were collated and pre-processed in Microsoft Excel, and econometric analysis was performed in RStudio. It includes descriptive statistics, correlation diagnostics, and panel data estimation methods based on gravity equations. In particular, Ordinary Least Squares (OLS), fixed- and random-effects models were estimated in a pooled framework to investigate the determinants and dynamics of multilateral trade with neighboring countries. The empirical results suggest that bilateral and multilateral export–import relationships between India and its immediate neighbors greatly influence regional trade. The coefficients of exports and imports of neighboring countries are statistically significant across all model specifications, implying that higher multilateral trade flows lead to higher trade flows in the region. The models' explanatory power is high (R^2 ranges from 0.945 to 0.972), and tests show the superiority of the fixed-effects model. However, India's global export and import levels are statistically insignificant in explaining regional trade flows. In summary, the findings suggest that multilateral trade remains the primary driver of India's regional trade. This study suggests that increased economic integration, structural reforms, and trade connectivity with neighboring nations are needed to promote regional integration and sustainable growth.

Keywords: Multilateral trade, Neighboring countries, Gravity model, Regional trade integration, Panel data analysis

Introduction

In the digital era, trading is no longer as rare as it was in the previous decade, owing to the digital revolution. In the modern period, a country's trade is not restricted to the country's neighbors but has widened to a greater extent. If a country has the resources, manufacturing ability, and technology to produce, it can expand its trade to any part of the world as and when required. This is an era where a country can grow to be a part of the world, not just with its neighbors or through multilateral trade. However, this study focuses on India's multilateral trade with its neighbors, considering the similarities between countries worldwide in terms of geographical proximity, economy, culture, and rituals. Multilateral trade is an important driver of both development and globalization. The establishment and evolution of the World Trade Organization have played a vital role in creating a rule-based system of global trading arrangements, which leads to better transparency, reduced tariffs and other barriers, and fosters cooperation between nations (Baldwin, 2016; Hannah et al., 2018) ^[1, 9]. Multilateral trade systems have also been important for developing nations, such as India, to open

their markets through exports, stimulating economic growth in the region, and joining global value chains (Hans, 2023; Singh, 2015) ^[10, 21]. However, there are some challenges in the contemporary world trade environment, including rising protectionism, institutional impediments to multilateralism, and a shift toward bilateral and regional trade agreements (Hopewell, 2025; Narlikar, 2022) ^[11, 17].

In this study, trade connections with neighboring countries play a significant role in policy development and regional engagement. Geographical proximity (geographical), bordering each other, cultural similarities, and lower transport costs tend to promote trade relationships between neighboring economies. Regional trade and export promotion policies are gaining increasing prominence in government reports and trade data to improve India's trade performance and strengthen its trade with its neighbors (DGCI&S, 2025; Press Information Bureau Gov. of India, 2025) ^[4, 18]. International bodies, such as the United Nations Conference on Trade and Development (UNCTAD), stress that active involvement in multilateral and regional trade systems and frameworks is crucial to sustainable

development processes and improving the competitiveness of developing nations (United Nations, 2024) [22].

Multilateral trade is the foundation of modern economic systems, enabling international trade under a common set of rules and regulations. For developing economies such as India, it is important to supplement multilateral and regional trade agreements with neighboring countries that are geographically close, share a border, and are economically dependent on each other (Hans, 2023) [10].

In this context, the gravity model of trade is a good empirical representation of trade, which suggests that trade between countries depends on the size of the economy, is inversely related to the geographic distance between the countries, and is further moderated by border distance and contractual distance (Singh, 2015) [21]. Hence, gravity model analysis helps us understand the factors affecting regional trade patterns in the globalizing trade environment and anticipates the potential for India's multilateral trade with its regional economies (Malik, 2024) [13].

Objective and rationale

One of the major aspects of global economic development design is its international trade mechanics, which promote sustainable growth, enhance integration between regions, and produce varied development outcomes in the global economy. It is regulated by the normative model introduced by the World Trade Organization, and there is a noticeable trend in which individual countries start to engage in trading agreements with each other, which enhances their market availability and amplifies mutual economic relations (Baldwin, 2016; Hannah et al., 2018) [1, 9].

The formation of trading relations with neighboring countries acquires a different meaning when it comes to emerging economies, and, in particular, to India. Geographical closeness, substantial historical ties, and much lower transaction costs contribute to more geographic integration of the regional economy by encouraging multilateral trade opportunities with neighboring countries (Dr V Basil Hans, n.d.; Singh, 2015) [6, 21].

It is now easier to reach the world, considering that the modern world of digitalization has turned trade from what it was a few years back, which was only restricted to neighboring nations, to the current world. Thus, an analytical study of trade relations between India and its nearest neighbors is critical even in the current changing circumstances and more convenient accessibility to the world through digitalization to determine how trading with neighboring countries affects coordination, commercial integration, and steady and long-term economic growth in the region.

Literature review

In exploring the multilateral trade relations between India and its peers, it is imperative to examine the same in the context of the evolution of the world trade system in general and the trade policy framework of India in particular. Multilateralism, preferential treatment, and the negotiating strategies employed by Indian negotiators in this area are all aspects that the

literature elaborates on in detail through conceptual analyses. This includes analytical research studies that drew the nexus between trade and developmental economics, as well as a spectrum of policy papers that map out the trade trends in the Indian regional scenario from the past decade through to the present and future.

The multilateral trading system and the World Trade Organization

The WTO is the centerpiece of the multilateral trading system, but its authority and influence are under threat. Baldwin, (2016) [1] suggests that mega-regional trade agreements, immense technological advancements, and changing power dynamics are all threats to WTO-centered multilateralism. These challenges come at the detriment of the traditional “equal-protection principle” of “Most-Favored-Nation” (MFN) multilateralism, leading countries to resort to preferential and regional trade agreements instead. This fact is readily evident from the WTO's dispute-settlement system, which reflects the weakness of the WTO and the withdrawal of large powers, undermining the predictability and rule of law in the multilateral system, disproportionately affecting vulnerable developing nations. This is especially inequitable for developing countries that depend on the security provided by rules (Hopewell, 2025).

The pioneering work of Bhagwati et al., (1996) and Ganesh et al., (2014) [2, 7] succinctly explains the interaction between multilateralism and Preferential Trade Agreements (PTAs). They establish that PTAs can be “building blocks” or “stumbling blocks” for multilateralism, based on whether they create new trade opportunities or simply divert existing trade. This concept is extremely relevant for assessing India's regional and multilateral trade agreements with its neighbors and for understanding how these agreements should align with WTO principles.

Other scholars have studied the effects of power and bargaining on the WTO. The rapport of the India-US trade agreement is a case in point, as Wilkinson, (2015) [24] shows that global trade governance is under pressure as emerging economies, such as India, take on a greater role in negotiations. Narlikar, (2022) [17] states that if the approach is combative or obstructionist in nature, it will hinder the process of multilateral trade negotiations and, hence, collective decision-making. These studies show that India's emerging economy not only plays a part in these dynamics but also has an impact on the nature of multilateralism.

Notwithstanding these challenges, Rena (2012) and Zhou & Law [19, 25] highlight the importance of a multilateral trading system based on rules, especially for small and developing countries without sufficient bargaining strength in a bilateral environment. They stress a particular aspect related to developing countries, noting that, as much as WTO rules provide market access and integration benefits, they tend to institutionalize inequality in various sectors (such as agriculture and intellectual property); as a result, this fact impacts how countries like India view and exploit the benefits of this system.

India's trade policy

One of the notable features of India's trade policy is that it is an amalgamation of international preparations and collegial negotiations. Katti, (2012) ^[12] and Singh, (2015) ^[21] Highlight India's approach to bilateral, regional, and multilateral talks, proposing that India's transition is from a defensive (or sovereignty-based) to a more pragmatic (or interest-based) approach. India is likely to see increasing participation at both economic and political levels in the areas of the WTO, Regional Trade Agreements (RTAs), and Preferential Trade Agreements (PTAs), but it will still work within the WTO framework to maintain stability. This is most visible in India's dealings with its neighbors, such as within SAARC, BIMSTEC, and other Asian groupings.

The idea of placing trade in the context of foreign policy and diplomatic goals is expressed in Hans, (2023) ^[10] and elsewhere in discussions of Indian multilateralism. He notes that India employs multilateral economic approaches in the WTO, G20, regional groupings, etc., to tackle global challenges, build its strategic autonomy, and establish partnerships with other developing countries. These partnerships often include their South Asian neighbors and the remote economies of the Indo-Pacific, highlighting the interdependence of multilateral and regional diplomacy.

Mattoo & Subramanian offer an economic analysis of India's multilateral trading system. They argue that while India has made great gains in terms of commitments to the WTO and the liberalizing influences of global reforms, it is unwilling to allow more openness in politically sensitive segments of the Indian economy, such as agriculture and some manufacturing sectors. It follows that this protectionist behavior - owing to domestic political-economic realities - is consistent with India's behavior within the WTO and its bilateral relations with its neighbors. One analysis underscores the importance of domestic politics, which views the WTO as a means of promoting exports and as something that limits its policy options (Mandot, 2024) ^[14].

Banners like "India remains committed to an open and inclusive, WTO-led trading system" - and press releases from the Ministry of Commerce & Industry (2024) ^[16] - remind us that while India asserts its support for an open and rules-based multilateral trading system, it also simultaneously (and routinely) affirms the need for "special and differential treatment" and "policy space". These announcements highlighted India's concerns regarding the need for access to the region while protecting its own development agenda.

Trade performance, structural change, and regional opportunities

Policy reports and empirical research play a significant role in India's trade performance and structural transformation, thus laying the foundation for India's trade with its regional partners. Some authors have reinforced in their study that foreign trade growth during the last few years has played an important role in India's recent development, which has been marked by a transformation (in terms of goods and services) from primary to manufactured products. But, at the same time, they add that

the economy continues to be vulnerable to global demand shocks (Bhattacharya et al., 2021) ^[5].

Shifts in the exportable items of India's export basket and their sectoral complements can be discerned from national statistical publications, such as the (DGCI&S, 2025) ^[4], the MIS reports of the Directorate General of Foreign Trade (DGFT), and reports published by the (Press Information Bureau Gov. of India, 2025) ^[18]. These statistics capture the diversification, increasing contribution of manufactured goods in the export basket, and the critical role of trade agreements and export-promotion initiatives in boosting its performance. While these statistics may not be available at a fine-grained level for each neighboring country, they provide a broad set of data to inform the analysis of regional trade patterns with India.

Malik, (2024) ^[13] suggests that, at present, global supply chains are being redefined by factors such as geopolitical factors, "near shoring" (moving manufacturing back to the neighbouring countries), and "friend shoring" (moving manufacturing back to friendly nations), which is an opportunity - but also a challenge - for India. India is at a stage where it can further strengthen its connections with Asian and South Asian production networks by identifying and tapping into complementary capacities and capabilities in its immediate neighborhood (in the textiles, pharmaceuticals, automobiles, and agri-food sectors). The risk is that without proper regional connectivity, India could be left out of these supply chain arrangements.

In a paper on the effects of major external Preferential Trade Agreements ('PTAs'), including large regional blocs, on the Indian economy, Ganesh-Kumar & Chatterjee (2014) ^[7] conclude that India cannot afford to miss the opportunity to access them and that there is a risk of trade and investment diversion away from India if it is not a part of such blocs. They warn that "non-inclusion" leads to a diversion of trade and investment to member nations, negatively affecting India's weakened competitiveness. The inherent nature of this phenomenon makes it necessary for India to carefully engage and plan with its neighbors and other regions in the conduct of its trade policy to ensure continued or improved market access and its role in the global value chain.

The United Nations, (2024, 2025) ^[22, 23] states that trade liberalization cannot drive development alone; it needs to be complemented by industrial, macroeconomic, and social policies. For India and its neighbors, the economic restructuring envisaged with increased regional trade can only happen if it is complemented by mutually agreed measures for industrial and technological development and inclusive economic growth.

Extra-regional relationships and regional trade repercussions

Lastly, India is able to use the experience gained in its trading activities with other parts of the world to offer incentives in its trade relationship with the other parts of the world, especially the European Union. The main points of discussion are the standards and sustainable development conditions in relation to the EU-India relationship on trade relations, which are the

subject of debate in the Civil Society Dialogue on trade relations with India, (2026). This issue may influence the cost of trade and create more harmonized regulations with neighboring economies because India is increasingly adopting global or European standards. Moreover, the signed new trade agreements - the 'Crafted in India, Delivered Globally' initiative—are an indication that India has matured in its trade agreements to include elements of investment, services, e-commerce, and sustainability (Press Information Bureau Gov. of India, 2025) [18].

Overall, the literature available points to India as a major player in a multilateral trading system as a developing country, which, although currently enjoying a rather pessimistic perspective, is still of outstanding importance. The conceptual and institutional approaches emphasize the contradictory nature of multilateralism and preferentialism, or development objectives and liberalization commitments (Baldwin, 2016; Bhagwati et al., 1996; Narlikar, 2022) [1, 2, 17].

The accumulating amount of literature in this area records how India is now becoming a part of the world trading system, how important trade is in promoting the growth of the economy, and how many valuable resources it still has on a regional level (Dr Sumanta Bhattacharya & Bhavneet Kaur Sachdev, 2021; Malik, 2024) [5, 13]. However, in the context of India and multilateral trade relations between the country and its immediate neighbors, specifically in terms of how much the WTO rules, regional agreements, and domestic political economy collectively impact trade patterns, not much specific-partner-centric research can be found at this time.

However, there is a lack of empirical studies on how India relates to its neighboring countries in terms of trade and how it has contributed to the development and cooperation in the region. Moreover, there is a paucity of quantitative research on

the determinants and strengths of trade flows between India and other economies using gravity models, a void that present research aims to fill.

Research methodology

This research is based on quantitative research aimed at studying India's multilateral trade relations with its neighboring countries: Afghanistan, Bangladesh, Bhutan, China, the Maldives, Myanmar, Nepal, Pakistan, and Sri Lanka. This assessment scrutinizes trade dynamics and their consequences for regional partnerships, utilizing the gravity model to interpret trade flows driven by economic size and various structural influences.

The analysis is based on key trade indicators: exports (NCEXP), imports (NCIMP), total trade (NCTTR), trade balance (NCTRBAL), trade growth, and neighboring countries' shares in India's exports (INDEXP), imports (INDIMP), total trade (INDTTR), and trade balance.

This research is based on secondary sources of information collected from the portal of the Department of Commerce and Industry, Government of India (https://tradestat.commerce.gov.in/eidb/commodity_wise_export). The data were first cleaned and tabulated using Microsoft Excel, and further interpretation was performed using R Studio statistical software. Trade patterns and correlation analysis, along with gravity model estimation, were employed to analyze the relationship between India and its neighbors in the study. The framework systematically assesses regional trade, offering empirical proof of the contribution of neighbors to India's trade and cooperation.

Results and discussion

Table 1: Descriptive statistics of India's multilateral trade indicators with neighbouring countries

Vars	N	Mean	SD	Min	Max	Skew	Kurtosis
NCEXP	99	4455.58	5201.29	152.38	21259.79	1.37	1.14
NCIMP	99	9339.09	25513.60	0.46	113447.34	2.73	6.11
INDEXP	99	348646.07	69570.20	262291.09	451070.00	0.39	-1.58
NCSTEXP	99	1.29	1.49	0.05	7.26	1.42	1.83
INDIMP	99	526421.70	127074.66	381007.76	721200.22	0.41	-1.42
NCSTIMP	99	1.78	4.74	0.00	16.53	2.47	4.19
NCTTR	99	13794.67	29545.86	156.70	127699.55	2.61	5.52
NCTTRG	99	8.49	32.57	-67.57	235.51	3.50	22.06
INDTTR	99	875067.77	195931.92	643298.84	1167038.89	0.40	-1.49
INDTTRG	99	6.38	16.57	-15.17	50.83	1.49	2.05
NCTTR_S_INDTTR	99	1.59	3.31	0.02	12.59	2.40	4.01
NCTRBAL	99	-4883.51	21978.09	-99195.14	14178.44	-2.71	6.40
INDTRBAL	99	-177775.63	59888.64	-283495.65	-102627.40	-0.45	-1.10

Descriptive statistics of the trade data

Table 1 presents descriptive statistics for 13 trade-related variables using 99 observations. Trade data shows that the variables are highly volatile. Exports to neighboring countries (NCEXP) have a mean of 4,455.58 and a standard deviation of 5,201.29, indicating variability in export flows. In comparison, imports from neighboring countries (NCIMP) have a

significantly higher standard deviation of 25,513.60. Furthermore, the import distribution exhibits a strong positive skew of 2.73 and a high kurtosis of 6.11, suggesting the occurrence of extreme import values at certain periods. India's total exports (INDEXP) and imports (INDIMP) show a more stable distribution, with a skewness (0.39 and 0.41,

respectively) and negative kurtosis, indicating that the distribution is flatter and more symmetric than other variables. However, the share of exports to neighboring countries in India's total exports, NCSTEXP and NCSTIMP, shows clear signs of asymmetry and a leptokurtic nature, meaning an uneven distribution with occasional peaks. Some auxiliary patterns in a set of trade variables show a high

degree of consistency. Aggregate trade volume (NCTTR) and its growth velocity (NCTTRG) both show strong positive skewness. Combined with a kurtosis of 22.06, confirms a trend toward high volatility and growth fluctuations. Conversely, India's aggregate trade indicator, known as INDTTR, reveals a significantly more stable situation characterized by low skewness and negative kurtosis.

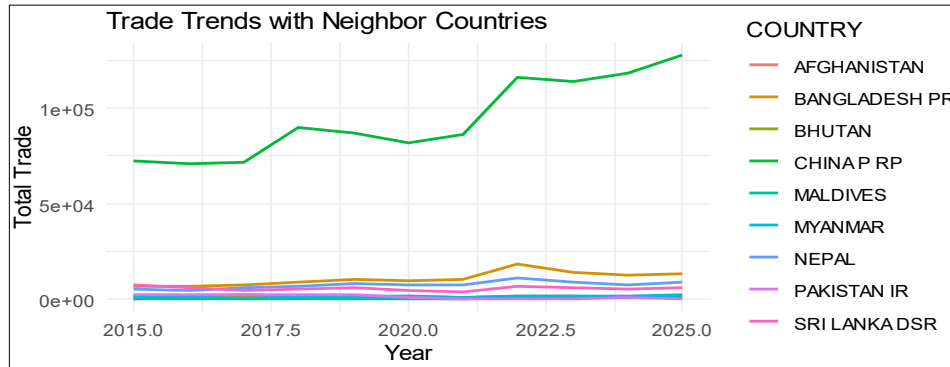


Fig 1: Trade trends with neighboring countries

The trade balance indicator also continued to decline. The average trade balances, specifically for multilateral trade with neighboring countries (NCTRBAL = -4,883.51) and India's total trade (INDTRBAL = -177,775.63), reveal an overall

negative trade balance. The high saturation of NCTRBAL also indicates that trade imbalances occur at a significantly lower frequency.

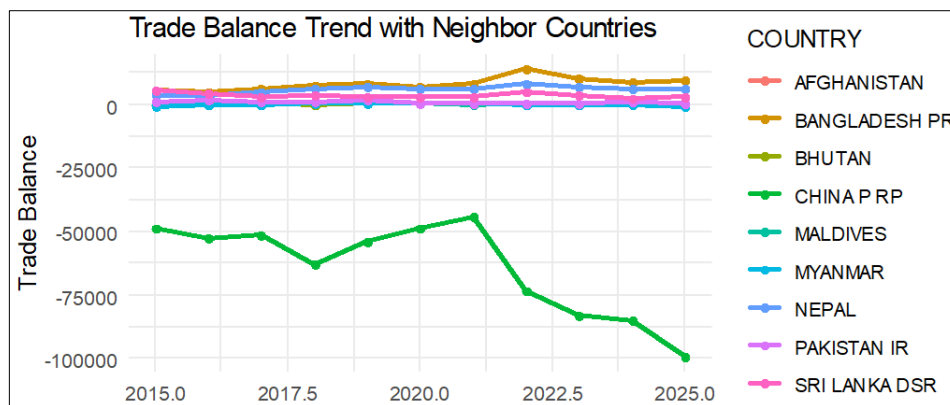


Fig 1: Trade balance of Neighboring countries by line graph

Descriptive statistics reveal that India's multilateral trade measures with its neighbours are highly varied and volatile in their distribution; In contrast, consolidated national trade statistics exhibit a high degree of similarity, revealing the

structural distinctions between different trade segments and the prevailing trade outcomes.

Correlation matrix

Table 2: Correlation matrix of trade variables with neighboring countries and worldwide

	NC EXP	NC IMP	IND EXP	IND IMP	NC TTR	IND TTR	NCTTR SINDTTR	NC TRBAL	IND TRBAL
NCEXP	1.000	0.735	0.106	0.092	0.810	0.097	0.804	-0.616	-0.073
NCIMP	0.735	1.000	0.082	0.082	0.993	0.082	0.960	-0.987	-0.080
INDEXP	0.106	0.082	1.000	0.984	0.089	0.993	-0.014	-0.070	-0.927
INDIMP	0.092	0.082	0.984	1.000	0.087	0.998	-0.016	-0.074	-0.979
NCTTR	0.810	0.993	0.089	0.087	1.000	0.088	0.970	-0.961	-0.082
INDTTR	0.097	0.082	0.993	0.998	0.088	1.000	-0.016	-0.073	-0.964
NCTTRS INDTTR	0.804	0.960	-0.014	-0.016	0.970	-0.016	1.000	-0.924	0.018
NC TRBAL	-0.616	-0.987	-0.070	-0.074	-0.961	-0.073	-0.924	1.000	0.076
IND TRBAL	-0.073	-0.080	-0.927	-0.979	-0.082	-0.964	0.018	0.076	1.000

Correlation matrix of trade data

The correlation matrix shows the correlation of India's multilateral trade indicators with those of the neighboring countries. There is also a strong positive correlation between exports to neighboring countries (NCEXP) and imports to neighboring countries (NCIMP) ($r = 0.735$), meaning that the higher the level of exports to neighboring countries, the higher the level of imports from neighboring countries. Correspondingly, total trade with neighboring countries (NCTTR) shows a highly positive correlation with NCIMP ($r = 0.993$) and a strong correlation with NCEXP ($r = 0.810$), indicating that multilateral trade with neighboring countries is the main factor determining overall trade, along with imports. India's global trade indicators also show a high degree of correlation. India's exports (INDEXP) and imports (INDIMP) are strongly correlated ($r = 0.984$), and both variables have a near-perfect correlation with the country's total international trade (INDTTR) ($r = 0.993$ and $r = 0.998$, respectively), reflecting the integrated character of India's international trade structure. India's share of total trade with neighboring countries (NCTTRSINDTTR) also shows a significant direct correlation with NCTTR ($r = 0.970$), implying that changes in multilateral trade with neighboring countries significantly impact India's share of total trade with neighboring countries.

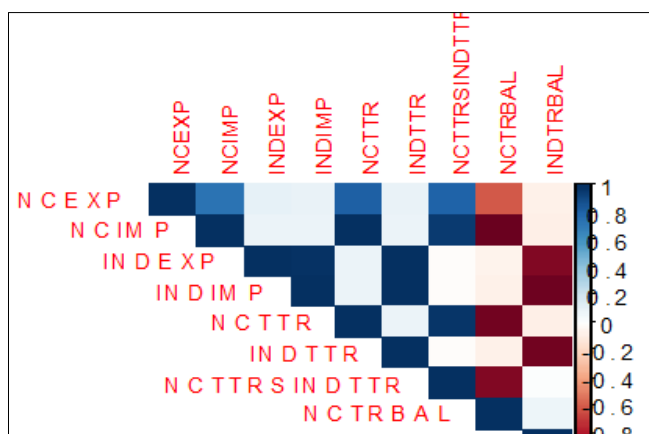


Fig 2: Correlation heatmap of India's multilateral trade

In contrast, trade-balance indicators establish a highly negative correlation with trade-volume variables. NCIMP ($r = -0.987$) and NCTTR ($r = -0.961$) are strongly negatively correlated with the trade balance with neighboring countries (NCTRBAL), indicating that rising imports from neighboring countries are a factor that increases the trade deficit. Similarly, India's overall trade balance (INDTRBAL) has a very strong negative correlation with INDIMP ($r = -0.979$) and INDTTR ($r = -0.964$), indicating the cumulative effects of high levels of imports on India's overall trade deficit. On average, the correlation results suggest that import dynamics have a significant impact on regional and global trade balances, and neighboring countries demonstrate a moderate but structurally significant impact on India's overall trade structure. The correlation heatmap shows the strength and polarity of the relationships between multilateral trade indicators between India and its neighbors. Strong positive relationships are

observed between imports from neighboring countries (NCIMP) and total trade with neighboring countries (NCTTR), and between exports to India (INDEXP), imports (INDIMP), and total trade (INDTTR), indicating that increases in both export and import volumes strengthen total trade. Furthermore, the share of neighboring countries in India's total trade (NCTTRSINDTTR) also shows a strong positive correlation with NCTTR, implying that changes in regional trade have a direct impact on their share of total trade in India. On the other hand, the trade-balance variables, namely, trade balance of neighbouring countries (NCTRBAL) and India's total trade balance (INDTRBAL), show large negative relationships with import indicators, supporting the view that increased imports are likely to increase the trade deficit on both regional and total trade platforms.

The gravity model

This model is inspired by Newton's law of universal gravitation. Because gravitational force is determined by the proximity and distance between two objects, the force is greater when objects are closer together and less when they are farther apart. Hence, the gravity model posits that trade between two countries is determined by their economic size and the distance between them.

Gravity model specification

$$Trade_{it} = \beta_0 + \beta_1 Export_{it} + \beta_2 Import_{it} + \beta_3 India\ Total\ Trade_t + \epsilon_{it}$$

Here,

Trade_{it} = refers to the cumulative trade between India and country i, which is a neighbor to India at time t.

β₀ = β₀ is the intercept or constant term, which is the level of trade at which all the explanatory variables take the value of zero.

β₁ Export_{it} = β₁, which is related to Export_{it}, is the impact of Indian exports to country i on the multilateral total trade.

β₂ Import_{it} = β₂, which is related to Import_{it}, represents the impact of imports of country i on the overall trade relationship.

β₃ India's Total Trade_t = β₃, which is related to the Total Trade_t of India, is the way in which the activity of the global trade of India influences its trade with the neighboring countries.

ε_{it} = (Error Term) Captures unobserved factors that may influence trade but are not included in the model, such as policy changes, exchange rates, political relations, transportation costs, or trade agreements.

Gravity model

1. Pooling model

Residuals:

Min.	1st Qu.	Median	3rd Qu.	Max.
-0.282957	-0.171313	-0.114723	0.063048	0.885866

Coefficients:

	Estimate	Std. error	t-value	Pr(>t)
(Intercept)	-1.339824	2.303534	-0.5816	0.5622
ln_NCEXP	0.752635	0.030427	24.7356	<2e-16 ***
ln_NCIMP	0.285203	0.017797	16.0249	<2e-16 ***
ln_INDEXP	0.079350	0.812478	0.0977	0.9224
ln_INDIMP	0.065308	0.670487	0.0974	0.9226

Total Sum of Squares: 263.48, Residual Sum of Squares: 7.398, R-Squared: 0.97192, Adj. R-Squared: 0.97073, F-statistic: 813.452 on 4 and 94 DF, p-value: < 2.22e-16

The results of the pooled regression, based on a panel dataset comprising 99 observations, discuss the factors determining total trade between India and its neighboring countries. The residual values range between -0.2829 and 0.8859; thus, these values are quite small and centered around a mean of 0.0, implying that the model fits the data reasonably well.

The coefficient estimates reveal that the impact of neighboring countries' exports (ln NCEXP) and imports (ln NCIMP) on total trade with these nations is robust and statistically significant. Specifically, the coefficient of 0.7526 for ln NCEXP suggests that a one-percentage-point increase in exports to neighboring countries leads to an increase of approximately 0.75 percentage points in total trade with these nations; conversely, the coefficient of 0.2852 for ln NCIMP suggests that a one-percentage-point increase in imports from neighboring countries results in an increase of approximately 0.29 percentage points in total trade with these nations. Both of these variables are highly significant at the 1% level (p < 0.001). In contrast, the impact of India's total exports (ln INDEXP) and imports (ln INDIMP) was found to be statistically insignificant; this implies that the global performance of India's trade has no direct bearing on the multilateral trade conducted between India and its neighboring countries.

The explanatory power of this model is also exceptionally strong, evidenced by an R² value of 0.9719. This suggests that about 97 percent of the variation in total trade with neighboring countries can be explained by the variables selected for this study. Furthermore, the F-statistic (813.452, p < 0.001) demonstrates that this model is statistically significant as a whole. These findings suggest that multilateral trade with neighboring economies is the key to the success of regional trade involving India.

2. One-way (individual) effect within the model

Balanced Panel: n = 9, T = 11, N = 99

Residuals:

Min.	1st Qu.	Median	3rd Qu.	Max.
-0.23740930	-0.05793007	-0.00063953	0.05280442	0.26207384

Coefficients:

	Estimate	Std. Error	t-value	Pr(>t)
ln_NCEXP	0.635371	0.035343	17.9774	<2e-16 ***
ln_NCIMP	0.165949	0.013736	12.0811	<2e-16 ***
ln_INDEXP	-0.036562	0.274496	-0.1332	0.8943
ln_INDIMP	0.289055	0.226564	1.2758	0.2055

Total Sum of Squares: 15.874, Residual Sum of Squares: 0.76908 R-Squared: 0.95155, Adj. R-Squared: 0.94479, F-statistic: 422.261 on 4 and 86 DF, p-value: < 2.22e-16

The one-way fixed effect specification examines the predictors of total trade between India and its nine neighboring countries, while accounting for country-specific heterogeneity. The balance panel consists of nine countries and was monitored for 11 years (N = 99). The residuals range between -0.237 and 0.262, indicating small deviations, and a robust model fit after controlling for country-specific effects.

The regression results demonstrate that the exports (ln NCEXP) and imports (ln NCIMP) of the neighboring countries exert a positive and statistically significant impact on total bilateral trade. A one percent increase in NCEXP leads to an approximate 0.64 percent increase in total trade, while a one percent increase in NCIMP results in an approximate 0.17 percent increase. Both of these parameters are significant at the 1% level (p < 0.001). Conversely, India's total exports (ln INDEXP) and imports (ln INDIMP) are statistically insignificant, implying that India's aggregate trade indicators have no significant bearing on its regional trade with its neighbors.

This model yields an R² value of 0.9515, underscoring its impressive explanatory power; this signifies that about 95 percent of the cross-sectional variation in regional trade is explained by the regressors included in this model, which control for country-specific effects. Furthermore, the F-statistic (422.261, p < 0.001) confirms the statistical significance of this specification. Collectively, these results emphasize that multilateral trade relationships with neighboring countries make up the most critical predictors of India's regional trade with its immediate neighbors.

3. One-way (individual) effect

Random effect model (Swamy-Arora's transformation)

Effects:

	Var	std. dev	Share
Idiosyncratic	0.008943	0.094566	0.129
Individual	0.060604	0.246179	0.871
theta: 0.8849			

Residuals:

Min.	1st Qu.	Median	3rd Qu.	Max.
-0.225167	-0.066712	-0.011418	0.043776	0.333764

Coefficients:

	Estimate	Std. error	z-value	Pr(>z)
(Intercept)	-1.240395	0.878777	-1.4115	0.1581
ln_NCEXP	0.673867	0.036600	18.4117	<2e-16 ***
ln_NCIMP	0.168115	0.014893	11.2879	<2e-16 ***
ln_INDEXP	-0.040577	0.307399	-0.1320	0.8950
ln_INDIMP	0.276238	0.253742	1.0887	0.2763

Total Sum of Squares: 19.151, Residual Sum of Squares: 1.0547, R-Squared: 0.94493, Adj. R-Squared: 0.94258, Chi sq: 1612.87 on 4 DF, p-value: < 2.22e-16, Signif. codes: 0, 0.001, 0.01, 0.05, 0.1, 1, Balanced Panel: n = 9, T = 11, N = 99

The current one-way random-effects specification, utilizing the Swamy-Arora transformation on a balanced panel (n = 9, T = 11, N = 99), examines the determinants of aggregate trade flows between India and its nine neighboring countries. Variance decomposition results indicate that 87.1 percent of the

total variance can be attributed to unobserved, country-specific effects, while the remaining 12.9 percent is explained by idiosyncratic disturbances. This pattern underscores the significance of country-level characteristics in shaping regional trade patterns. The residuals fall within a small range of -0.225 to 0.334, suggesting a reasonably good fit for the model.

The estimated coefficients confirm a robust, positive, and statistically significant impact of neighboring countries' exports (ln_NCEXP) and imports (ln_NCIMP) on aggregate multilateral trade. A one percent increase in exports to neighboring countries is associated with an approximate 0.67 percent increase in aggregate trade, whereas a one percent increase in imports leads to a 0.17 percent increase. Both effects are significant at the 0.001 level ($p < 0.001$). In contrast, the coefficients of India's aggregate export and import indicators, ln_INDEXP and ln_INDIMP, are not statistically significant; therefore, India's external trade performance does not exert a significant influence on its multilateral trade flows with neighboring countries.

The overall model yields an R^2 value of 0.9449, demonstrating its impressive explanatory power; this implies that approximately 94 percent of the variation in regional trade flows between these nations can be accounted for by the specified regressors (explanatory variables). Furthermore, a Wald Chi-square value of 1612.87 ($p < 0.001$) supports the global statistical significance of the model. Overall, these findings indicate that multilateral trade relations with neighboring economies are the most significant predictors of India's regional trade activity, while the impact of global trade measures is secondary.

Hausman test and the multicollinearity test

Hausman test

ln_NCEXP	ln_NCIMP	ln_INDEXP	ln_INDIMP
2.225729	2.228451	31.421540	31.434619

chisq = 43.107, df = 4, p-value = 9.832e-09

The Hausman test has been conducted to determine the most appropriate panel estimation model to use in the analysis of bilateral trade flows between India and its neighbouring states; that is, whether fixed effects or random effects. The chi-square test statistic was 43.107 with a p-value of 9.83; hence, the statistic is significant at the one percent level. Consequently, the null hypothesis of consistency of the random effects specification is rejected, and hence, proves the advantage of the fixed effects model in explaining the relationships between variables in the context of the gravity model.

At the same time, the Variance Inflation Factor (VIF) was used to investigate the possibility of multicollinearity between the explanatory variables. The VIFs of ln_NCEXP (2.23) and ln_NCIMP (2.23) are small, indicating that there is no consequential multicollinearity between these endogenous predictors. However, the VIF indices of ln_INDEXP (31.42) and ln_INDIMP (31.43) are significantly higher, which means that the level of multicollinearity between aggregate export and

aggregate import measures of India is strong. The correlation is very high, which means that neither variable may provide independent explanatory power as far as variations in regional trade dynamics involving India are concerned.

Heteroskedasticity and robust coefficient test

studentized Breusch-Pagan test

BP = 7.2602, df = 4, p-value = 0.1228

t-test of coefficients:

	Estimate	Std. error	t value	Pr(>t)
ln_NCEXP	0.635371	0.078899	8.0529	4.135e-12 ***
ln_NCIMP	0.165949	0.033028	5.0245	2.712e-06 ***
ln_INDEXP	-0.036562	0.160999	-0.2271	0.82089
ln_INDIMP	0.289055	0.158141	1.8278	0.07104

Signif. codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 '.'

The Breusch-Pagan test was employed to check for heteroskedasticity in the gravity model equation. The calculated test statistic, BP = 7.2602, yields a p-value of 0.1228, which exceeds the conventional 5% significance level; thus, there is no major issue of heteroskedasticity in this model. Robust standard errors were incorporated into the fixed-effects regression, and the estimated coefficients show that exports to, and imports from neighboring economies, denoted as ln_NCEXP and ln_NCIMP, respectively, are positive and statistically significant, with point estimates of 0.635 and 0.166. Consequently, the expansion of trade channels between India and its neighboring countries contributes significantly to regional trade. Conversely, the country-wide export index, ln_INDEXP, is statistically insignificant, whereas the domestic import variable, ln_INDIMP, is marginally significant at the 10% level. These trends support the argument that multilateral trade linkages with neighboring economies are the primary drivers of regional trade flows, while India's macro-level trade indicators do not add much explanatory value to the model.

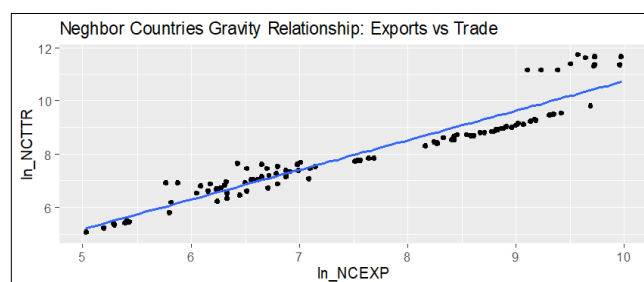


Fig 3: Neighboring countries trade gravity relationship by scatter plot

As illustrated in the scatter plot, there is a strong positive correlation between exports to neighboring countries and the volume of total trade; this implies that an increase in export flows will significantly boost the process of expanding India's regional trade.

Comparison of panel gravity models

Table 3: Gravity model analyses

	Pooled OLS	Fixed Effects	Random Effects
	(1)	(2)	(3)
Constant	-1.340 (2.304)		-1.240 (0.879)
ln_NCEXP	0.753*** (0.030)	0.635*** (0.035)	0.674*** (0.037)
ln_NCIMP	0.285*** (0.018)	0.166*** (0.014)	0.168*** (0.015)
ln_INDEXP	0.079 (0.812)	-0.037 (0.274)	-0.041 (0.307)
ln_INDIMP	0.065 (0.670)	0.289 (0.227)	0.276 (0.254)
Num.Obs	99	99	99
R ²	0.972	0.952	0.945
R ² Adj.	0.971	0.945	0.943
F Statistic	813.452*** (df = 4; 94)	422.261*** (df = 4; 86)	1,612.866***
AIC	36.2	-190.0	-156.7
BIC	51.7	-177.0	-141.1
RMSE	0.27	0.09	0.10

Note: $p < 0.1$; $p < 0.05^*$; $p < 0.01^{**}$; $p < 0.001^{***}$

A systematic comparison of three panel estimates, Pooled OLS, Fixed Effects, and Random Effects derived from the 'Gravity Model of Trade' used to examine the determinants of multilateral trade flows between India and its neighboring countries is presented in the table.

Across all three specifications, the neighboring countries' export variable (lnNCEXP) demonstrates a positive impact on total trade; this effect is both significant and positive, with estimated coefficients ranging between 0.635 and 0.753 ($p < 0.001$).

Correspondingly, the neighboring countries' import variable (lnNCIMP) exhibits a positive and highly significant correlation with regional trade, though its magnitude is slightly lower (0.166 - 0.285). These trends suggest that multilateral trade linkages form the primary drivers of trade interactions between India and its neighbors. Conversely, India's total exports (lnINDEXP) and imports (lnINDIMP) are not statistically significant across any of the model specifications; this implies that the country's overall performance in the realm of international trade does not adequately explain the fluctuations observed in its trade with neighboring nations. This finding suggests that bilateral trade activities play a more influential role in defining the dynamics of regional trade compared to India's broader global trade patterns.

In terms of the performance of the various models, the Pooled OLS specification yields the highest R² value (0.972), indicating its superior explanatory power. The Fixed Effects model (R² = 0.952) more effectively captures the country-specific heterogeneities existing between the neighboring economies; although the Random Effects model (R² = 0.945) yields broadly similar results, its level of explanatory power is marginally lower. Overall, the fact that the export and import variables of neighboring countries remain significant across all specifications underscores the relevance and power of the 'Gravity Framework' in explaining multilateral trade patterns between India and its neighbors.

Discussion

Empirical results derived from applying the Gravity Model to multilateral trade demonstrate that the directional dynamics of

trade between India and its nine neighboring countries exert a profound influence on the overall regional multilateral trade balance (Hans, 2023) ^[10]. Across Pooled OLS, Fixed-Effects, and Random-Effects specifications, the neighbor-country export variable (lnNCEXP), and the neighbor-country import variable (lnNCIMP) emerge as statistically significant, which underscores the fact that increased bilateral trade volume has a large positive impact on total regional trade. These findings provide empirical support for the theoretical structure of the Gravity Framework and align with existing literature, which highlights the pivotal role of geographic proximity and intra-regional trade linkages in shaping trade patterns (Singh, 2015) ^[21].

These models exhibit high explanatory power (with R² values ranging between 0.945 and 0.972), and the Hausman test indicates that the Fixed-Effects model constitutes the most efficient specification, thereby reflecting the diversity of country-specific characteristics that influence trade dynamics (Katti, 2012) ^[12]. However, India's aggregate trade, specifically its exports (ln_INDEXP) and imports (ln_INDIMP), does not prove to be statistically significant; this implies that India's performance in global trade does not necessarily translate into increased trade with its neighboring countries. This finding stands in partial contrast to the literature emphasizing the role of global trade liberalization and production networks in fostering regional trade flows (García, 2012; Sauvart & Strauss, 2012) ^[8, 20].

Overall, these findings highlight multilateral trade linkages as key determinants of trade with neighboring countries, suggesting that strengthening economic cooperation with these neighbors could serve as a viable strategy for enhancing regional integration and facilitating regional development. These findings also support previous arguments that enhancing regional trade partnerships fosters economic engagement and cooperation (Bhagwati et al., 1996) ^[2], although structural and policy barriers may continue to limit the potential for regional trade integration (Narlikar, 2022; Wilkinson, 2015) ^[17, 24].

Conclusion

Employing the gravity model of trade, this study examines the multilateral trade relationships between India and its nine

neighboring countries, aiming to understand the mechanics of multilateral cooperation and its impact on national development. Empirical data indicate that multilateral relationships in this region exert a significant influence on total regional trade, thereby lending support to the assertion that direct multilateral ties serve as the primary drivers of trade processes in India. Furthermore, trade variables of neighboring nations were found to be highly significant across all estimations; however, India's aggregate global export and import values appear to have no statistically significant impact on regional multilateral trade flows. In turn, this research validates the premise that regional multilateral trade relations are largely governed by multilateral economic interactions, regardless of India's overall performance in the global trade arena.

This study also substantiates the finding that a 'fixed-effects model' constitutes the most appropriate estimation framework, highlighting the critical role of country-specific heterogeneity in shaping trade relations with neighboring economies. Collectively, these findings reinforce the notion that strengthening multilateral trade ties and mitigating structural impediments can enhance regional cooperation and foster greater economic integration between neighboring nations.

For all its contributions, the current study is subject to certain limitations. Its empirical scope is primarily confined to trade-specific variables, thereby excluding key factors - such as tariff regimes, transportation costs, institutional frameworks, political relations, and geopolitical forces - that could potentially influence regional trade patterns; such omissions may limit the generalizability of the findings. Further academic research can advance this discussion by incorporating additional covariates into the gravity model - such as GDP, geographic distance, trade agreement provisions, and logistics infrastructure - thereby yielding a more sophisticated understanding of regional trade dynamics. Future studies could also explore questions as to sector-specific trade flows and examine how regional trade agreements contribute to strengthening economic cooperation in South Asia and its surrounding regions.

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