Trade Flows between India and Other BRICS Countries: An Empirical Analysis Using Gravity Model

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Abstract
This article provides a detailed theoretical justification for the application of gravity model in the context of India's trade relation with other BRICS countries. Based on 20 years data set from 1990 to 2010, the study finds that there is a positive relationship between gross national product (GNP)/per capita GNP of the nation and its volume of trade. Also the study finds that where as the transport cost play a negative role in influencing foreign trade among BRICS nations, other variables related to foreign trade like exchange rate, inflation and import-GDP ratio does not play a major role in influencing it.

Keywords
BRICS, gravity model, foreign trade, panel data method, Hausman test

Introduction
Increased participation in world trade is considered as the single most important key to rapid economic growth and development. The possible set of factors affecting a country’s direction of trade (DOT) can be quite large, touching many aspects of its existence. Some of the important economic factors are comparative advantage relative to the other countries, economies of scale, the aggregate income of home

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as well as partner residents, government (especially related to trade and exchange rate) policies, membership to currency unions.

There are many regional trade agreements (RTAs)—bilateral or multilateral—to include more dimensions of economic integration, one of which is the BRICS an acronym for the economies of Brazil, Russia, India, China and South Africa combined. Before the inclusion of South Africa in 2010, it was typically rendered as BRIC (Brazil, Russia, India and China), an idea conceived in 2001 by Goldman Sachs as part of an economic modelling exercise to forecast global economic trends over the next half century. BRIC foreign ministers met in New York on 21 September 2010 and agreed to invite South Africa as a member in BRIC owing to its contribution in the global economy. As a result, South Africa formally joined with BRIC group on 24 December 2010 bringing it into this important organization of rising powerful nations from Asia, Latin America and Europe. BRICS now accounts for more than 40 per cent of the global population, nearly 30 per cent of the land mass, and account for nearly 25 per cent of the total global gross domestic product (GDP) in 2010 (in terms of PPP) from 16 per cent in 2000 and is expected to rise significantly in the near future (Government of India, 2012). Moreover, it holds huge amount of foreign exchange reserves and major attracting destinations for foreign investments. Whilst Brazil is known for world’s raw material base, Russia as the world gas station, India and China are considered as the world’s services and manufacturing hub and South Africa as the base for mineral resources.

After the lessons from Balance of Payment (BOP) crisis of 1991, India implemented full-fledged reform measures in spheres of international trade. As a result, India’s international as well as intra-regional trade has increased, since 1990s. The direction and volume of India’s foreign trade with other members of BRICS was also high particularly since 2000 (Table 1).

India participated almost all the BRICS meetings of foreign ministers, finance ministers, agriculture ministers, trade ministers, business forums and other sectoral meetings. India has successfully hosted the forth BRICS summit in New Delhi during March 2012 under the leadership of Honourable Prime Minister Dr. Manmohan Singh. The Delhi declaration gave a special focus on the issues of global governance, global economic and financial situation, Euro zone debt crisis and developments in Afghanistan, Iran, Syria and other issues in the present global economic and developmental perspectives. India conducted three important workshops with the participation of experts from other BRICS countries

### Table 1. Import and Export of Goods and Commercial Services—India with Other BRICS Countries

<table>
<thead>
<tr>
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<tbody>
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<td><strong>Import</strong></td>
<td></td>
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<tr>
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<td>893.06</td>
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<td>1185.96</td>
<td>3437.97</td>
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<td>2409.05</td>
<td>2478.16</td>
<td>4328.28</td>
<td>3566.79</td>
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<td>32497.02</td>
<td>30824.02</td>
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<td>2470.14</td>
<td>3605.35</td>
<td>5513.58</td>
<td>5674.5</td>
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<tr>
<td>Brazil</td>
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<td>2525.9</td>
<td>2651.43</td>
<td>2414.29</td>
<td>3970.8</td>
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<tr>
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<td>China</td>
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<tr>
<td>South Africa</td>
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<td>2241.61</td>
<td>2660.75</td>
<td>1980.28</td>
<td>2058.5</td>
<td>3985</td>
</tr>
</tbody>
</table>

*Source: BRICS Joint Statistical Publication (2012).*
based on the idea of a joint economic study proposed by the Indian Prime Minister Dr Manmohan Singh. Also, India conducted the first meeting of BRICS Economic Research group by bringing research institutions as well as the editors of the leading economic and financial magazines of the member’s countries to coordinate research activities.

Against the background, this study examined trade relationship between India and other members of BRICS since 1990s. Over the years, the functions of BRICS and its impact on India’s foreign trade have given rise to several policy issues and questions. For instance:

- What is the impact of external sector reforms of India on the volume, growth, composition and direction of exports and imports with BRICS countries?
- What is the nature and magnitude of changes in exports and imports with BRICS during pre and post BRICS?
- Does BRICS promote positive impact on India’s foreign trade?
- What lessons India may draw from the experience of other countries that have a record of successful trade with BRICS countries?

It seems very significant to find credible answers to the earlier questions. The relevance of the answers lies in providing the external sector reforms particularly, BRICS economic cooperation and trade policy reforms of India with both growth foundations and justifications.

Accordingly, the most important objective of the study is to analyse the impact of external sector reforms on India’s foreign trade with BRICS nations since 1990s and thereby derive policy implications favourable trade relationship. The article proceeds as follows. The section ‘Literature Review’ critically reviews the existing literature. While the section ‘Methodology’ explains the different models and data used, giving reasons for the variables used and the section ‘An Empirical Analysis’ evaluates performance of all the variables used. The econometric analysis examining a balanced panel data estimating the impact each variable has on the trade variable of India. The section ‘Conclusions’ presents our conclusions.

**Literature Review**

In the literature there have been several attempts to derive this relationship between trade, GDPs and distance from theoretical considerations. These are met with moderate success. It has been shown that the positive relationship with the GDPs and the negative relationship with distance can be established from a variety of assumptions regarding the production structure and preferences. The GM, analogous to the gravity law, is based on the fundamental premise that trade between two countries is directly proportional to the size of their economy and inversely proportional to the distance between them.

The application of the GM in international trade was initially developed by Tinbergen (1962). Use of the GM in international trade at an aggregate level has been extensive: examination of bilateral trade (Prentice et al., 1998); block trade analysis (Carrillo and Li, 2002; Martinez-Zarzoso and Nowak-Lehmann, 2003); multilateral trade agreements (Rose, 2002); trade policy analysis (Wall, 2000); estimation of trade potential (Pravorne et al., 2003); hypothesis testing, such as the Linder Hypothesis (McPherson, 2001) and border effect (McCallum, 1995; Wall, 2000).

Linnemann (1966) was the first to develop the most common justification of the gravity model, used by Aitken (1973), Geraci and Prewo (1977), Abrams (1980) and Sapir (1981).
The gravity model has inspired many researchers due to its frequent use in describing bilateral trade flows. Brada and Mendez (1983) mentioned Bergstrand’s theoretical foundation of the gravity model in their comparative analysis of integration schemes among developed, developing and centrally planned economies. Summary (1989) presented the gravity model in an attempt to provide a political–economic model of the US bilateral trade. Sanso, Cuairan and Sanz (1993) inquired empirically as to whether or not the log-linear form was efficient and concluded that the log-linear specification, while not optimal, was a fair and ready approximation of the optimal form.

Wall (2000) provided new estimates of the effects of protectionism on the US trade and obtained rough estimates of the resulting welfare effects, using a specific form of the gravity model which allowed for trading-pair heterogeneity and was statistically superior to the standard model. Cheng and Wall’s (1999) work involved the use of the simple panel data methods, allowing the intercepts of the gravity equation to be specific to each trading country. They applied the model to the question of the effects of regional integration on trade volumes and concluded that the fixed effects model (FEM) was the most appropriate specification. In the same year, Soloaga and Winters examined the effects of the preferential trade area (PTA) on trade.

Income was the most used variable in the gravity equations. Geraci and Prewo (1977), Bergstrand (1985, 1989), Summary (1989), McCallum (1995), among others, used GDP in order to represent the income of exporting or importing countries. Brada and Mendez (1983) also used GDP, assuming that it would have a positive influence on trade since greater income promotes trade. According to Koo, Karemera and Taylor (1994), the income of exporting countries represents the country’s production capacity, and the income of importing countries represents the country’s purchasing power, both of which are positively related to trade flows. Bougheas, Demetriades and Morgenroth (1999) confirmed that a higher level of income in the exporting country indicates a high level of production which increases the availability of products for export, while a high level of income in the importing country suggests higher imports.

GDP per capita has also been very commonly employed (Bergstrand, 1989; Cheng and Wall, 1999; Sanso et al., 1993; Tamirisa, 1999). Linder (1961) made the interesting remark that countries with similar per capita incomes would have similar demands. Gros and Gonciarz (1996) argued that per capita output is used to take into account the idea that as income increases, the share of tradable in overall income might increase; that is, for a given overall income a country with a higher income per capita would trade more intensively (have more exports and imports) than a poorer country.

Transportation cost is an important factor of trade. Production of the same good in two or more countries in the presence of transport costs is inconsistent with factor price equalization. Moreover, different trade models might behave differently in the presence of transport cost and differences in demand across countries (Paas, 2000, quoted from Davis and Weinstein, 1996). Transport costs are proxied by the distance. So distance between a pair of countries naturally determines the volume of trade between them. Studied based on general equilibrium approach (Bergstrand, 1985, 1989; Poyhonen, 1963; Tinbergen, 1962; etc.) concluded that incomes of trading partners and the distances between them were statistically significant and had expected positive and negative signs, respectively (Oguledo and Macphee, 1994). Three kinds of costs are associated with doing business at a distance: (a) physical shipping costs, (b) time-related costs and (c) costs of (cultural) unfamiliarity. Among these costs, shipping costs are obvious (Frankel, 1997 quoted from Linnemann, 1966).

The remoteness variable was formulated as the distance of country $i$ to the partner country $j$, weighted by the share of GDP of country $i$ in the total GDP of countries was used by Soloaga and Winters (1999), who expected a positive sign of the degree of remoteness of the importing country from its suppliers. The
hypothesis that, after controlling for distance between \(i\) and \(j\), the further country \(i\) is from all its partners, the greater will be its imports from country \(j\) (Polak, 1996). Wall (2000) and Cheng and Wall (1999) used the fixed-effects model in order to capture the effect of distance between the countries on the trade flows. Their arguments against the use of distance stemmed from the problem of assuming that overland transport costs are the same as those overseas, and that all overland and overseas distances are equally costly. Another problem arises from the assumption that the capital city (used by all of the authors) is a useful proxy for the economic centre. This is particularly important for studies which include the US and Canada which have major cities thousands of miles apart on different oceans.

Exchange rates are one of the most important factors affecting trade flows (Koo et al., 1994). The appreciation of a country’s currency against other currencies reduces the country’s exports and increases imports, while depreciation stimulates the country’s exports (Bergstrand, 1985, 1989; Koo et al., 1994).

Trade barriers such as tariff have a statistically significant negative effect on trade flows between countries. On the other hand, preferential arrangements are found to be trade-enhancing and statistically significant (Oguledo and Macphee, 1994).

From the earlier literature survey and research questions, it is apparent that there is a need to fill the research gap through systematic empirical and theoretical research to find answers for the research questions related to the trade relationship between India and other BRICS countries.

**Methodology**

This model originates from the Newtonian physics notion. Newton’s gravity law in mechanics states that two bodies attract each other proportionally to the product of each body’s mass (in kilogrammes) divided by the square of the distance between their respective centres of gravity (in metres).

\[
F = G \frac{M_1 M_2}{D^2}
\]

(1)

Where, \(F\) is the force between the masses; \(G\) is the gravitational constant; \(M_1\) is the first mass; \(M_2\) is the second mass, and \(D\) is the distance between the centres of the masses.

The equation in its basic form takes the following specification:

\[
T_{ij} = f(Y_i, Y_j, F_{ij})(i, j = 1, \ldots, m)
\]

(2)

Where, \(T_{ij}\) is the aggregate value of trade flow between countries \(i\) and \(j\); \(Y_i\) and \(Y_j\) is the nominal GDP of country \(i\) and \(j\); representing final output and domestic real income, respectively; and \(F_{ij}\) is a vector of factors either enhancing or resisting trade.

The gravity model (GM henceforth) for trade is analogous to this law. The analogy is as follows: the trade flows between two countries is proportional to the product of each country’s ‘economic mass’, generally measured by GDP (national income) and inversely proportional to the distance between
the countries respective ‘economic centres of gravity’, generally their capitals. This formulation can be generalized to

\[
T_{ij} = \frac{G(M_i^\beta M_j^\beta)}{D_{ij}^\gamma}
\]  

(3)

where \(T_{ij}\) represents volume of trade from country to country, \(M_i\) and \(M_j\) typically represent the GDPs for countries \(i\) and \(j\), \(D_{ij}\) denotes the trade costs (basically denotes distance between the two countries).

The traditional econometric approach to estimating this equation consists in taking logs of both sides, leading to a log–log model of the form:

\[
\ln(T_{ij}) = \beta_0 + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij}) + \varepsilon_{ij}
\]  

(4)

However, this approach has two major problems. First, it obviously cannot be used when there are observations for which \(T_{ij}\) is equal to zero. Second, it has been argued by Santos Silva and Tenreyro (2006) that estimating the log-linearized equation by least squares (OLS) can lead to significant biases. As an alternative, these authors have suggested that the model should be estimated in its multiplicative form, that is,

\[
F_{ij} = \exp(\beta_0 + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij})) \eta_{ij}
\]

\[
T_{ij} = \exp\left[\beta_0 + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij})\right] \eta_{ij}
\]  

(5)

This equation is the baseline model where bilateral trade flows are expected to be a positive function of income and negative function of distance. When estimated, the model gives relatively good results.

Standard proxies for trade costs used in gravity equations often take into account variables relating to language relationships, tariffs, contiguity, access to sea, colonial history, exchange rate regimes and other variables of interest.

The generalized gravity model of trade states that the volume of trade/exports/imports between pairs of countries, \(X_{ij}\), is a function of their incomes (GNPs or GDPs), their populations, their distance (proxy of transportation costs) and a set of dummy variables either facilitating or restricting trade between pairs of countries. That is,

\[
X_{ij} = \beta_0 Y_i^\gamma Y_j^\gamma N_i^\gamma N_j^\gamma D_{ij}^\gamma A_{ij}^\gamma U_{ij}
\]  

(6)

Where \(Y\) indicates the GDP of the country \(i\), \(j\), \(N\) is the population of the country \(i\), \(j\), \(D_{ij}\) measures the distance between the two countries’ capitals (or economic centres), \(A_{ij}\) represents dummy variables, \(U_{ij}\) is the error term and \(\beta\)’s are parameters of the model. Using per capita income instead of population, an alternative formulation can be written as

\[
X_{ij} = \beta_0 Y_i^\gamma Y_j^\gamma N_i^\gamma N_j^\gamma D_{ij}^\gamma A_{ij}^\gamma U_{ij}
\]  

(7)
Where \(y_i, (y_j)\) are per capita income of country \(i, (j)\). As the gravity model is originally formulated in multiplicative form, we can linearize the model by taking the natural logarithm of all variables. So for estimation purpose, the model in log-linear form in year \(t\) is expressed as

\[
\ln X_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln y_{it} + \beta_4 \ln y_{jt} + \beta_5 \ln D_{ijt} + \sum \delta h P_{ijt} + U_{ijt} \tag{8}
\]

Where, \(P_{ij}\) is a sum of preferential trade dummy variables. Dummy variable takes the value one when a certain condition is satisfied, zero otherwise.

We estimate three gravity models of India’s trade:

(a) The gravity model of India’s trade (exports + imports)
(b) The gravity model of India’s exports and
(c) The gravity model of India’s imports.

(a) The gravity model for trade:

\[
\begin{align*}
\log(X_{ijt}) &= \alpha_0 + \alpha_1 \log(GNP_{it} \ast GNP_{jt}) + \alpha_2 \log(PCGNP_{it} \ast PCGNP_{jt}) \\
&\quad+ \alpha_3 \log(Tax_{it} \ast Tax_{jt}) + \alpha_4 \log(Distance_{ijt}) + \alpha_5 \log(PCGNPD_{ijt}) \\
&\quad+ \alpha_6 \left(\frac{TR}{GDP_{it}}\right) + \alpha_7 \left(\frac{TR}{GDP_{jt}}\right) + \alpha_8 \left(Border_{ijt}\right) + U_{ijt}
\end{align*}
\tag{9}
\]

Where,
- \(X_{ijt}\) = total trade between India (country \(i\)) and country \(j\),
- \(GNP_{i} (GNP_{j})\) = gross national product of country \(i\) \((j)\),
- \(PCGNP_{i} (PCGNP_{j})\) = per capita GNP of country \(i\) \((j)\),
- \(Tax_{i} (Tax_{j})\) = trade tax as % of revenue of country \(i\) \((j)\),
- \(Distance_{ij}\) = distance between country \(i\) and country \(j\),
- \(PCGNPD_{ij}\) = per capita GNP differential between country \(i\) and \(j\),
- \(TR/GDP_{i(j)}\) = trade-GDP ratio of country \(i\) \((j)\),
- \(Border_{ij}\) = land border between country \(i\) and \(j\) (dummy variable),
- \(U_{ijt}\) = error term,
- \(t\) = time period,
- \(\alpha’s\) = parameters.

Per capita GNP provides a good proxy for the level of development and infrastructures that are essential to conduct trade, and as such the more developed the countries are, the more would be the trade between the pairs of countries (Frankel, 1993).

TR/GDP variable indicates the openness of the country. The more open the country is the more would be the trade.

(b) The gravity model for exports:

\[
\begin{align*}
\log(X_{ijt}) &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln y_{it} + \beta_4 \ln y_{jt} + \beta_5 \ln D_{ijt} \\
&\quad+ \beta_6 \ln y_{it} + \beta_7 \ln ER_{it} + \beta_8 \ln in_{it} + \beta_9 \ln in_{jt} + \beta_{10} \ln TE_{ijt} \\
&\quad+ \beta_{11} \ln TI_{it} + \beta_{12} \left(\frac{IM}{Y_{it}}\right) + \beta_{13} (TR/Y)_{it} + \beta_{14} (TR/Y)_{jt} + \sum \delta h P_{ijt} + U_{ijt}
\end{align*}
\tag{10}
\]
Where, $X = \text{exports}$, $Y = \text{GDP}$, $y = \text{per capita GDP}$, $D = \text{distance}$, $yd = \text{per capita GDP differential}$, $ER = \text{exchange rate}$, $In = \text{inflation rate}$, $TE = \text{total export}$, $TI = \text{total import}$, $IM/Y = \text{import-GDP ratio}$, $TR/Y = \text{trade-GDP ratio}$, $P = \text{preferential dummies}$.

(c) The gravity model for imports:

$$
\log(Z_{ij}) = \beta_0 + \beta_1 \ln Y_i^u + \beta_2 \ln Y_j^u + \beta_3 \ln y_i^p + \beta_4 \ln y_j^p + \beta_5 \ln D_{ij} + \\
+ \beta_6 \ln y_{ij} + \beta_7 \ln ER_{ij} + \beta_8 \ln in_{ij} + \beta_9 \ln in_{ij} + \beta_{10} \left( \frac{EX}{Y} \right)_{ij} + \\
+ \beta_{11} (TR/Y)_{ij} + \beta_{12} (TR/Y)_{ji} + \sum \delta_{ij} P_{ij} + U_{ij} \quad (11)
$$

Where, $Z = \text{imports}$, $EX/Y = \text{export-GDP ratio}$, remaining are same as for exports equation.

**Reasons and Explanation of Explanatory Variables**

**GDP:** The larger the country is in terms of its GDP/GNP, the larger the number of varieties of goods offered for trade. The more similar the countries are in terms of GDP/GNP, the larger is the volume of this bilateral trade. Thus, with economies of scale and differentiated products, the volume of trade depends in an important way on country size in terms of its GDP/GNP (Paas, 2000). For our estimated model, we have used constant GDP (in 2000 US dollars).

**Per Capita GDP:** While we are taking GNP as a variable, the reason for taking per capita GNP as a separate independent variable is that it indicates the level of development. If a country develops, the consumers demand more exotic foreign varieties that are considered superior goods. Further, the process of development may be led by the innovation or invention of new products that are then demanded as exports by other countries. Also it is true that more developed countries have more advanced transportation infrastructures which facilitate trade.

Moreover, per capita GDP, as a separate independent variable, is widely used to analyse bilateral trade flows as the standard gravity model predicts that countries with similar levels of output per capita will trade more than countries with dissimilar levels. Also the volume of trade should increase with increasingly equal distribution of national income. This theory predicts that per capita GDP will have a positive effect on trade. We have used constant per capita GDP (in 2000 US dollars) for our estimated model.

**Per capita GDP differential:** This variable has been included to explore which hypothesis—Heckscher–Ohlin hypothesis or Linder hypothesis—dominates Indian bilateral trade. The Heckscher–Ohlin hypothesis predicts that countries with dissimilar levels of per capita income will trade more than countries with similar levels. On the contrary, the Linder hypothesis predicts that countries with similar levels of per capita income will trade more with each other, as they will have similar preferences for differentiated products. Thus, the Linder hypothesis is associated with a negative effect of per capita GDP differential between country $i$ and $j$ on bilateral trade. A positive effect of this variable is associated with the Heckscher–Ohlin hypothesis.

**Trade-GDP ratio:** Trade-GDP ratio variable indicates the openness of the country. The more open the countries are the greater would be the trade between them. So a positive sign for this variable is expected. Since we are estimating our gravity model with cross-section data, this variable is considered for country $j$ only.
**Distance:** Transportation cost is an important factor of trade. Production of the same good in two or more countries in the presence of transport costs is inconsistent with factor price equalization. Moreover, different trade models might behave differently in the presence of transport cost and differences in demand across countries (Paas, 2000, quoted from Davis and Weinstein, 1996).

Transport costs are proxied by the distance. So distance between a pair of countries naturally determines the volume of trade between them. Three kinds of costs are associated with doing business at a distance: (a) physical shipping costs, (b) time-related costs and (c) costs of (cultural) unfamiliarity. Among these costs, shipping costs are obvious (Frankel, 1997 quoted from Linnemann, 1966).

The following two dummy variables are also included to capture the impact of historical and cultural ties between the fair of countries on bilateral trade. These are explained next.

**Common Language:** If trading partners share a common language, transaction costs of trading is expected to be reduced, because speaking the same language helps facilitate and expedite trade negotiations. Thus, trade is expected to increase between them. If both trading countries in a group have common official language, the dummy variable is equal to one and zero otherwise. This variable should have positive effect on trade. We have omitted this as in our analysis none of the countries have a common language.

**Border:** Countries with common borders are likely to have more trade than countries without common borders. Since none of the countries have common borders we put value zero for all the dummies, so it is as good as neglecting it.

**An Empirical Analysis**

The gravity model of trade is an important model in the field of international trade. It predicts trade flows between two nations and such predictions are based on the distance between two trading countries as well as their respective economic dimensions. It is a well known model at the basic level to evaluate trade relationship between two countries. Based on this model, the following figure explains India’s trade with other BRICS countries since 1990s.

**Results**

Trade variable has been regressed on GNP, import/export-GDP ratio, trade-GDP ratio and per capita GNP differential.

**Model (a) Total Trade**

**Hausman Test:** This is a very useful and important test used to determine the model of estimation between FEM and random effects model.

The null hypothesis is,

- H0: both random and fixed effects give similar results.
- H1: FEM is more appropriate.

If the value of test statistic is high that means the difference between the coefficients produced by random and FEMs differ greatly, this is when we reject the null hypothesis.

The required analysis has been done using the software Eviews and the results are given in the Table 2.
As we can see from the earlier table that the variable difference is going till 2.3 which might be unacceptable, thus we reject the null hypothesis saying that FEM is more useful here.

**Panel OLS Estimation:** Since there are presences of few variables that do not vary much upon time and we get a singular matrix because of that making us impossible to use FEM model. Thus, we use the panel OLS model instead. Here we have taken the dependent variable as total trade between India and country \( j \) and the independent variables as, GNP, per capita GNP, Tax and distance between centres, per capita differential and trade to GDP ratio as indicator of openness of economy. The analysis has been done using Eviews software and the results have been shown Table 3.

From the Table 3 it is clear that there is strong negative impact of per capita GNP differential on trade as suggested by Frankel (1993). We can also see that there is negative relationship with tax and distance between two countries and there is positive relationship with GNP, per capita GNP and trade-GDP ratio. The distance between two countries is supposed to have a negative impact on the trade of any country according to our analysis. In our estimation we find a negative coefficient of suggesting the same;

### Table 2. Hausman Test (Fixed versus Random Effects)

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<th>Test summary</th>
<th>Chi-Sq. Statistic</th>
<th>Chi-Sq. d.f.</th>
<th>Prob.</th>
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<td>Period random</td>
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<td>6</td>
<td>0.003</td>
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</tbody>
</table>

**Period random effects test comparisons:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fixed</th>
<th>Random</th>
<th>Var(Diff.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(GNP_hi*GNP_j)</td>
<td>0.138023</td>
<td>0.252298</td>
<td>0.001912</td>
</tr>
<tr>
<td>LOG(PCGNP_hi*PCGNP_j)</td>
<td>-1.277371</td>
<td>1.502962</td>
<td>2.308753</td>
</tr>
<tr>
<td>LOG(Tax_i*Tax_j)</td>
<td>-0.33166</td>
<td>-0.280264</td>
<td>0.000885</td>
</tr>
<tr>
<td>LOG(Distance_ij)</td>
<td>0.286026</td>
<td>-0.062886</td>
<td>0.065259</td>
</tr>
<tr>
<td>LOG(PCGNPD_ij)</td>
<td>-0.222786</td>
<td>-1.744611</td>
<td>0.756591</td>
</tr>
<tr>
<td>TR/GDP_i</td>
<td>0.010632</td>
<td>0.015683</td>
<td>0.000013</td>
</tr>
</tbody>
</table>

### Table 3. Panel OLS Estimation: Dependent Variable: LOG (TOTAL_TRADE)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(GNP_hi*GNP_j)</td>
<td>0.2418</td>
<td>0.05912</td>
<td>4.089966</td>
<td>0.0001</td>
</tr>
<tr>
<td>LOG(PCGNP_hi*PCGNP_j)</td>
<td>1.43769</td>
<td>0.463485</td>
<td>3.101911</td>
<td>0.0027</td>
</tr>
<tr>
<td>LOG(Tax_i*Tax_j)</td>
<td>-0.2825</td>
<td>0.064886</td>
<td>-4.353798</td>
<td>0</td>
</tr>
<tr>
<td>LOG(Distance_ij)</td>
<td>-0.071444</td>
<td>0.233503</td>
<td>-0.305965</td>
<td>0.7605</td>
</tr>
<tr>
<td>LOG(PCGNPD_ij)</td>
<td>-1.707248</td>
<td>0.310751</td>
<td>-5.493948</td>
<td>0</td>
</tr>
<tr>
<td>TR/GDP_i</td>
<td>0.064435</td>
<td>0.0121</td>
<td>5.325241</td>
<td>0</td>
</tr>
<tr>
<td>TR/GDP_j</td>
<td>0.015114</td>
<td>0.004534</td>
<td>3.333699</td>
<td>0.0013</td>
</tr>
</tbody>
</table>

R-squared | 0.882807 | Mean dependent var | 21.20263 |
Adjusted R-squared | 0.873675 | S.D. dependent var | 1.447088 |
S.E. of regression | 0.514328 | Akaike info criterion | 1.587742 |
Sum squared resid | 20.36902 | Schwarz criterion | 1.79031 |
Log likelihood | -59.68518 | Hannan-Quinn criter | 1.669173 |
Durbin–Watson statistics | 0.576515 | | |
however, the coefficient is of the value $-0.07$ which is of less significance when compared to the coefficients of other variables used in the analysis. This may be due to the fact that in our study we have used it as a proxy variable for transportation cost but there might be other factors affecting it depending on the policies of the country. According to H–O theory, the countries with similar per capita income trade lesser compared to the ones with a difference in their per capita. We get a negative value of $-1.7$ suggesting that it not only depends on the per capita income but also many other factors like the production culture, business culture and the policies of the country.” And the lines “The R-squared value for the model is also $0.88$ suggesting that the model is a significant one and the observed and modelled values are in agreement.

**Model (b) Exports**

From the above Table 4 we see that a few of the variables vary show differences in their coefficients thus again letting us reject the null hypothesis and telling that FEM model is more effective. But due to the same reasons for the previous model we have to conduct a panel OLS instead of FEM.

From the above analysis, the study has considered the export between India and country (j) as dependent variable and the independent variables are GDP, per capita GDP, distance between countries, per capita differential, exchange rate with respect to other country, inflation rate, total exports of India, and total imports of target country, import-GDP ratio, and Trade-GDP ratio. From above, exchange rate, import-GDP ratio, trade-GDP ratio, inflation rate of target country has insignificant values indicating that they don’t contribute much towards the trade. But contrary to the previous model we get a significant positive relationship with per capita differential (Table 5).

**Model (c) Imports**

Therefore for the above analysis, the study has considered imports of India from country (j) as the dependent variable and independent variables are same as the previous model except that we don’t have total imports and exports here and instead of imports-GDP ratio we use export-GDP ratio. Here also we get a positive relationship with per capita differential and many variables are having insignificant values. Here we see that exchange rate has a negative insignificant relationship with imports, so does GDP and inflation rate (Table 6).

### Table 4. Hausman Test

<table>
<thead>
<tr>
<th>Test Summary</th>
<th>Chi-Sq. Statistic</th>
<th>Chi-Sq. d.f.</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period random</td>
<td>2.879764</td>
<td>9</td>
<td>0.9689</td>
</tr>
</tbody>
</table>

### Period random effects test comparisons:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fixed</th>
<th>Random</th>
<th>Var(Diff.)</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(Y)</td>
<td>-0.239701</td>
<td>-0.177909</td>
<td>0.04462</td>
<td>0.7699</td>
</tr>
<tr>
<td>LOG(y)</td>
<td>-5.242345</td>
<td>-4.471313</td>
<td>3.494102</td>
<td>0.68</td>
</tr>
<tr>
<td>LOG(D)</td>
<td>2.382017</td>
<td>2.090325</td>
<td>0.339478</td>
<td>0.6166</td>
</tr>
<tr>
<td>LOG(yd)</td>
<td>2.12916</td>
<td>1.72715</td>
<td>1.05921</td>
<td>0.6961</td>
</tr>
<tr>
<td>LOG(ER)</td>
<td>-0.015329</td>
<td>0.002921</td>
<td>0.002684</td>
<td>0.7246</td>
</tr>
<tr>
<td>LOG(in)</td>
<td>-0.075525</td>
<td>-0.088539</td>
<td>0.003783</td>
<td>0.8324</td>
</tr>
<tr>
<td>LOG(TI)</td>
<td>0.748878</td>
<td>0.659648</td>
<td>0.06912</td>
<td>0.7343</td>
</tr>
<tr>
<td>(IM/Y)</td>
<td>-0.04335</td>
<td>-0.037555</td>
<td>0.000446</td>
<td>0.7838</td>
</tr>
<tr>
<td>(TR/Y)</td>
<td>0.042289</td>
<td>0.038765</td>
<td>0.000159</td>
<td>0.7798</td>
</tr>
</tbody>
</table>
### Table 5. Panel OLS Estimation: Dependent Variable-LOG (export)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(Y_{it})</td>
<td>−1.036391</td>
<td>0.999798</td>
<td>−1.0366</td>
<td>0.3035</td>
</tr>
<tr>
<td>LOG(Y_{jt})</td>
<td>−0.166864</td>
<td>0.462069</td>
<td>−0.361124</td>
<td>0.7191</td>
</tr>
<tr>
<td>LOG(y_{it})</td>
<td>4.579653</td>
<td>1.758084</td>
<td>2.604911</td>
<td>0.0112</td>
</tr>
<tr>
<td>LOG(y_{jt})</td>
<td>−3.972767</td>
<td>1.811993</td>
<td>−2.192485</td>
<td>0.0317</td>
</tr>
<tr>
<td>LOG(D_{ijt})</td>
<td>1.97446</td>
<td>0.803391</td>
<td>2.457658</td>
<td>0.0165</td>
</tr>
<tr>
<td>LOG(y_{dijt})</td>
<td>1.438831</td>
<td>1.030204</td>
<td>1.396647</td>
<td>0.1669</td>
</tr>
<tr>
<td>LOG(ER_{ijt})</td>
<td>0.01184</td>
<td>0.064158</td>
<td>0.184545</td>
<td>0.8541</td>
</tr>
<tr>
<td>LOG(init)</td>
<td>0.384271</td>
<td>0.262991</td>
<td>1.461157</td>
<td>0.1484</td>
</tr>
<tr>
<td>LOG(injt)</td>
<td>−0.091098</td>
<td>0.069957</td>
<td>−1.302204</td>
<td>0.1971</td>
</tr>
<tr>
<td>LOG(TE_{jt})</td>
<td>0.413746</td>
<td>1.17873</td>
<td>0.35101</td>
<td>0.7266</td>
</tr>
<tr>
<td>LOG(TI_{jt})</td>
<td>0.640258</td>
<td>0.516307</td>
<td>1.240073</td>
<td>0.2191</td>
</tr>
<tr>
<td>(IM/Y)_{it}</td>
<td>0.036647</td>
<td>0.048715</td>
<td>−0.748165</td>
<td>0.4569</td>
</tr>
<tr>
<td>(TR/Y)_{it}</td>
<td>0.001711</td>
<td>0.041</td>
<td>−0.041726</td>
<td>0.9668</td>
</tr>
<tr>
<td>(TR/Y)_{jt}</td>
<td>0.038092</td>
<td>0.025673</td>
<td>1.48374</td>
<td>0.1424</td>
</tr>
</tbody>
</table>

R-squared: 0.841181, Mean dependent var: 20.1752
Adjusted R-squared: 0.811687, S.D. dependent var: 1.458205
S.E. of regression: 0.632789, Akaike info criterion: 2.073653
Sum squared resid: 28.02956, Schwarz criterion: 2.478789
Log likelihood: −73.09344, Hannan-Quinn criter: 2.236515
Durbin–Watson statistics: 0.864347

### Table 6. Panel OLS Estimation: Dependent Variable: LOG (import)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(Y_{it})</td>
<td>−0.044632</td>
<td>0.370924</td>
<td>−0.120326</td>
<td>0.9046</td>
</tr>
<tr>
<td>LOG(Y_{jt})</td>
<td>0.207116</td>
<td>0.124085</td>
<td>1.669154</td>
<td>0.0994</td>
</tr>
<tr>
<td>LOG(y_{it})</td>
<td>3.445397</td>
<td>1.301408</td>
<td>2.647438</td>
<td>0.01</td>
</tr>
<tr>
<td>LOG(y_{jt})</td>
<td>−1.094167</td>
<td>1.45506</td>
<td>−0.751974</td>
<td>0.4545</td>
</tr>
<tr>
<td>LOG(D_{ijt})</td>
<td>0.096204</td>
<td>0.371566</td>
<td>0.258915</td>
<td>0.7964</td>
</tr>
<tr>
<td>LOG(y_{dijt})</td>
<td>0.145015</td>
<td>0.859948</td>
<td>0.168633</td>
<td>0.8666</td>
</tr>
<tr>
<td>LOG(ER_{ijt})</td>
<td>−0.033404</td>
<td>0.053943</td>
<td>−0.61924</td>
<td>0.5377</td>
</tr>
<tr>
<td>LOG(init)</td>
<td>0.278025</td>
<td>0.191421</td>
<td>1.452425</td>
<td>0.1507</td>
</tr>
<tr>
<td>LOG(injt)</td>
<td>−0.097698</td>
<td>0.05875</td>
<td>−1.66294</td>
<td>0.1007</td>
</tr>
<tr>
<td>(EX/Y)_{it}</td>
<td>−0.09793</td>
<td>0.040646</td>
<td>−2.409333</td>
<td>0.0185</td>
</tr>
<tr>
<td>(TR/Y)_{it}</td>
<td>0.013239</td>
<td>0.023831</td>
<td>0.555521</td>
<td>0.5803</td>
</tr>
<tr>
<td>(TR/Y)_{jt}</td>
<td>0.077239</td>
<td>0.021219</td>
<td>3.640053</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

R-squared: 0.884474, Mean dependent var: 20.6776
Adjusted R-squared: 0.866824, S.D. dependent var: 1.520649
S.E. of regression: 0.554934, Akaike info criterion: 1.520649
Sum squared resid: 22.17255, Schwarz criterion: 2.138889
Log likelihood: −63.24845, Hannan-Quinn criter: 2.138889
Durbin–Watson stat: 0.730908
Empirical Results for All Models

We have used the data set from 1990 to 2010 for five BRICS countries, Brazil, Russia, India, China and South Africa, respectively. Due to unavailability of data a few observations of the variable tax on international trade have been linearly interpolated to have a balanced panel data. We have used panel OLS estimation technique as fixed effects method could not be used due to the presence of few time invariant variables.

The product of GNPs is considered as the size of the economy. As it is bigger, there will be more trade between the two countries; in our first model we get a positive relationship between them thus affirming it. Per capita GNP provides a good proxy for the level of development and infrastructures that are essential to conduct trade, and as such the more developed the countries are, the more would be the trade between the pairs of countries (Frankel, 1993). Therefore, in our model we get a coefficient of about 1.4 which says that it significantly has a positive effect confirming the foregoing statement. Trade tax always prevents trade. Also trade flow is inversely related to the transport costs. In our analysis we have found that its coefficient is about −0.28 which proves the negative relationship mentioned earlier. The distance between two countries is supposed to have a negative impact on the trade of any country according to our analysis. In our estimation we find a negative coefficient of suggesting the same; however, the coefficient is of the value −0.07 which is of less significance when compared to the coefficients of other variables used in the analysis. This may be due to the fact that in our study we have used it as a proxy variable for transportation cost but there might be other factors affecting it depending on the policies of the country. According to H–O theory, the countries with similar per capita income trade lesser compared to the ones with a difference in their per capita. A negative value of −1.7 suggests that total trade not only depends on the Per Capita income but also many other factors like the production culture, business culture and the policies of the country. TR/GDP variable indicates the openness of the country. The more open the country is the more would be the trade. We have found out that it is pretty much insignificant in this case of BRICS countries but it still has a positive sign thus proving the point made. The R-squared value for the model is also 0.88 suggesting that the model is robustly fits the observed and estimated values of the dependent variable (i.e., total trade). The adjusted R-squared value is also a significant one eliminating the possibility of any kitchen sink regression.

The second and the third model that we have used show somewhat ambiguous results. In both the cases we observe that the value of R-squared and adjusted R-squared are significant implying the soundness of the model we have used. In the second model for exports we expect only the distance variable and inflation rate of India variable to be negative. In our analysis we get those variables to be positive along with total imports of country \(j\) because as we are exporting more to country \(j\) their imports are supposed to increase and our results show the opposite though its value is insignificant. We find that distance has a positive impact on trade which contradicts our expectation that exports are inversely related to the distance between countries. We also find that the per capita GDP differential is significantly positive, contradicting the result that was seen in the total trade analysis where we found the per capita differential to have a negative impact on total trade. We also get a positive sign for per capita GDP of India variable; this could be due to the reason that with higher per capita income there is economies of scale effect. The negative sign of per capita GDP of target country \(j\) can be explained by same economies of scale effect telling that more goods are produced in the target country. We have found the TR/Y variable, which is proxy for the openness of the economy, to be insignificant when compared to the other variables.

The third model we expect that the variables distance, exchange rate and inflation rate to have negative coefficients. In our analysis we exchange rate as negative but along with that we get GDP India as
insignificantly negative but we expected it to be positive. We get an insignificant positive impact of distance on imports which contradict our expectations. We find a positive coefficient for per capita GDP differential suggesting that more the difference there is more the imports, which contradicts the results we found in total trade analysis where the coefficient has come up as negative. We have found the TR/Y variable, which is proxy for the openness of the economy, to be insignificantly positive. We get a positive sign for per capita GDP of India, the reason behind this could be that with higher per capita income India surely enjoys economies of scale effects but at the same time due to absorption effect the imports are more. We also get a negative sign for per capita GDP of target country, the reason could be that due to absorption effect the target country can be demanding more of India’s goods but also there are economies of scale effects due to which more goods are produced in target country itself thus giving a negative sign.

Conclusions

It has been widely acknowledged that an increase in trade resulting from a deeper economic integration can sustain economic growth of the region and so also for the global economy (Banik and Yoonus, 2012) and in this context, the BRICS countries have made a significant contribution to world trade from the beginning of 1990s. The volume of trade, capital and transfer of technology of BRICS nations have increased due to the decreased inflation rate and increased the degree of openness in almost all spheres. Apart from these improvements, it is well known that there is an increasing volume of merchandise trade among BRICS nations. Consequently, it is important to know the contribution of India (one of the two Asian giants) to BRICS trade. The article examined trade relationship between India and other BRICS nations, arguing the major factors that are responsible for strong and favourable trade.

Using various quantitative and qualitative techniques, this study observed lot of interesting results. Based on the first objective, this study finds that the external sector reforms increases India’s foreign trade with other BRICS nations, particularly the volume and growth rate was quite high since 2001. For second objective, this study attempted to test the relationship between GNP (Gross National Product) and the volume of trade by using panel OLS estimation technique. It is found that there is a positive relationship between GNP/per capita GDP and trade-GNP ratio. For the third objective, this study found mixed implications. First, exchange rate, import-GDP ratio, inflation rate of target country has insignificant values indicating that their contribution to trade was very low. Also the study finds that the trade flows is universally related to the distance/transport cost because its coefficient is about −0.28. The study concluded that the similar GNP/per capita GDP nations have more bilateral trade which is true to the case of India with other BRICS nations.

This study suggests that India should simplify its export–import (EXIM) procedures and trade barriers especially through 100 per cent duty free import of capital and other inputs used in export products. So also there is a need for huge infrastructural investment and development and technological advancement in India towards sustainability of trade relationships with BRICS and other countries in the world.

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References


