INDIA'S BILATERAL TRADE FLOWS: A GRAVITY MODEL ANALYSIS

Naila Fatima[1], Simran Sethi[2]

[1]Student, B.A. (H) Economics, III[rd] Year, Hansraj College, University of Delhi, nailafatima2001@gmail.com

[2]Assistant Professor, Department of Economics, Hansraj College, University of Delhi, simran.dse@gmail.com

Abstract

International trade has undoubtedly become an inevitable part of the nations as the world becomes more globalized. This paper aims to investigate the determinants of the bilateral trade flows of India. Inferring from previous literature, an augmented gravity model for India is constructed. Cross sectional data consisting of 55 countries for the year 2019 is taken and estimation for the factors affecting bilateral trade flows of India, is carried out using ordinary least squares estimators. The results are in line with the theoretical expectations of the gravity model. GDP affects the trade positively; distance is found to negatively impact the trade flows between India and its trading partners and dummy variable taken for the development status of the trading partners is negative implying that India trades less with developed countries. The per capita GDP differential influences India's trade flows positively and the Linder hypothesis is not supported.

Keywords: Gravity Model of Trade, Cross Sectional Data, OLS Estimation, India

Introduction

International trade forms an integral part of an economy as a country imports and exports goods and services from other countries. It is concurred by many economists that trade between nations makes the world well off. Foreign trade boosts economic growth as global integration improves living standards. It increases competition amongst nations in the manufacture of goods. Nations produce products in which they have a comparative advantage over other nations as no one country is self-sufficient in producing all goods.

India was a closed economy until 1991. Only post-1991 measures were taken by the Indian government to open up the economy to trade. This happened by lifting many trade barriers, which led to a significant improvement in international trade. In 2019, at the HS6 digit level, India exported around 4442 commodities to 226 countries and imported 4356 products from 210 countries and the trade was not just

restricted to goods. India also carried out trade of services. **(World Integrated Trade Solution, World Bank)**

India's merchandise export share in global exports has increased from 0.8% in 2003 to 1.8% in 2019. India still has a long way to go if we compare it to its neighbour country, China which had an export share of 13.6% in 2019 **(World Statistical Review, 2020)**. The trade-GDP ratio of India declined from 43.6% in 2018 to 39.39% in 2019 **(DataBank, World Bank).** Therefore, special attention should be paid to increasing foreign trade in India, as it is undoubtedly a critical determinant for the growth of an economy.

As many new trade theories develop, this study attempts to examine if the distance between countries and their GDP, as established by the gravity model, is still an important determinant in explaining bilateral trade between countries. We examine this model by applying it to the bilateral trade flows between India and a sample of 55 countries. Moreover, this study is recent and provides a fresh insight using the latest data set.

Previous theories explaining international trade, such as the Ricardian and Heckscher-Ohlin-Samuelson models, did not consider the size of an economy an essential determinant in explaining trade flows between countries. Heckscher-Ohlin-Samuelson's theory is based on the differences in factor endowments between nations. It states that countries tend to be the net exporter of the factors they are relatively well endowed with. The theory focused on the supply side phenomenon of the economy and implied that countries that are relatively labour abundant trade more with countries that are relatively capital abundant **(Gandolfo, 2014).** However, Jan Tinbergen **(1962)** was the first one to present the gravity model, and he proposed that it was analogous to Newton's law of gravitation, which states that the force of attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The same logic can be observed in trade flows between two countries, which are directly proportional to the product of the GDPs of the two countries and inversely proportional to the distance between them.

$$Tr_{ij} = \alpha\, Y_i Y_j / D_{ij}$$

where Tr_{ij} represents the bilateral trade flows between country i and country j; Y_i and Y_j are country i's and country j's GDPs. D_{ij} is the geographical distance between the country's centroids, and α is a constant of proportionality.

This makes it apparent that countries with larger GDP will have more bilateral trade. Also lower the distance between them, the lower the transportation costs. Thus, countries will trade more if the distance between them is less.

Another theory of interest to us is the Linder

hypothesis, which states that a country trades with countries with similar levels of taste and preferences trade more as they tend to have overlapping demands. Countries with lower GDP per capita demand similar products and vice versa for countries with higher GDP per capita. We take the GDP per capita differential, i.e. the difference in GDP per capita of India with each country taken in the sample dataset. Lower GDP per capita differential implies a minor difference in income and more similarity in the patterns of consumption of the two countries. This indicates higher trade between them, thereby supporting the Linder hypothesis pattern of trade. **(Bergstrand, 1990)**

Development is of crucial interest in economics. Looking at developing countries, it is apparent that there is an expansion of trade. Developing countries have increased their presence in the international market, especially in the manufactured goods sector. In addition to that, there has been a rise in import demand in developing countries **(Ali & Stancil, 2009).** Thus, India, a developing country, is expected to have more trade flows with developing countries.

Even though the distance and the countries' GDP are essential determinants of the trade flows, tariff trading agreements aimed at easing international trade between nations through regional integration are also expected to positively impact the trade flow amongst nations.

Literature Review

There have been numerous studies on the empirical evidence of the gravity model. Most research for the result of the model has been carried out using both sectional and panel data estimation techniques. In almost all studies, the gravity equation can reasonably explain trade volume.

Batra **(2004)** used an augmented gravity model with a sample of 146 countries and analyzed the cross-sectional data for the year 2000, using OLS estimators; used the coefficients found to predict the trade potential for India. It clearly indicated that the gravity equation fits the data well and that the estimated results were "significant, " thereby explaining the income and distance elasticities. The results were further supported by another study by Rahman **(2010)** which analyzed Bangladesh's exports using a generalized gravity model approach, covering 31 countries and estimating them with a panel data estimation technique and discerned that the significant factors affecting them were: the exchange rate, the partner countries' total import demand and the openness of the Bangladesh economy. All the three factors impacted the exports positively. In his study on Korea, C.H. Sohn (2005) observed that the gravity model was very effective in explaining Korea's trade flows as all the variables were found to fit well. The study also included per capita GDP as a factor influencing the trade flows and reported the significance of the coefficients of the GDPs but not of per capita GDPs; concluding that Korea's trade

relies more on the economic size of the trading partner rather than its income level.

Rahman, Shadat and Das **(2006)** investigated the impact of regional trade agreements (RTA), explicitly focusing on the South Asian Free Trade Agreement (SAFTA), on trade creation; using the gravity model. It also included the import-GDP ratio, which was statistically significant and positive, implying that an increased openness would increase the bilateral export flow between the SAARC nations, thereby indicating a boost in intra-regional trade. The study showed that population growth in the SAARC nations has minimal impact on explaining the increase in bilateral trade flows. The effect of both exporter and importer's exchange rates is found to have very little effect on bilateral export flows. The study also reported intra-bloc export creation associated with SAPTA. A paper by Tansey & Hanson (**2013**) applied the gravity model to developing countries and reported that developing countries have favourable outcomes when they trade with other developing countries rather than with developed countries.

Rahman **(2009)** estimated the trade potential for Australia using OLS estimators and ascertained the use of the augmented gravity model in explaining bilateral trade flows. Another important finding was the effect of a common language on Australia's trade flows; countries having English as their official language had more trade flows with Australia compared to other countries. The per capita GDP differential inclusion for testing the Linder hypothesis showed results supporting it as the coefficient was negative and significant. Hrvoje & Maja **(2018)** combined the Linder hypothesis with the gravity model. The absolute difference between the per capita GDP of the trading partners is taken as the Linder variable used to study the Linder effect. The study was carried out using panel regression analysis. The results validate the USA, Japan, and Germany trade patterns according to the gravity model. However, the Linder variable was positively related to the trade flows, consequently rejecting the Linder hypothesis for the three countries.

Data and Methodology

This study is a cross-section analysis based on the bilateral trade flows between India and its trading partners. It takes a sample of 55 countries for the same. The data is collected for the year 2019. Data on exports from India (country i) to other countries (country j) and imports to India from other countries is obtained from the website of the World Trade Organization. Data on gross domestic products of the countries is taken from the World Bank's website. Data on the distance between India and its trading partners is collected from www.geodatas.net. The distance measured is the distance between the centroids of the two countries. The data on the development status of the countries is collected from the statistical annex prepared by the World Economic Situation and Prospects, United Nations. The sample consists of 21 developed economies, 32 developing economies and 2 economies in

transition.

All the estimations are carried out using ordinary least squares (OLS) estimators. OLS is a method used to estimate unknown parameters in a linear regression model. The estimators' exhibit unbiasedness, are efficient and have minimum variances provided there is no multicollinearity; the errors are homoscedastic and are serially uncorrelated.

Firstly, we estimate the basic gravity model which is as follows:

$$\log (Y_{ij}) = \alpha_0 + \alpha_1 \log (GDP_i * GDP_j) + \alpha_2 \log (d_{ij}) \quad \text{---------- (1)}$$

Secondly, we estimate the augmented gravity model as assayed in various literature. An independent variable $PCGD_{ij}$ is added for the per capita GDP differential, which is used to test the Linder hypothesis. Dummy variables are taken for the development status of the trading partners, for countries having a tariff trading agreement with India and countries having a common border with India, to test if these factors effectively explain India's trade flows. The model is written as:

$$\log (Y_{ij}) = \alpha_0 + \alpha_1 \log(GDP_i * GDP_j) + \alpha_2 \log(d_{ij}) + \alpha_3 \log(PCGD_{ij}) + \alpha_4 (DEV) + \alpha_5 (CB) + \alpha_6 (TA) + u_{ij} \quad \text{---------- (2)}$$

where, Y_{ij} : total bilateral trade flow between country i & country j

GDP_i : gross domestic product of country i (i.e. India)

GDP_j : gross domestic product of country j,

d_{ij} : distance between country i and j,

$PCGD_{ij}$: per capita differential between country i and j,

DEV : dummy variable taken for countries that are developed

TA : dummy variable taken for countries in a tariff trading agreement with India,

CB : dummy variable taken for countries who share a common land or water border with India

u_{ij} : error term.

Empirical Results

4.1 Results of the Basic Gravity Model

The estimates of the regression of equation (1) are given in Table I. The R squared value is 0.66 means that the basic gravity model can explain 66 per cent of the variation in the trade flows of the model.

The coefficients of both the product of GDPs and the distance are significant. The coefficient of the product of GDPs is positive as expected. This implies that if the trading nation's economy is larger, India will trade more with it. An increase of 1 per cent in the product of GDPs leads to an increase of 0.85 per cent in the trade flows between India and the trading partner.

Table I: Estimation results of the basic gravity model

Variables	Coefficient	Std. Error	t- statistic	P>t
log(GDP_i*GDP_j)	.8503163	.0809369	10.51	0.000
log(d_{ij})	-.9639634	.2251931	-4.28	0.000
_cons	-.0541414	2.4021	-0.02	0.982
F statistic	55.51			
Prob. (F statistic)	0.0000			
R-squared	0.6810			
Adj. R-squared	0.6688			

The distance coefficient is also negative, as expected. As the distance between India and country j increases by 1 per cent, the trade between the country falls by 0.94 per cent. The results are significantly in line with the gravity model.

4.2 Results of The Augmented Gravity Model

As apparent from Table II, the R squared value is 0.76, revealing that the augmented gravity model can explain 76 per cent of India's variation in trade flows.

Table II: Estimation results of the augmented gravity model

Variables	Coefficient	Std. Error	t- statistic	P>t
log(GDP_i*GDP_j)	.8594404	.0810913	10.60	0.000
log(d_{ij})	-.906907	.2924062	-3.10	0.003
log($PCGD_{ij}$)	.3005307	.1244144	2.42	0.020
DEV	-1.622872	.4233618	-3.83	0.000
CB	.2997555	.5608606	0.53	0.702
TA	-.6083861	.3838402	-1.58	0.120
F statistic	25.61			
Prob. (F statistic)	0.000			
R squared	0.7620			
Adj. R squared	0.7322			

The estimates for the product of GDPs and distance are significant and have the signs as predicted. An increase of 1 per cent in the product of the GDPs will lead to a rise of 0.86 per cent in the trade flows between India and the trading country. An increase of 1 per cent in the distance between India and the trading partner would decrease the trade flows by 0.90 per cent.

The Linder variable, per capita GDP differential coefficient, is positive and significant. A rise of 1 per cent in per capita GDP differential causes an increase of 0.30 per cent in the trade flows between India and the trading country. As the difference in incomes of the trading pair increases, i.e. the trading nation has higher dissimilarity in preferences indicated by the country's income with India, the higher the trade is with that nation. The result goes against the Linder hypothesis. Thus, India tends to trade more with dissimilar countries.

The coefficient of the dummy variable taken for the developed countries is negative and significant. The benchmark category was set as the developing economies & economies in transition, which are given the value 0, and developed countries are allotted the value 1. Thus, on average, developed countries have 82% lesser trade flows with India than developing countries in transition.

However, the coefficients for tariff trading agreement and having a common border with a country are insignificant, suggesting that they have no role in explaining trade flows between India and the trading countries.

Conclusion

This paper has discussed the determinants of the bilateral trade flows of India using the gravity model. The findings reaffirmed the use of the gravity model in explaining trade flows. OLS estimators were used to analyze cross-sectional data of 55 countries that trade with India for 2019.

The empirical findings are in line with the theoretical expectations of the gravity model. India trades more with countries that are larger in terms of their economic size as measured by their GDPs, and as the distance increases, the trade flows are impacted by falling more than proportionately.

The inclusion of per capita GDP differential for testing the Linder hypothesis, showed that India’s trade flows are positively influenced by it. The result does not support the hypothesis as India increases its bilateral trade flows if there is dissimilarity of incomes between India and the trading partners and India trades more with countries with different levels of income.

The model was augmented with dummy variables for tariff trading agreements, common border and development status of the trading partners, and a per capita GDP differential variable. A significant finding that emerges from the study is that India’s bilateral trade flows are negatively impacted by the country's development status and, thereby, trading less

with developed countries. Results are consistent with the findings of Tansey & Hanson (**2013**), which suggested that developing countries trade more with developing countries as they are found to provide them with export engines of growth.

Despite being involved in tariff trading agreements, the variable indicates that they have no significant impact on India's trade flows. Likewise, sharing a common land or water border with India made no significant difference in India's trade.

As the GDP of its trading partner positively impacts India's trade, India could pursue policies that focus on building more trade relations with countries with higher GDPs. Simultaneously, trading more with neighbouring countries can help India increase its trade, which would entail lower shipping or transportation costs. Moreover, trade policies should be implemented effectively so that they are actually helpful in increasing India's trade flows. In addition, India needs to work on its trade agreements as they don't seem to impact the trade flows significantly. Trading more with developing countries can also help India boost its trade flows.

This work contributes to the existing knowledge of the gravity model and tests it using the latest set of trade data available for India. With greater globalization and liberalization, international trade has become an essential part of the economies. Thus, it becomes crucial to assess the influences on the trade flows between countries. Though determinants of trade flows change over time, the gravity model still exhibits its utility in explaining those trade flows. Using an augmented model, we examined the flow of international trade for India with not just the traditional variables but also with variables that were found to be relevant in current global trade scenarios.

For estimation, we have used the OLS estimators. However, further research could be carried out using a panel dataset to capture the effect of the time dimension on trade flows of India, thereby enhancing the results further and calculating India's trade potential with different countries using the estimated parameters.

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