India's global trade potential.
A panel gravity model approach

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Abstract. *In this paper, India's global trade potential, export potential and import potential with its 29 major trading partners (which contributed 77.63 per cent of India's global trade in 2021) have been estimated for the year 2021 with the help of augmented panel gravity model. The time span of this study is 31 years, from 1991 to 2021.The variables used for estimating the augmented panel gravity model are GDP, population, per capita GDP, T.R/GDP, bilateral real exchange rate, distance, and three dummy variables, namely, common language, common colonization and common border. Initially, India's global trade, export and import gravity models were estimated by POLS, EFM and REM and then model selection tests were applied to select the appropriate model. The study suggested that FEM is appropriate for India's global trade gravity model and REM is appropriate for India's global export and global import gravity models. However, these models suffered from the problems of cross-section dependence, autocorrelation, and heteroscedasticity. Therefore, finally FGLS method was used to estimate India's trade, export and import gravity models and then using the FGLS model India's global trade, export and import potential were estimated for the year 2021. The findings of the study indicate that India is over trading with countries such as China, United States, Australia, Brazil, Indonesia, Iraq, South Korea, Kuwait, Malaysia, Nepal, Qatar, Netherlands, Saudi Arabi, Thailand, United Arab Emirates, Vietnam and South Africa and it has trade potential with Hong Kong, Bangladesh, France, Germany, Italy, Japan, Russian Federation, Nigeria, Singapore, Turkiye, Sri Lanka and United Kingdom. India should focus on boosting trade with these countries as India has strong trade as well as export potential with them. This will help India in strengthening its export revenues and increase its rate of growth.*

Keywords: India, trading partners, trade potential, export potential, import potential, gravity model, panel data model, FGLS.

**JEL Classification:** R120, F140, F120, C330.

1. Introduction

The structure and composition of India's foreign trade has undergone significant change since 1950 with the changing structure and composition of world trade. After independence, India adopted a policy of import substitution and export promotion. This strategy aimed to reduce dependence on foreign imports by imposing high import tariffs and non-tariff barriers so that domestic industries can be promoted. As a result, India's foreign trade was heavily regulated and limited during this period. Exports were primarily composed of agricultural products and raw materials. In 1991, India initiated the policy of economic reforms and liberalization, and opened up its economy to foreign trade and investment. Tariffs were reduced, and non-tariff barriers were gradually dismantled, leading to increased integration with the world economy. Exports diversified to include services, information technology (IT), pharmaceuticals, textiles, and other manufactured goods. India experienced rapid economic growth and an increase in trade volume, leading to a substantial trade surplus in services, consequently it had emerged as a global hub for services. Software services, business process outsourcing, and knowledge-based services have become significant contributors to its foreign exchange earnings. Now India's export portfolio comprises items such as textiles, petroleum products, gems and jewellery, drugs and pharmaceuticals, organic and inorganic chemicals, engineering goods, and agricultural products. The diversification of trade commodities reflects India's growing industrial and technological capabilities. India's imports comprise petroleum, crude and products, electrical and non-electrical machinery, electronic goods, coal, coke and briquettes, precious metals and gold.

India also diversified its trading partners, reducing its historical dependence on the United Kingdom and other Western countries. Trade with countries in North America, Asia, the Middle East, and Africa has expanded significantly, with a focus on strengthening economic ties with regional neighbours. Now United States, China, United Arab Emirates, Malaysia, South Korea, Indonesia, Hong Kong, Germany, Singapore, and Saudi Arabia are important trading partners of India. India has actively engaged in bilateral and regional trade agreements. These agreements aimed at expanding market access for Indian goods and services. As a result, India's total trade (sum of exports and imports) as a percentage of gross domestic product (GDP), known as trade openness, has increased substantially as shown in Figure 1.

As per Figure 1, India's total trade as a percentage of GDP has been lower than global levels during the period under study from 1970 to 2021, but it has increased significantly after 1991. It was in the range of 8-15 per cent in the 1970s, 12-15 per cent in the 1980s, 16-25 per cent in the 1990s and 25-56 per cent in the 2000s. It was highest in 2012 with the value 55.79 per cent. Not only that India's exports and imports have increased significantly from 1949-1950 to 2021-2022. India's exports increased from ₹485 crore in 1949-1950 to ₹3,147, 021 crore in 2021-22 and India's imports increased from ₹617 in 1949-1950 to ₹4,572,775 in 2021-2022. Trend of India's exports and imports clearly shows that there was a rapid and robust surge in India's exports and imports in post-1991 period. However, India's imports remained always more than India's exports, so India's trade balance has been always in deficit, except for a few years as depicted in Figure 2.

Figure 1. *India's total trade (as a percentage of GDP)*
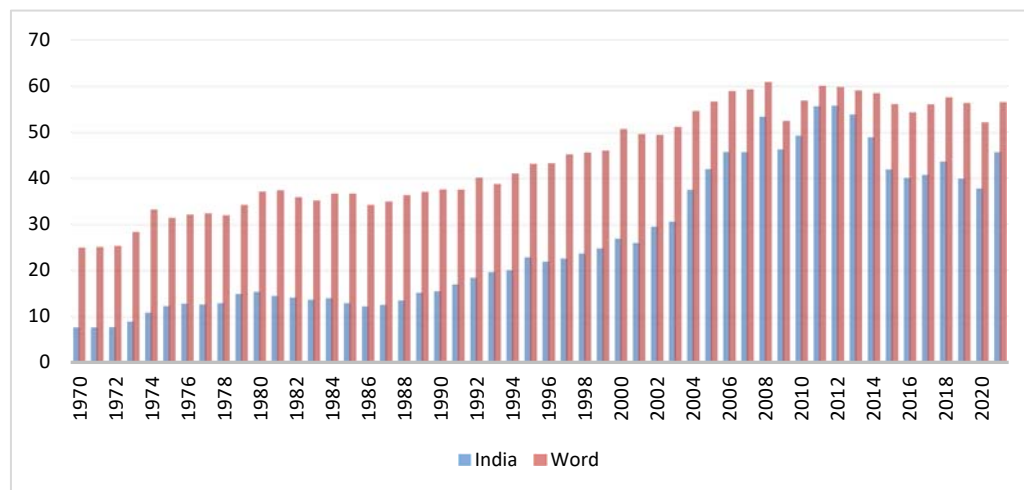
Source: Constructed by authors.

**Figure 2.** *India's trade balance from 1950-1951 to 2021-2022*
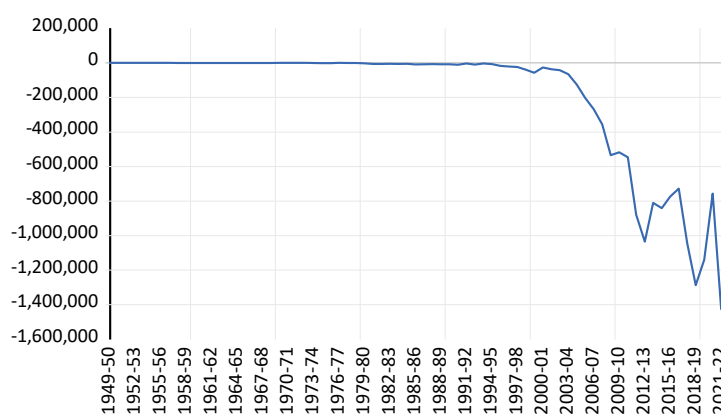
Source: Constructed by authors.

It is clear from Figure 2 that there was a huge surge in India's trade deficit during post-1991 period. There are various reasons for it. One of the most significant reasons for India's trade deficit has been its dependence on oil imports. As India industrialized and urbanized, its demand for energy increased, and it had to import a substantial portion of its crude oil and petroleum products. The increase in global oil price has had a substantial impact on the trade balance. India imported a significant amount of capital goods, machinery, and equipment for industrial and infrastructure development. These imports were essential for economic growth but added to the trade deficit. The demand for consumer goods, including electronics, has risen in India. The country has been importing a considerable number of these items, contributing to the trade deficit. India has a cultural affinity for gold, which has led to substantial imports of this precious metal. Gold imports, though not a productive asset, have been a persistent contributor to the trade deficit. Currency exchange rate

movements can affect the trade balance. A depreciating currency can make exports more competitive but can also increase the cost of imports. All these factors are responsible for trade deficit of India. The trade deficit has put pressure on the balance of payments and Indian rupee.

Therefore, this study has been undertaken to estimate India's trade potential- not only total trade potential, but also export potential and import potential on a global scale taking the data from 1991 to 2021 and employing an augmented panel gravity model. The selection of India's trade partner countries was done by ranking trade partners in descending order based on their trade volume with India and then top 29 countries were singled out, namely, Australia, Bangladesh, Brazil, China P.R. mainland, Hong Kong, France, Germany, Indonesia, Iraq, Italy, Japan, Republic of Korea, Kuwait, Malaysia, Nepal, Netherlands, Nigeria, Qatar, Russia Federation, Saudi Arabia, Singapore, South Africa, Sri Lanka, Thailand, Republic of Turkiye, United Arab Emirates (UAE), United Kingdom, United States and Vietnam. These countries collectively contributed 77.63 per cent of India's global trade in 2021. The share of these countries in India's global trade in 2021 is illustrated in Figure 3

Figure 3: *Percentage share of partner countries in India's global trade in 2021*
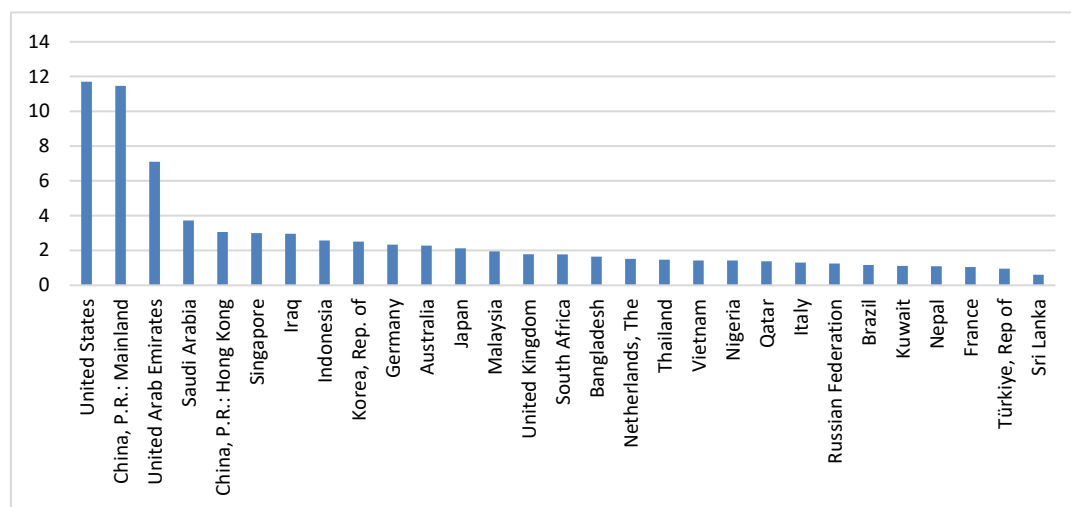
Source: Constructed by authors.

Figure 3 shows that United States, China, UAE, Saudi Arabia and Hong Kong were top five trade partners of India and the place of Sri Lanka was the last in 29 trading partners of India in 2021.

Paper's subsequent sections are organized as follows. Section 2 encompasses a review of existing literature, succeeded by Section 3, which specifies model selection, data sources, description of variables, and the analytical approach employed for estimating trade potential of India. Subsequently, the result outcomes are deliberated in Section 4. The estimation of India's global trade potential is given in Section 5. Finally, Section 6 presents conclusion and suggestions drawn from the study's findings.

2. Selected Literature Review

Various researchers have been working in the field of international trade among various countries through the application of the gravity model. Presented below is a concise overview of select pre-existing academic works.

Batra (2006) employed an augmented gravity model to analyze global trade among 146 countries with cross-section data for the year 2000. India's trade potential showed significant growth possibilities with China. The study highlighted the importance of historical and cultural affinities in bilateral trade and suggested that removing trade barriers could double trade. Bhattacharyya and Banerjee (2006) used a panel gravity model taking data of 177 trading partners of India for the period 1950-2000. Their study showed that developed countries were engaged in more trade with India as compared to underdeveloped countries. Elshehawy, Shen and Ahmed (2014) analysed Egypt's trade relations with its 42 major trading partner from 2000 to 2013 with the help of panel models, including pooled ordinary least squares (POLS) model, fixed effects model (FEM), and random effects model (REM). The FEM was the appropriate model for their analysis. Manglani (2020) examined the trade flow between India and selected SAARC (South Asian Association for Regional Cooperation) countries by estimating the panel gravity model for the time period 1996-2018.The study concluded that the trade flow between India and these SAARC countries exhibited a positive dependence on the GDP of both trading partners. Jan and Shah (2019) examined Pakistan's bilateral trade relationship with the SAARC countries during the period from 2003 to 2016.The methodology employed in the study included the POLS and FEM. The study highlighted that Pakistan's trade with Afghanistan and India was relatively low, despite having Pakistan a common border with these countries. Similarly, the trade potential with Maldives was also observed to be very low. Khayat (2019) analysed GCC's (Gulf Cooperation Council) trade with the help of gravity model. For this study, six developed countries' trade with GCC members was studied from 2001 to 2012.The study concluded that GDP per capita and population were significant factors affecting trade flow and it was suggested that trade barriers should be removed so that trade flow may be increased. Lohani (2020) examined the trade flow of India with Brazil, Russia, India, China and South Africa (BRICS) countries by using gravity model from 2001 to 2016. As per the results of study distance, common official language and common border have positive effect on trade. The study suggested that government should remove trade barriers and market hurdles between India and the BRICS countries.

Kaur and Sarin (2020) estimated the trade intensity and trade potential indices to analyze the existing trade dynamics and future trade potential of India from 2001 to 2017. The study highlighted the increasing intensity of India-ASEAN trade, despite some fluctuations. Siddique, Quddus and Iqbal (2022) estimated gravity model to investigate Pakistan's trade potential with China, United Arab Emirates (UAE), Saudi Arabia (KSA), Kuwait, United States (USA), Malaysia, Japan, India, Singapore, Afghanistan, Iran, Spain, Germany, United Kingdom (UK), and Belgium spanning from 2000 to 2020. Static and dynamic econometric techniques revealed that economic size and distance are crucial factors affecting bilateral trade. The study emphasized the impact of political globalization on economic dynamics, aligning with theoretical models that highlight the roles of economic

integration, political globalization, and geographical distance in Pakistan's trade relations. De (2010) used an advance gravity model to evaluate India's trade potential. India's pre- and post- crisis trade potential have been estimated using panel data. Results highlighted substantial trade potential in the Asia-Pacific region, followed by Africa and Latin America. Post- crisis, China emerged as a key trade expansion partner. Tripathi and Leitao (2013) examined India's trade flow from 1998 to 2012 using a gravity model with twenty key trade partners namely China PRP, UAE, USA, Saudi Arabia, and more. Both static and dynamic panel analyses were employed. The findings highlighted the positive effects of political globalization, cultural closeness, economic size and shared borders on trade. Filipini and Molini (2003) estimated gravity model to examine trade flow among East-Asian industrialized countries, including China and developed countries for the last 30 years. In this study, new variable, technological distance, has been used to illuminate the impact of technological disparities on trade pattern. Dummy variables were used for regional tendencies, particularly for East-Asia and China and these were interacted with time and technological distance variable to capture evolving dynamics. The study concluded that from the late 1970s onwards, East-Asian countries and starting from the mid-1990s, China, have emerged as primary exporters to developed countries.

Rahman (2009) estimated augmented gravity model using cross-sectional data from 50 countries to investigate Australia's trade potential. The OLS method was used for model estimation using 2001 and 2005 data. The study showed positive impact of economic size, per capita GDP, trade openness, and shared language, while distance has a negative influence on Australia's bilateral trade. Several countries, including Singapore, Argentina, Russia, Portugal, Greece, and more have a substantial trade potential. Jomit (2014) estimated panel gravity model using POLS method. The study focused on India's export potential with a sample of 58 countries from 1991 to 2011.The study concluded that India's export potential was most significant when trading with China and Japan. Gulnaz and Manglani (2022) analysed India's trade relationship with ten ASEAN countries for the period from 1988 to 2019 with the help of gravity model and employed Feasible Generalized Least Squares (FGLS) estimation to assess India's trade with these nations. They concluded that several factors including GDP, trade openness, bilateral exchange rates, and population had a positive effect on trade between India and ASEAN countries. Conversely, certain factors such as transaction costs, common language and border related issues and tariff rates had a negative influence on bilateral trade flow. Sharma and Kathuria (2020) employed gravity model to analyse foreign trade dynamics between India and ten ASEAN members with the help of panel data from 2010 to 2019. Data for the variables including trade flows, GDP, distance, population, border sharing and common language were taken from official websites such as Director General of Foreign Trade, Government of India, World Trade Organisation, and the CEPII database. The findings highlighted that trade opportunities between India and ASEAN countries are underscoring a mutually advantageous trade relationship for trade of goods and services.

From the review of literature, it is clear that no enough research has been done to estimate India's global trade potential - total trade potential as well as export potential and import potential with major trading partners of India. In this study India's global trade (total trade

as well as export and import) potential with 29 top trade partner countries has been estimated for the year 2021 using augmented panel gravity model.

3. Methodology

3.1. Model selection

This study employs an augmented panel gravity model to examine India's trade interactions on a global scale from the year 1991 to 2021. Originally gravity model was introduced by Tinbergen in 1962. This model takes clues from Isaac Newton's "Universal Law of Gravitation." The conceptual basis of this model suggests that bilateral trade flow is directly linked to the size of national income and inversely linked to the distance between trade partners. Notably, countries boasting larger economies and closer geographical proximity tend to exhibit a propensity for heightened trade volumes.

The equation of the gravity model of trade is:

$$T_{ij} = A(Y_i Y_j / D_{ij} \tag{1}$$

Where,
T_{ij} = total bilateral trade between country i and country j,
Y_i = economic size of country i,
Y_j = economic size of country j,
D_{ij} = distance between two countries i and j, and
A = constant term.

Since the gravity model for trade does not hold exactly, so in econometric applications it is customary to include stochastic disturbance term(ε) in the model and specify it as follows:

$$T_{ij} = A\left(\frac{Y_i^{\beta_1} Y_j^{\beta_2}}{D_{ij}^{\beta_3}}\right) e^{\varepsilon ij}$$

In log form the equation becomes

$$\ln(T_{ij)} = \ln A + \beta_1 \ln(Yi) + \beta_2 \ln(Yj) - \beta_3 \ln(D_{ij}) + \varepsilon_{ij} \tag{2}$$

Where $\ln A$, β_1 and β_2 are regression coefficients and ε_{ij} is stochastic disturbance term.

In this paper, determinants of bilateral trade have been analysed by using augmented gravity model, in which products of GDPs and populations of trading countries as well as absolute difference between per capita GDP of India and 29 countries, ratio of total trade to GDP of India and 29 countries, bilateral real exchange rate, distance, language, colonization and border have also been taken as independent variables. So, the model used in this study is as follows:

$$\ln(Trade_{ijt}) = \beta_0 + \beta_1 \ln(GDPit*GDPjt) + \beta_2 \ln(POPit*POPjt) + \beta_3 \ln(DPGDPijt) + \beta_4(T.R./GDPit) + \beta_5(T.R./GDPjt + \beta_6 \ln(BiRERijt) + \beta_7 \ln(Distijt) + \beta_8(Lang) + \beta_9(Col) + \beta_{10}(Border) + \varepsilon ijt$$

$$\tag{3}$$

3.2. Data and variables

Tradeijt is the dependent variable, which is total of bilateral trade between India and 29 countries (India's export to all the 29 nations + India's imports from them). The values are in current US$ sourced from Direction of Trade Statistics (DTS), International Monetary Fund (IMF). Independent Variables used in this paper are described in Table 1.

Table 1. *Description of independent variables*

Variables	Description	Notes	Source	Expected Sign of Regression Coefficient
GDPit*GDPjt	GDP of India*GDP of trading partners	Value in Current US$	WDI	+
POPit*POPjt	Population of India*population of trading partners	In million	WDI	+
DPGDPijt	Absolute difference between per capita GDP of India and trading partners	Value in current US$	WDI	+
(T.R./GDPit)	Ratio of total trade to GDP of India	(ratio)	WDI	+
(T.R./GDPjt)	Ratio of total trade to GDP of 29 countries	(ratio)	WDI	+
BiRERijt	Bilateral real exchange rate between India and trading countries =(NERi/CPIi)/(NERj/CPIj) NER nominal exchange in terms of US dollar. CPI is Consumer Price Index	Ratio	WDI	+
Distij	Distance between trade centres of India and trading partners	KMs	Dist_cepii (Database of CEPII)	−
Common Language	Dummy variable for official language between India and 29 countries. If the language is common, dummy variable =1, otherwise zero (0)		Dist_cepii (Database of CEPII)	+
Common Colonization	Dummy variable for colonizer of India and its trading countries. If trading partners share same colonizer than dummy variable=1, otherwise zero (0)		Dist_cepii (Database of CEPII)	+
Border	Dummy variable for border between India and 29 trading countries. If they share common border then dummy variable =1, otherwise zero (0)		Dist_cepii (Database of CEPII)	+

Notes: WDI: World Development Indicators (World Bank).
Source: Prepared by authors.

Reasoning and description of independent variables

Based on a review of existing literature, we identified variables and established visualized relationships between trade flow between India and its 29 trading partners. GDP variables represent the economic sizes of countries. A rise in GDP typically correlates with increased exports, suggesting a positive sign for the coefficient of ln(GDPit*GDPjt). In bilateral trade, the population variables denote the market sizes of countries. A larger population signifies greater demand for products from partner countries, leading to heightened trade. Therefore, the coefficient of ln(POPit*POPjt) is expected to be positive. T.R./GDPit and T.R./GDPjt ratio are used as a measure of trade openness of trading countries. The regression coefficients of T.R./GDPit and T.R./GDPjt are expected to be positive. The bilateral real exchange rate (BiRER) was derived using nominal exchange rate (NER) and consumer price index (CPI) data for both countries. An elevated BiRER suggests Indian rupee's devaluation, resulting in more affordable Indian exports and relatively costlier imports. Hence, the sign of the coefficient of ln(BiRERijt) is expected to be positive. The

variable Distij represents the trade centre distance between India and its trading partners. Elevated distances elevate transport costs. Consequently, the coefficient of Distij is expected to bear a negative sign. The dummy variable common language represents countries, which have common official language with India. Such countries will tend to trade more with India. So, the sign of the coefficient of Lang is expected to be positive. The dummy variable common colonization means countries that were once colonies and their former colonizing countries, along with countries that have the same colonizer, tend to engage in strong trade relationships. So, the expected sign of the coefficient of Col is positive. The dummy variable border means that countries sharing common border with India. Such countries tend to trade more than countries without a common border with India. So, the expected sign of the coefficient of border is positive.

3.3. Approach for estimating global trade potential, export potential and import potential

According to Baldwin (1994) the difference between predicted (P) and actual values of trade (A) of a country may be considered as its trade potential. Therefore, to calculate India's trade potential, initially, the augmented gravity model was estimated and by using this model the predicted value of trade of India was calculated, and then by comparing the predicted and actual values of trade of India in year 2021 the trade potential of India was estimated for year 2021. Similar approach was used to estimate India's export potential and import potential.

Estimation of augmented gravity model

The augmented gravity model was estimated using panel data of a 31-year timeframe from 1991 to 2021, focusing on India's trade with 29 countries, which contributed 77.63 per cent of India's global trade in 2021. Use of the panel data analysis offers several advantages. By amalgamating cross-sectional and time series elements, it provides enhanced information, greater variability, reduced problem of multicollinearity, greater degrees of freedom, and the capability to account for latent individual heterogeneity (Bhaumik, 2015).

In this study, three established techniques were used to estimate the augmented panel gravity model: POLS, FEM, and REM. Firstly, F test was conducted to make the suitable choice between POLS and FEM models, with the null hypothesis that the POLS model is valid. Subsequently, the selection between POLS and REM was determined through the Breusch-Pagan LM Test, with the null hypothesis that there is no panel effect. Finally, the Hausman test was used to decide between FEM and REM with the null hypothesis that the REM estimators exhibit superior consistency and efficiency.

After the selection of appropriate model, the subsequent step involved diagnostic assessment to ascertain whether the selected model is free from the problems of cross-section dependence, autocorrelation and heteroscedasticity. Pesaran test and the Breusch-Pagan LM test for independence were used to test the presence of cross-section dependence. The presence of heteroskedasticity was tested by using the modified Wald test for GroupWise Heteroskedasticity, while the presence of autocorrelation was tested with the help of Wooldridge test. If the selected model suffers from any one or all these three problems, then the FGLS method was to be used to estimate the panel augmented gravity

model, as the number of cross-sectional units was fewer than the time periods available (Parks, 1967).

Estimation of India's global trade potential, export potential and import potential

In this stage, the predicted value of trade (P) is compared with the actual value of trade (A) using the formulas P - A and P/A. A positive value of P-A signifies a projected increase in trade volume between the concerned countries. Conversely, a negative value of P-A indicates an excessive level of trade. Furthermore, a P/A ratio exceeding one denotes an anticipated expansion in future trade between the trading countries, whereas a P/A ratio falling below one signifies over-trade. Similar approach was used to estimate export and import potential.

4. Results discussion

4.1. Descriptive statistics and correlation matrix

The results of descriptive statistics of the variables used in the model show that all variables are negatively skewed except (trade/GDP) of trading partners and have a positive kurtosis coefficient. As per the Jarque-Bera test for normality, none of the variables are normally distributed. Similarly, the results of correlation matrix reveal that in two variables namely lngdpitgdpjt (GDP of India and its trading partners) and trgdpit (trade as a percentage of GDP of India) are highly positively correlated with the dependent variable lntradeijt. On the other hand, other variables show low positive correlation. Border has low negative correlation with lntradeijt.

4.2. Estimation of gravity model for India's global trade potential

The results of trade gravity model estimated by different methods (POLS, REM, FEM and FGLS) are illustrated in Table 2.

Table 2. *Results of trade gravity model estimated by different methods*

Dependent Variable is ln(Tradeijt)				
	POLS Model	FEM	REM	FGLS Mocdel
Ln(GDPit*GDPjt)	0.6908***	0.6427***	0.6828***	0.6547***
	(0.0387)	(0.0394)	(0.0362)	(0.0259)
Ln(DPGDPijt)	0.0375	0.2181***	0.1579***	0.0242
	(0.0372)	(0.0411)	(0.0398)	(0.0245)
Ln(POPit*POPjt)	0.0471	0.4465***	0.2534***	-0.0146
	(0.0538)	(0.1288)	(0.0944)	(0.0489)
Ln(BiRERijt)	-0.0110	0.0897***	0.0505**	0.0025
	(0.0105)	(0.0227)	(0.0198)	(0.0109)
Ln(Distij)	-0.8958***	0	-1.2693***	-0.7224***
	(0.0761)	0	(0.2513)	(0.1061)
Lang	0.7172***	0	0.5104*	0.5633***
	(0.0699)	0	(0.2641)	(0.0863)
Col	0.6737***	0	0.8754***	0.6227***
	(0.0715)	0	(0.2484)	(0.1096)
Border	-0.0998	0	-0.2414	0.0236
	(0.1137)	0	(0.3855)	(0.1706)
(T.R./GDPit)	0.0232***	0.0064**	0.0103***	0.0213***
	(0.0029)	(0.0027)	(0.0026)	(0.0016)

Dependent Variable is ln(Tradeijt)				
	POLS Model	FEM	REM	FGLS Mocdel
(T.R./GDPjt)	0.0001	0.0059***	0.0038***	0.0008**
	(0.0003)	(0.0009)	(0.0007)	(0.0004)
CONS	-21.4181***	-46.4629***	-30.3359***	-22.0559***
	(0.8918)	(3.5916)	(2.5953)	(1.2779)
Observations	899	899	899	899
R-square	0.8416	0.8804	0.8789	
F-test	471.65	1060.03		
Prob>F	0.0000	0.0000		

Standard errors are given in parentheses.
***Significant at 1 per cent level of significance.
**Significant at 5 per cent level of significance.
*Significant at 5 per cent level of significance
Source: Calculated by authors.

After estimating the trade gravity model by POLS, EFM and REM, model selection and model diagnostic tests were conducted. The results of these tests are presented in Table 3.

Table 3. *Model selection and model diagnostic tests*

Test	Test statistic	p value	Selected Model /Conclusion
Model Selection Tests			
F test	F = 46.09	0.0000	Fixed Effects Model
Hausman Test	$\chi^2 = 39.58$	0.0000	Fixed Effects Model
Breusch-Pagan LM test	$\chi^2 = 1598.72$	0.0000	Random Effects Model
Model Diagnostic Tests			
Pesaran CSD Test	6.958	0.0000	Presence of Contemporaneous Correlation
Breusch-Pagan LM test of Independence	$\chi^2 = 2509.730$	0.0000	Presence of Cross-section Dependence
Modified Wald Test for Groupwise Heteroskedasticity	$\chi^2 = 37663.74$	0.0000	Presence of Heteroscedasticity
Wooldridge Test for Autocorrelation	F=104.133	0.0000	Presence of Autocorrelation

Source: Calculated by authors.

From Table 3 it is clear that FEM is the appropriate model. Therefore, diagnostic tests were applied on it to test whether the FEM is free from the problems of cross-section dependence, autocorrelation and heteroscedasticity. The results of these diagnostic tests clearly indicate that the FEM suffers from all these problems. Hence, it cannot be used to estimate the trade potential of India. Therefore, the trade gravity model was estimated by the FGLS method as the number of time periods (31 years) is more than the number of cross-section units (29 countries). The results of FGLS model are also given in Table 2.

The FGLS model shows that the estimated regression coefficient of Ln(GDPit*GDPjt) is positive (0.6547) and significant at 1 per cent level of significance. This suggests that India's bilateral trade is expected to increase by approximately 0.65 per cent, if both India's GDP and its trading partners' GDP increase by 1 per cent. However, the effects of Ln(DPGDPijt) and Ln(BiRERijt) between India and its trading partners are positive but statistically insignificant. Similarly, the effect of Ln(POPit*POPjt) is negative and insignificant. T.R./GDPit and T.R./GDPjt ratio are used as a measure of trade openness of trading countries. The regression coefficients of T.R./GDPit and T.R./GDPjt are positive and significant at 1 per cent and 5 per cent levels of significant, respectively, signifying their roles in India's bilateral trade. Additionally, it was found that there is a negative and significant effect of distance between trade centres of India and its trading partners. Lastly, in our analysis three dummy variables are considered. The dummy variables-language and

colonization have positive and significant effect on India's bilateral trade with its trading partners, whereas the dummy variable-border has positive but insignificant impact on India's trade.

4.3. Estimation of export gravity model for India's global export potential

The results of export gravity model estimated by different methods (POLS, REM, FEM and FGLS) are illustrated in Table 4.

Table 4. *Results of export gravity model estimated by different methods*

Dependent Variable is ln(Expijt)				
	POLS Model	FEM	RME	FGLS Model
Ln(GDPit*GDPjt)	0.7466***	0.6676***	0.6927***	0.5966***
	(0.0435)	(0.0404)	(0.0376)	(0.0263)
Ln(DPGDPijt)	-0.0047	0.0337	0.0218	0.0269
	(0.0418)	(0.0421)	(0.0409)	(0.0215)
Ln(POPit*POPjt)	-0.0160	0.3182**	0.1947*	0.1286**
	(0.0605)	(0.1321)	(0.1062)	(0.0574)
Ln(BiRERijt)	0.0106	0.0524**	0.0462**	0.0239**
	(0.0118)	(0.0232)	(0.0212)	(0.0110)
Ln(Distij)	-1.0255***	0	-1.1053***	-0.8867***
	(0.0854)	0	(0.3291)	(0.1347)
Lang	0.6772***	0	0.4582	0.6651***
	(0.0786)	0	(0.3557)	(0.1078)
Col	0.5817***	0	0.6926**	0.4714***
	(0.0803)	0	(0.3299)	(0.1309)
Border	0.3814***	0	0.2313	0.3539
	(0.1277)	0	(0.5008)	(0.2313)
(T.R./GDPit)	0.0123***	0.0094***	0.0103***	0.0166***
	(0.0032)	(0.0027)	(0.0027)	(0.0016)
(T.R./GDPjt)	0.0020***	0.0063***	0.0053***	0.0019***
	(0.0004)	(0.0009)	(0.0008)	(0.0005)
CONS	-24.9074***	-42.2736***	-29.8316***	-23.8492***
	(1.0017)	(3.6816)	(3.2772)	(1.6878)
Observations	899	899	899	899
R-square	0.8083	0.8613	0.8610	
F-test	374.31	894.24		
Prob>F	0.0000	0.0000		

Standard errors in parentheses.
***Significant at 1 per cent level of significance.
**Significant at 5 per cent level of significance.
Source: Calculated by authors.

After estimating the export gravity model by POLS, EFM and REM, model selection and model diagnostic tests were conducted. The results of these tests are presented in Table 5.

Table 5. *Model selection and model diagnostic tests*

Test	Test statistic	p value	Selected Model /Conclusion
Model Selection Tests			
F test	F = 68.01	0.0000	Fixed Effects Model
Hausman Test	$\chi^2 = 7.69$	0.2615	Random Effects Model
Breusch-Pagan LM test	$\chi^2 = 3328.52$	0.0000	Random Effects Model
Model Diagnostic Tests			
Pesaran CSD Test	7.526	0.0000	Presence of Contemporaneous Correlation
Breusch-Pagan LM test of Independence	$\chi^2 = 3223.293$	0.0000	Presence of Cross-section Dependence
Wooldridge Test for Autocorrelation	F=38.424	0.0000	Presence of Autocorrelation

Source: Calculated by authors.

From Table 5 it is clear that REM is the appropriate model. Therefore, diagnostic tests were applied on it. The results of these diagnostic tests clearly indicate that the REM suffers from the problems of cross-section dependence and autocorrelation. Hence, it cannot be used to estimate the export potential of India. Therefore, the export gravity model was estimated by FGLS method because the number of time periods (31 years) is more than the number of cross-section units (29 countries). The results of FGLS model are also given in Table 4.

The FGLS model shows that that the estimated regression coefficient for Ln(GDPit*GDPjt) is positive (0.5966) and significant at 1 per cent level of significance. This finding suggests that India's exports are expected to increase by approximately 0.60 per cent, if both India's GDP and its trading partners' GDP increase by 1 per cent. On the other hand, the effects of Ln(DPGDPijt)) between India and its trading partners is positive but statistically insignificant. Similarly, the effect of Ln(POPit*POPjt) and Ln(BiRERijt) are positive and significant at 5 per cent level of significance. The regression coefficients of T.R./GDPit and T.R./GDPjt are positive and significant at 1 per cent level of significance, signifying their role in India's exports. Furthermore, it was found that there is a negative and significant effect of distance between trade centres of India and its trading partners on India's exports. Lastly, in our analysis three dummy variables are considered. The dummy variables-language and colonization have positive and significant effect on India's exports to its trading partners, whereas the dummy variable-border has positive but insignificant impact on exports.

4.4. Estimation of import gravity model for India's global import potential

Results of import gravity model estimated by different methods (POLS, REM, FEM and FGLS) are illustrated in Table 6.

Table 6. *Results of import gravity model estimated by different methods*

Dependent Variable is ln(Impijt)				
	POLS Model	FE Model	RE Model	FGLS Model
Ln(GDPit*GDPjt)	0.5995***	0.6673***	0.6816***	0.6597***
	(0.0683)	(0.0715)	(0.0646)	(0.0469)
Ln(DPGDPijt)	0.2429***	0.4297***	0.3527***	0.0365
	(0.0656)	(0.0745)	(0.0712)	(0.0509)
Ln(POPit*POPjt)	0.1484	0.3939*	0.3279**	-0.0236
	(0.0949)	(0.2335)	(0.1668)	(0.0826)
Ln(BiRERijt)	-0.0003	0.1119***	0.0594*	0.0039
	(0.0185)	(0.0411)	(0.0352)	(0.0179)
Ln(Distij)	-0.8882***	0	-1.2519***	-0.8180***
	(0.1341)	0	(0.4369)	(0.1802)
Lang	0.6995***	0	0.4659	0.4237***
	(0.1234)	0	(0.4575)	(0.1433)
Col	0.8525***	0	0.9629**	0.6125***
	(0.1260)	0	(0.4310)	(0.1844)
Border	-0.8297***	0	-0.7196	-1.1911***
	(0.2005)	0	(0.6707)	(0.2859)
(T.R./GDPit)	0.0292***	0.0044	0.0095**	0.0231***
	(0.0050)	(0.0048)	(0.0047)	(0.0025)
(T.R./GDPjt)	-0.0008	0.0055***	0.0030**	0.0004
	(0.0006)	(0.0016)	(0.0013)	(0.0006)
CONS	-26.8137***	-48.3965***	-35.7174***	-21.9589***

Dependent Variable is ln(Impijt)				
	POLS Model	FE Model	RE Model	FGLS Model
	(1.5725)	(6.5086)	(4.5302)	(2.0729)
Observations	899	899	899	899
R-square	0.6956	0.7291	0.7276	
F-test	202.91	387.52		
Prob>F	0.0000	0.0000		

Standard errors in parentheses.
***Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
Source: Calculated by authors.

After estimating the import gravity model by POLS, EFM and REM, model selection and model diagnostic tests were conducted. The results of these tests are presented in Table 7.

Table 7. *Model selection and model diagnostic tests*

Test	Test statistic	p value	Selected Model /Conclusion
Model Selection Tests			
F test	F = 26.60	0.0000	Fixed Effects Model
Hausman Test	$\chi^2 = 13.95$	0.0302	Random Effects Model
Breusch-Pagan LM test	$\chi^2 = 1625.61$	0.0000	Random Effects Model
Model Diagnostic Tests			
Pesaran CSD Test	9.413	0.0000	Presence of Contemporaneous Correlation
Breusch-Pagan LM test of Independence	$\chi^2 = 1788.561$	0.0000	Presence of Cross-section Dependence
Modified Wald Test for Groupwise Heteroskedasticity	$\chi^2 = 48717.83$	0.0000	Presence of Heteroscedasticity
Wooldridge Test for Autocorrelation	F=127.229	0.0000	Presence of Autocorrelation

Source: Calculated by authors.

From Table 7 it is clear that REM is the appropriate model. Therefore, diagnostic tests were applied on it to test whether the REM is free from the problems of cross-section dependence, heteroscedasticity and autocorrelation. The results of these diagnostic tests clearly indicate that the REM suffers from all these problems. Hence, it cannot be used to estimate the import potential of India. Therefore, the import gravity model was estimated by FGLS method because the number of time periods (31 years) is more than the number of cross-section units (29 countries). The results of FGLS model are also given in Table 6.

The FGLS model shows that the estimated regression coefficient for Ln(GDPit*GDPjt) is positive (0.6597) and significant at 1 per cent level of significance. This finding suggests that India's import is expected to increase by approximately 0.66 per cent, if both India's GDP and its trading partners' GDP increase by 1 per cent. On the other hand, the effects of Ln(DPGDPijt) and Ln(BiRERijt) between India and its trading partners are positive but statistically insignificant. Similarly, the effect of Ln(POPit*POPjt) is negative and insignificant. The regression coefficient of T.R./GDPit is positive and significant at 1 per cent level of significance, signifying its role in India's imports. In contrast, the coefficient of T.R./GDPjt is positive but insignificant. Furthermore, it was found that there is a negative and significant effect of distance between trade centres of India and its trading partners on India's imports. Lastly, in our analysis three dummy variables are considered The dummy variales-language and colonization have positive border and significant effect on India's imports from its trading partners, whereas the dummy variable- has negative and significant impact on imports.

5. Estimation of India's global trade potential, export potential and import potential

5.1. Estimation of India's global trade potential for year 2021

Table A.1 presents the global trade potential of India for year 2021 with its 29 trading partners. The estimation was done with the help of augmented trade gravity model, which was fitted with the help of FGLS method. Here, P represents the predicted value of trade and A shows actual value of trade. The results of India's trade potential reveals that India is doing good trade with countries like Australia, Brazil, China, Indonesia, Iraq, South Korea, Kuwait, Malaysia, Nepal, Netherlands, Qatar, Saudi Arabia, South Africa, Thailand, UAE, US and Vietnam. Conversely, India has substantial untapped trade potential with Hong Kong, UK, France, Bangladesh, Germany, Italy, Japan, Nigeria, Russia, Singapore, Sri Lanka and Turkiye. India should maintain its existing trade relationship with the countries where it is over trading. Additionally, India should explore trade ties with those countries where there is high trade potential.

5.2. Estimation of India's global export potential for year 2021

After estimation of India's trade potential, an assessment of its export potential was done, the results are presented in Table A.2. The findings show that India is currently exceeding its export potential to countries namely Australia, Brazil, China, Indonesia, Italy, Korea, Malaysia, Nepal, Netherlands, Saudi Arabia, South Africa, Sri Lanka, Thailand, UAE, US and Vietnam. On the other hand, India has untapped export potential with Hong Kong, Russia, France, Germany, Iraq, Japan, Kuwait, Nigeria, Qatar, Singapore and United Kingdom. As India has vast export potential, it should consider expanding its export to these countries.

5.3. Estimation of India's global import potential for year 2021

After assessment of export potential, India's import potential was estimated, and the findings are presented in the Table A.3. As per the estimation, India is currently surpassing its import potential with the countries like Australia, Brazil, China, Hong Kong, Indonesia, Iraq, Korea, Kuwait, Malaysia, Nepal, Nigeria, Qatar, Saudi Arabia, Singapore, South Africa, Thailand, UAE, US and Vietnam. On the other hand, India has significant untapped import potential with Turkiye, France, Bangladesh, U.K., Italy, Germany, Japan, Netherlands, Russia and Sri Lanka. Rather than exclusively relying on imports from existing countries, India should focus towards expanding imports from other countries, where the results has shown significant import potential.

5.4 Comparative analysis of India's export potential, import potential and trade potential

Table 8 presents a comparative analysis of India's global trade potential, export capacity and import possibilities with its 29 key trading partners for year 2021.

Table 8. *India's export potential, import potential and trade potential: comparative analysis*

Trading partners of India	Export Potential/ Over Export	Import Potential/Over Import	Trade Potential/ Over Trade
Australia	Over Export	Over Import	Over Trade
Bangladesh	Export Potential	Import Potential	Trade Potential
Brazil	Over Export	Over Import	Over Trade
China, P.R.: Mainland	Over Export	Over Import	Over Trade
China, P.R.: Hong Kong	Export Potential	Over Import	Trade Potential
France	Export Potential	Import Potential	Trade Potential
Germany	Export Potential	Import Potential	Trade Potential
Indonesia	Over Export	Over Import	Over Trade
Iraq	Export Potential	Over Import	Over Trade
Italy	Over Export	Import Potential	Trade Potential
Japan	Export Potential	Import Potential	Trade Potential
Korea, Rep. of	Over Export	Over Import	Over Trade
Kuwait	Export Potential	Over Import	Over Trade
Malaysia	Over Export	Over Import	Over Trade
Nepal	Over Export	Over Import	Over Trade
Netherlands	Over Export	Import Potential	Over Trade
Nigeria	Export Potential	Over Import	Trade Potential
Qatar	Export Potential	Over Import	Over Trade
Russian Federation	Export Potential	Import Potential	Trade Potential
Saudi Arabia	Over Export	Over Import	Over Trade
Singapore	Export Potential	Over Import	Trade Potential
South Africa	Over Export	Over Import	Over Trade
Sri Lanka	Over Export	Import Potential	Trade Potential
Thailand	Over Export	Over Import	Over Trade
Türkiye, Rep of	Over Export	Import Potential	Trade Potential
United Arab Emirates	Over Export	Over Import	Over Trade
United Kingdom	Export Potential	Import Potential	Trade Potential
United States	Over Export	Over Import	Over Trade
Vietnam	Over Export	Over Import	Over Trade

Source: Calculated by authors.

As per the estimation, India is engaged in over-exporting, over-importing and overtrading with countries namely Australia, Brazil, China, Indonesia, Korea, Malaysia, Nepal, Saudi Arabia, South Africa, Thailand, UAE, U.S. and Vietnam. This indicates India has established favourable trade terms and trade policies with these countries. However, while maintaining these trade relationships, India should also prioritize expanding its export, import and trade relations with countries like Bangladesh, France, Germany, Japan, Russia and UK where high untapped market potential exists.

6. Conclusion and suggestions

The liberalization of India's trade policies has strengthened India's international trade connections, positioning India favourably in global trade. This study has estimated India's trade potential, export capabilities, and import possibilities with 29 major trading partners from 1991 to 2021. Furthermore, Table 8 presents a comparative analysis of India's trade potential, export potential and import potential with these key trading partners. As per this analysis, among these 29 nations, India has achieved over trade with 17 countries, while the remaining 12 countries offer substantial potential for trade expansion. These estimations hold significant consequences for India's trade policies and economic growth.

India's success in trade relationship with certain countries requires effective market penetration and meeting market demands. However, it is advisable for India to reduce its reliance on countries like China, Brazil, Nepal, Saudi Arabia, United States, Australia, Indonesia, Iraq, South Korea, Kuwait, Malaysia, Qatar, Netherlands, Thailand, United Arab Emirates, Vietnam and South Africa, where its trade is very high and India should recognize untapped markets such as Hong Kong, Bangladesh, France, Germany, Italy, Japan, Russian Federation, Nigeria, Singapore, Turkiye, Sri Lanka and United Kingdom for further exploration and expansion.

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Table A.1. *Trade potential of India with its trading partners for year 2021*

Trading partners of India	P	A	P-A	P/A	Trade Potential/Over Trade
Australia	17332.61	21976.38	-4643.77	0.7887	Over Trade
Bangladesh	27948.25	15852.00	12096.25	1.7631	Trade Potential
Brazil	7284.405	11180.57	-3896.17	0.6515	Over Trade
China, P.R.: Mainland	35372.86	110526.01	-75153.15	0.3200	Over Trade
China, P.R.: Hong Kong	93126.12	29484.15	63641.97	3.1585	Trade Potential
France	20862.47	10024.51	10837.96	2.0811	Trade Potential
Germany	28246.65	22476.84	5769.81	1.2567	Trade Potential
Indonesia	12269.38	24819.17	-12549.79	0.4944	Over Trade
Iraq	5767.31	28542.83	-22775.52	0.2021	Over Trade
Italy	18033.58	12522.80	5510.78	1.4401	Trade Potential
Japan	30504.82	20486.16	10018.66	1.4890	Trade Potential
Korea, Rep. of	19259.64	24164.34	-4904.70	0.7970	Over Trade
Kuwait	7328.821	10697.10	-3368.28	0.6851	Over Trade
Malaysia	15167.60	18784.51	-3616.91	0.8075	Over Trade
Nepal	4967.858	10519.56	-5551.70	0.4722	Over Trade
Netherlands	11748.36	14612.90	-2864.54	0.8040	Over Trade
Nigeria	14059.94	9296.84	4763.10	1.5123	Trade Potential
Qatar	12348.76	13241.21	-892.45	0.9326	Over Trade
Russian Federation	19004.71	12055.48	6949.23	1.5764	Trade Potential
Saudi Arabia	15687.63	35866.78	-20179.15	0.4374	Over Trade
Singapore	33445.08	28850.30	4594.78	1.1593	Trade Potential
South Africa	7481.713	17046.57	-9564.86	0.4389	Over Trade
Sri Lanka	7311.151	5772.13	1539.02	1.2666	Trade Potential
Thailand	11615.2	14178.19	-2562.99	0.8192	Over Trade
Türkiye, Rep of	11286.18	9215.27	2070.91	1.2247	Trade Potential
United Arab Emirates	22401.43	68458.09	-46056.66	0.3272	Over Trade
United Kingdom	37479.9	17122.04	20357.86	2.1890	Trade Potential
United States	89621.45	112832.41	-23210.96	0.7943	Over Trade
Vietnam	9261.766	13711.76	-4449.99	0.6755	Over Trade

Source: Prepared by authors.

Table A.2. *Export potential of India with its trading partners for year 2021*

Trading partners of India	P	A	P-A	P/A	Export Potential/Over Export
Australia	5685.82	6900.45	-1214.63	0.8240	Over Export
Bangladesh	17434.22	14073.06	3361.15	1.2388	Export Potential
Brazil	2688.39	6261.89	-3573.50	0.4293	Over Export
China, P.R.: Mainland	15724.02	23044.28	-7320.25	0.6823	Over Export
China, P.R.: Hong Kong	67100.72	11293.77	55806.95	5.9414	Export Potential
France	7613.99	6131.42	1482.57	1.2418	Export Potential
Germany	10849.37	9512.57	1336.80	1.1405	Export Potential
Indonesia	4773.30	8089.33	-3316.03	0.5901	Over Export
Iraq	2207.59	2028.54	179.05	1.0883	Export Potential
Italy	6712.71	7703.45	-990.74	0.8714	Over Export
Japan	10532.24	6073.29	4458.94	1.7342	Export Potential
Korea, Rep. of	6448.11	7094.59	-646.48	0.9089	Over Export
Kuwait	2328.33	1230.68	1097.65	1.8919	Export Potential
Malaysia	5538.36	6698.82	-1160.46	0.8268	Over Export

Trading partners of India	P	A	P-A	P/A	Export Potential/Over Export
Nepal	3660.53	9203.23	-5542.70	0.3977	Over Export
Netherlands	4229.91	10262.84	-6032.93	0.4122	Over Export
Nigeria	5384.81	4524.41	860.39	1.1902	Export Potential
Qatar	3031.61	1713.47	1318.15	1.7693	Export Potential
Russian Federation	7722.55	3331.57	4390.98	2.3180	Export Potential
Saudi Arabia	6172.91	8233.41	-2060.50	0.7497	Over Export
Singapore	13412.91	10657.15	2755.76	1.2586	Export Potential
South Africa	2944.82	5987.60	-3042.78	0.4918	Over Export
Sri Lanka	3238.29	4793.63	-1555.34	0.6755	Export Potential
Thailand	5306.05	5515.92	-209.87	0.9620	Over Export
Türkiye, Rep of	4762.29	7251.60	-2489.31	0.6567	Over Export
United Arab Emirates	6347.59	25423.47	-19075.87	0.2497	Export Potential
United Kingdom	15032.29	10375.40	4656.89	1.4488	Export Potential
United States	35170.04	71444.32	-36274.28	0.4923	Export Potential
Vietnam	4241.35	6637.33	-2395.98	0.6390	Over Export

Source: Prepared by authors.

Table A3. *Import potential of India with its trading partners for year 2021*

Trading partners of India	P	A	P-A	P/A	Import Potential/Over Import
Australia	7961.24	15075.93	-7114.69	0.5281	Over Import
Bangladesh	4773.42	1778.93	2994.49	2.6833	Import Potential
Brazil	3548.34	4918.68	-1370.34	0.7214	Over Import
China, P.R.: Mainland	15629.40	87481.74	-71852.34	0.1787	Over Import
China, P.R.: Hong Kong	15349.11	18190.38	-2841.27	0.8438	Over Import
France	11324.12	3893.09	7431.03	2.9088	Import Potential
Germany	15299.72	12964.27	2335.45	1.1801	Import Potential
Indonesia	6440.95	16729.84	-10288.89	0.3850	Over Import
Iraq	3181.58	26514.29	-23332.71	0.1200	Over Import
Italy	9851.66	4819.35	5032.31	2.0442	Import Potential
Japan	16698.95	14412.87	2286.08	1.1586	Import Potential
Korea, Rep. of	10591.46	17069.75	-6478.29	0.6205	Over Import
Kuwait	4231.33	9466.42	-5235.09	0.4470	Over Import
Malaysia	8168.49	12085.70	-3917.21	0.6759	Over Import
Nepal	922.44	1316.33	-393.89	0.7008	Over Import
Netherlands	6258.01	4350.06	1907.95	1.4386	Import Potential
Nigeria	5956.94	9143.08	-3186.14	0.6515	Over Import
Qatar	7553.50	11527.75	-3974.25	0.6552	Over Import
Russian Federation	10426.47	8723.91	1702.56	1.1952	Import Potential
Saudi Arabia	9071.21	27633.37	-18562.16	0.3283	Over Import
Singapore	15118.90	18193.15	-3074.25	0.8310	Over Import
South Africa	3293.51	11058.97	-7765.46	0.2978	Over Import
Sri Lanka	1241.31	978.50	262.81	1.2686	Import Potential
Thailand	6417.32	8662.27	-2244.95	0.7408	Over Import
Türkiye, Rep of	6127.99	1963.67	4164.32	3.1207	Import Potential
United Arab Emirates	13668.95	43034.62	-29365.68	0.3176	Over Import
United Kingdom	17712.66	6746.63	10966.03	2.6254	Import Potential
United States	40603.92	41388.09	-784.16	0.9811	Over Import
Vietnam	4847.29	7074.43	-2227.14	0.6852	Over Import

Source: Prepared by authors.