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Sabyasachi Tripathi and Nuno Carlos Leitão

Institute for Social and Economic Change, Polytechnic Institute of Santarém, CEFAGE, University of Évora

March 2013

Online at https://mpra.ub.uni-muenchen.de/45502/
MPRA Paper No. 45502, posted 25 March 2013 10:52 UTC

India's Trade and Gravity Model: A Static and Dynamic Panel Data

Sabyasachi Tripathi

Institute for Social and Economic Change, Bangalore, India
E-mail: sabya.tripathi@gmail.com

Nuno Carlos Leitão

Polytechnic Institute of Santarém, and CEFAGE, University of Évora, Portugal
E-mail: nunocarlosleitao@gmail.com

Abstract

This paper examines the India's trade flows using a gravity model for the period 1998-2012. We selected the following major trade partners: China PRP, United Arab Emirates, United States, Saudi Arab, Switzerland, Singapore, Germany, Hong Kong, Indonesia, Iraq, Japan, Belgium, Kuwait, Korea RP, Nigeria, Australia, United Kingdom, Iran, South Africa, and Qatar. In this research we apply a static and dynamic panel. We find evidence that political globalization and cultural proximity have a positive influence in bilateral trade. We also introduce economic size and common border these proxies confirming a positive impact of bilateral trade. These results show that the gravity model can explain the pattern of bloc's trade.

Key words: Trade, Panel Data, Gravity model; India.

JEL Classification: C20, C30, F12.

1. Introduction

The Approach to the Twelfth Five-Year Plan (2012-17) has pointed out that India's international trade volumes have been growing faster than GDP and will continue to do so. Exports of goods and services, as a percentage of GDP have increased from 14 per cent in 2000-01 to 22 per cent in 2010-11, which indicates the increased openness of the economy in the past few years. World Development Indicators (WDI) published by World Bank reveals that since 1991 trade reforms have made significant improvement on India's trade to GDP ratio from 13.9 percent in 1991 to 40.5 percent in 2011. In addition, WDI also shows that India's export value index (or import value index) in percentage of the average for the base period (2000) has increased from 41.8 (or 39.7) percent in 1991 to 700.7 (or 886.4) in 2011.

Recent India's foreign trade policy are mainly focused in increasing volume of bilateral trade with several economic cooperation arrangements with different countries (e.g., East Asia, South and South East Asia, etc.). India also aggressively looking for the new and emerging markets to increase the market share by introducing a new post-export Export Promotion Capital Goods (EPCG) scheme which mainly reduces the transport cost in trade. A numerous policy reforms have been made in export sector in India to facilitate the brand and quality of the export commodities to create international awareness of the "Made in India" label in a globalised market place. In fact, recently, foreign investment in retail trade somewhat is relaxed for the greater promotion of India's foreign trade.

However, the recent past downturn in the industrialized countries have also created uncertainty about the export markets in industrialized economy. The growth rate of export is reduced from 40.5 per cent in 2010-11 to 20.9 per cent in 2011-12 (RBI, 2012). On the other hand, the share of India's world export is very low and only just over one per cent. Even more, the export growth rate of India is far lesser than China's economy with lower level of competitiveness. Therefore, to increase the export which is declined due to falling demand from developed countries, India's trade policies are mainly focused to diversify the markets to other countries (such as, Latin America, Africa, parts of Asia and Oceania).

In this backdrop, the paper attempts to identify the relevant determinants of India's bilateral trade flows to major trading partners by adopting the gravity model approach for the period of 1998 to

2012. We consider these major 20 trading partners, as India's 70 per cent bilateral trade in 2011-12 are mostly directed to these countries. The study uses Tobit model, static (random-effect), and dynamic (GMM-system) panel data approach for the estimation by considering country-specific characteristics (per capita income, geographical distances, cultural proximity, and political globalization). The results are extremely important for policy implication for recent India's bilateral trade direction and to reduce the uncertainty.

The structure of the paper is a follows. The next section reviews the empirical studies on trade and gravity model from international and Indian perspectives. Section 3 discusses methodological issues regarding the econometric specification and estimation of the empirical gravity model. Estimated results are reported in Section 4. Major conclusions and implications are presented in section 5.

2. Literature Review and Empirical Studies

The gravity model has been able to capture more and more adherents in academia. This model is analogous to Newton's Law of Gravity, which states that the gravity between two objects is directly related to their masses and inversely related to the distance them.

$$F_{ij} = G \frac{Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\delta}} \qquad (1)$$

Where Fij denotes the flow from country i to country j. Yi and Yj are the economic sizes of the two countries, usually measured as the gross domestic product (GDP), or per-capita GDP. Dij is the distance between countries. G is a gravitational constant.

In order to facilitate the econometric estimations, we apply logs the gravity equation (1) and hence, we obtain a linear relationship as follows:

$$Ln\ Fij = ln\ G + \alpha\ ln\ Yi + \beta\ ln\ Yj - \delta\ ln\ Dij \qquad (2)$$

Where lnG corresponds to the intercept, while α, β and δ are elasticity's.

The pioneering empirical models (Tinbergen, 1961; Poyhonen, 1963; Anderson, 1979; Caves 1981; and Toh 1982) consider that geographical distance is an important determinant of gravity model. As in Rauch (1999), and Eichengree and Irwin (1998) demonstrated cultural proxies (border, common

language) should be consider in gravity equation. The empirical model use dummy variables to the cultural distance, language and to the border. The cost of transport is measure usually of geographical distance. According to previous studies (Balassa, 1966; Balassa and Bauwens, 1987) there is a negative correlation between geographical distance and trade, i.e., an increase in bilateral trade is explained when the transportation cost decrease

The similarities of the countries encourage bilateral trade. The study Frankel and Rose (1998) demonstrates the importance of these qualitative variables to analyze the regional trading agreements (RTAs). Balassa (1966) and Balassa and Bauwens (1987) found a positive sign. The issue of product differentiation was introduced by Anderson (1979). In this context, Bergstrand (1985) applied the income per capita to specify the supply side of economies.

Kepaptsoglou et al. (2010) provide an excellent review of early contributors to empirical literature on gravity models for a 10-Year (1999-2009) period. They argue that gravity model is very popular among researchers and has been extensively used for assessing trade policy implications for the last 40 years because of its considerable empirical robustness and explanatory power.

Among the selected Indian empirical studies, Tharakan et al. (2005) apply the gravity model specification to evaluate the determinants of India's bilateral software. Using Tobit model for the period of 1997–2001, the authors find that distance to be insignificant in comparing Indian software exports to overall goods trade flows. De (2013) estimates a gravity model to analyze the linkages between India's services trade flow and its probable barriers by using a panel dataset from 2000 to 2006. The study finds that a 1 per cent improvement in services trade facilitation measures would lead to a 2 per cent rise in services exports in India. Finally, the paper recommends for more effective policy toward an improved services trade infrastructure for the greater facilitation of service exports from India. Bhattacharyya and Banerjee (2006) apply gravity model for 177 countries with which India had trade relations at least once between 1950 and 2000 and by using cross section and panel data model find that India's trade responds less than proportionally to size and more than proportionally to distance. In addition, they find that India trades more with developed rather than underdeveloped countries. Using OLS estimation technique in a gravity model for the year of 2000 and considering the possible coverage of world

trade flows from the sample of 146 countries, Batra (2004) finds that higher economic size of a country pair and geographical proximity positively influence India's bilateral trade flows. Using gravity model, Bhattacharya's (2004) paper do a comparative analysis and simulates the increase in India-Bangladesh bilateral trade under four hypothetical scenarios of differing tariff rate cuts. The author finds that in free trade regime India's exports will be more than the increase in its imports from Bangladesh.

3. Econometric Model

Following the literature, our study applies a gravity equation with panel data. The dependent variable used is India's bilateral trade and the following countries: China PRP, United Arab Emirates, United States, Saudi Arab, Switzerland, Singapore, Germany, Hong Kong, Indonesia, Iraq, Japan, Belgium, Kuwait, Korea RP, Nigeria, Australia, United Kingdom, Iran, South Africa, and Qatar for the period 1998-2012. The data for the explanatory variables are sourced from the World Bank and Dreher et al. (2008) and, the source used for the dependent variable is Directorate General of Commercial Intelligence and Statistics (DGCI&S), Kolkata, under the Ministry of Commerce, GOI, at 8 digit level Harmonized System Codes (HS Code).

3.1. Static and Dynamic Panel Data

The static panel data have some problems in serial correlation, heteroskedasticity and endogeneity of some explanatory variables. The estimator GMM-system (GMM-SYS) permits the researchers to solve the problems of serial correlation, heteroskedasticity and endogeneity for some explanatory variables. These econometric problems were resolved by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998, 2000), who developed the first differenced GMM (GMM-DIF) estimator and the GMM system (GMM-SYS) estimator. The GMM-SYS estimator is a system containing both first differenced and levels equations. The GMM- SYS estimator is an alternative to the standard first differenced GMM estimator. To estimate the dynamic model, we applied the methodology of Blundell and Bond (1998, 2000), and Windmeijer (2005) to small sample correction to correct the standard errors of Blundell and Bond (1998, 2000). The GMM system estimator that we report was computed using STATA. The GMM- system estimator is consistent if there is no second order serial correlation in the residuals (m2 statistics). The dynamic panel data model is valid if the estimator is consistent and the instruments are valid.

3.2. Explanatory variables and testing of hypotheses

Based on the literature, we formulate the following hypothesis:

Hypothesis 1: ***The larger economic dimension increases trade***.

According to the literature (Anderson, 2011, Leitão et al., 2012, Faustino and Proença, 2011) we expect a positive sign.

In this paper we use the following proxies to market size:

- GDPi is the absolute value of India's GDP per capita (PP, in current international dollars).

- GDPk is the absolute value GDP per capita of trade partner k (PP, in current international dollars).

Hypothesis 2: ***Trade increases when partners are geographically close.***

- DIST (Geographical Distance): This is the geographical distance between India and partner country. According to the gravity model, a negative sign is expected.

Ghatak et al. (2009) and Martinez-Zarzoso and Lehman-Nowak (2003) found a negative relationship between distance and bilateral trade. For Indian case, Tharakan et al. (2005), De (2013), Bhattacharyya and Banerjee (2006), and Batra (2004) have found a negative relationship between distance and India's bilateral trade. The geographic distance between India and each partner in km (DIST) is the variable used. This variable is collected in CEPII dataset.

- BORDER , this a dummy variable takes values 1 and 0. Equals 1 if the partner-country shares a border with India and 0, otherwise. In our sample only China shares common border with India.

According to previous studies, a positive sign is expected.

Hypothesis 3: ***Cultural and Political globalizations promote bilateral trade***.

We decided to introduce globalization as a control variable, since this provides information about the economic structures of countries. According to Dreher (2008) the cultural proximity is measured by (McDonald's restaurants (per capita). The political globalization is composed by embassies in

country, membership in international. These variables are collected in http://globalization.kof.ethz.ch/.

3.3. Model Specification

The econometric model of India's trade takes the following representation:

$$y_{it} = \beta_0 + \beta_1 X_{it} + \delta t + \eta_i + \varepsilon_{it} \qquad (3)$$

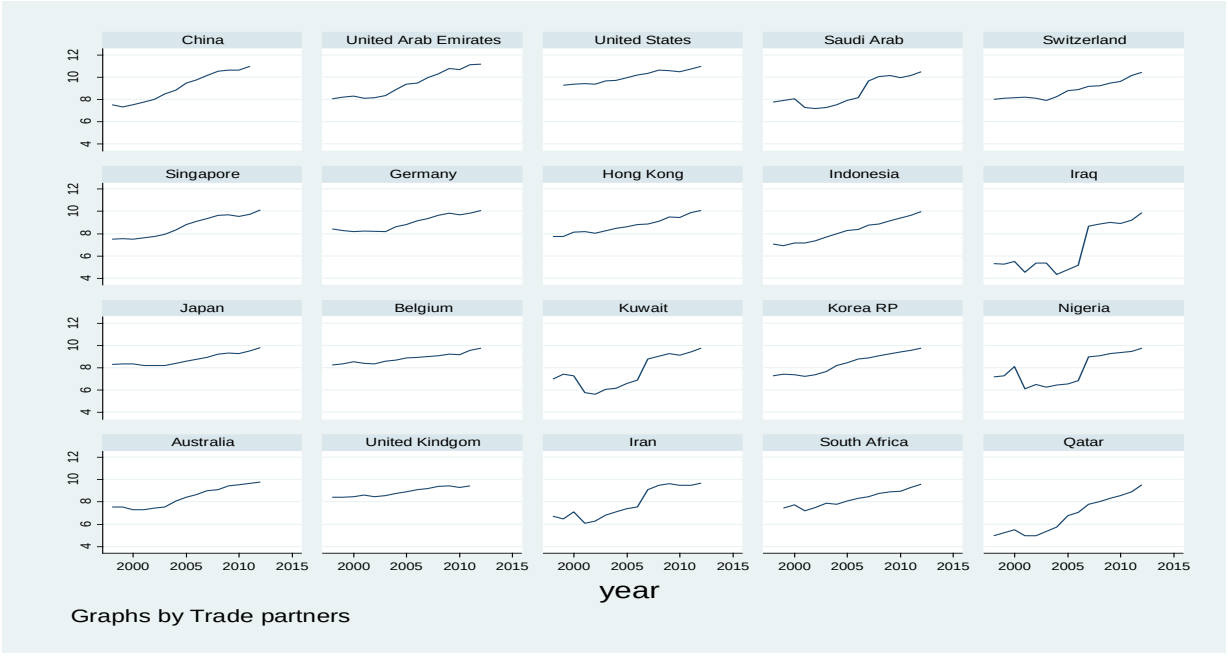
Where y_{it} is the India's bilateral trade respectively, and X is a set of explanatory variables. All variables are in the logarithm form; η_i is the unobserved time-invariant specific effects; δt captures a common deterministic trend; ε_{it} is a random disturbance assumed to be normal, and identically distributed with E (ε_{it})=0; Var (ε_{it}) = $\sigma^2 \succ 0$.

The model can be rewritten in the following dynamic representation:

$$y_{it} = y_{it-1} + \beta_0 + \beta_1 X_{it} - \rho\beta_1 X_{it-1} + \delta t + \eta_i + \varepsilon_{it} \qquad (4)$$

In figure 1, we can observe the panel data line plot for dependent variable.

Figure 1: Panel data line plot: Bilateral trade between India and trade partners



Source: Authors'

4. Empirical Results

Table 1 presents summary statistics for each variable.

Table 1: Descriptive statistics for panel data

Variable	Obs.	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Coefficient of Variation
LnTRADE	300	8.446	1.347	4.322	11.233	-0.668	3.385	15.951
$LnGDP_i$	280	6.580	0.433	6.043	7.306	0.271	1.610	6.578
$LnGDP_k$	277	9.476	1.448	5.607	11.435	-0.960	2.604	15.284
LnDIST	300	8.507	0.469	7.717	9.479	0.166	2.069	5.508
BORDER	300	0.050	0.218	0.000	1.000	4.129	18.053	436.618
LnCULT	260	3.581	1.357	0.000	4.578	-1.642	4.489	37.891
LnPolKOF	260	4.135	0.653	1.521	4.586	-3.025	12.206	15.785

Source: Authors'

LnTRADE, $LnGDP_i$, *LnDIST*, and $LnGDP_k$ appear to have only little differences in their means, implying a more symmetrical distribution. However it is not the case for *LnCULT*, *LnPolKOF* and *BORDER*, where the difference is significant.

The results of random effects and Tobit model estimator are reported in Table 2. The random effect model performs well, explaining up to 62 per cent of sample variation in the India's bilateral trade.

Market size variables: GDP per capita of India's bilateral trade partners (GDP_k) and India's GDP per capita (GDP_i), both have the positive and significant (at 1 percent level) effect on India's bilateral trade. The results are consistent in random effects and Tobit models. In Tobit model, the estimated values of the coefficients show that, in particular, a 10 per cent increase in GDP per capita of India's trade partners (or India's GDP per capita) is associated with 1.6 (or 19) per cent increase in India's bilateral trade and supports the positive effect of market size on India's bilateral trade. This indicates that market size promotes India's bilateral trade.

Table 2: India's trade and Gravity: Random Effects and Tobit Model

DEPENDENT VARIABLE: *LnTRADE*			
	Coefficeint		
Independent Variables	Random Effect Model	Tobit Model	Expected Signs
$LnGDP_i$	1.521 (12.66)***	1.879 (14.63)***	(+)
$LnGDP_k$	0.601 (5.37)***	0.164 (3.19)***	(+)
LnDIST	0.634 (1.79)*	0.774 (6.86)***	(-)
BORDER	2.232 (2.90)***	1.183 (4.55)***	(+)
LnCULT	-0.198 (-1.59)	0.198 (3.76)***	(+)
LnPolKOF	0.406 (1.80)*	-0.110 (-1.32)	(+)
C	-13.837 (-4.79)***	-12.485 (-10.41)***	
Adjusted R-squared	0.622		
Sigma		0.774	
Log likelihood		-299.96	
N	258	258	

Z-statistics for Random Effect model and t-statistics for Tobit model (heteroskedasticity corrected) are in round brackets.
****/*- statistically significant at the 1%, and 10% level, respectively.*

Geographical proximity variables: geographical distance between India and partner country (*DIST*) and border dummy (*BORDER*), both have the positive and statistically significant effect on India's bilateral trade in both the models. The results in Tobit model indicates that an increase of 10 per cent in the geographical distance between India and partner country (or India made border with partner trade) leads to 7.7 (or 11.8) per cent increase in the India's bilateral trade. Though, the sign of the coefficient of border dummy supports the expected hypothesis, but the sign of the coefficient of distance variable runs against the predicted hypothesis. The results indicate that geographical proximity does not matter for India's bilateral trade. However, the significance level of the distance variable (*DIST*) is reduced from 1 per cent in Tobit model to 10 per cent random effect model.

The estimated coefficient of the political globalization (*PolKOF*) in random effect model is positively and significantly (at 10 per cent level) related to the India's bilateral trade, which runs

with our predicted hypothesis. An increase of 10 per cent in political globalization leads to 4 per cent increase in India's bilateral trade.

The coefficient of cultural proximity ($CULT$) is positive (as predicted) and statistically significant (at 1 per cent level) in Tobit model. The coefficient 0.198 indicates that with a 10 per cent increase in cultural proximity of India's trading partner, India's bilateral trade increases by about 2 per cent. This result suggests that cultural proximity of the trading partner promotes India's bilateral trade.

Table 3: India's trade and Gravity: GMM-System

DEPENDENT VARIABLE: *LnTRADE*		
Independent Variables	Coefficient	Expect Signs
$LnTRADE_{t-1}$	0.582 (29.14)***	(+)
$LnGDP_i$	0.439 (3.00)***	(+)
$LnGDP_k$	0.624 (5.15)***	(+)
LnDIST	-1.337 (-0.78)	(-)
BORDER	-0.481 (-0.15)	(+)
LnCULT	0.028 (0.12)	(+)
LnPolKOF	1.603 (3.53)***	(+)
C	-0.628 (-0.05)	
Arellano-Bond test for Ar(2) (P-value)	0.163	
Sargan test (P-value)	1.00	
N	238	

*The null hypothesis that each coefficient is equal to zero is tested using one-step robust standard error. Z-statistics (heteroskedasticity corrected) are in round brackets. P-values are in square brackets; *** - statistically significant at the 1 per cent level. Ar(2) is tests for second–order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation (based on the efficient two-step GMM estimator). The Sargan test addresses the over- identifying restrictions, asymptotically distributed X^2 under the null of the instruments' validity (with the two-step estimator).*

Table 3 presents the results of GMM-System estimator. The model presents consistent estimates, with no serial correlation (the Arellano and Bond test for Ar(2)). The specification Sargan test shows that there are no problems with the validity of instruments used. The Windmeijer (2005) finite sample correction is used. The model presents four significant variables ($LnTRADE_{t-1}$, $LnGDP_i$, $LnGDP_k$, and $LnPolKOF$).

The lagged dependent variable ($LnTRADE_{t-1}$) presents a positive sign. As expected, the variables $LnGDP_i$, and $LnGDP_k$ have a significant and a positive effect on bilateral trade. These variables are also introduced to control for relative size effects. Our result is according to previous studies (Helpman 1987, Hummels and Levinshon 1995, and Greenaway et al., 1994). The coefficient of political globalization ($LnPolKOF$) is positively correlated with bilateral trade, i.e., political globalization encourage bilateral trade.

5. Conclusions

The objective of this paper is to analyze the determinants of India's bilateral trade flows to the major 20 trading partners by using a gravity model for the period of 1998 to 2012. We apply a Tobit, random effects and GMM system estimator for the analyses. In this research we use a dynamic panel (GMM system estimator) to solve the problems of serial correlation, heteroskedasticity and endogeneity for some explanatory variables.

Market size variables: GDP per capita of India's bilateral trade partners ($LnGDP_k$) and India's GDP per capita ($LnGDP_i$), both have the positive and significant effect on India's bilateral trade flows, when we use Tobit, random effect, and system GMM. The results are according to the literature (Kabir, and Salim, 2010; Anderson, 2011; Leitão et al., 2012; Faustino and Proença, 2011; Batra, 2004; De, 2013; and Bhattacharyya and Banerjee, 2006). The results conclude that higher GDP (for the country pairing) increases trade.

Geographical proximity variables: geographical distance between India and partner country ($LnDIST$) and border dummy ($BORDER$), both have the positive and statistically significant effect on India's bilateral trade in Tobit and random effect models. The positive effect of distance variable on India's bilateral trade does not support the findings of the past studies (Ghatak et al., 2009; Martinez-Zarzoso et al., 2003; Tharakan et al., 2005; Bhattacharyya and Banerjee; 2006; and Batra, 2004). The results indicate that the India's bilateral trade increases with geographical proximity only for the major trading partners.

Finally, the results show the political globalization ($LnPolKOF$) and cultural proximity ($LnCULT$) have a positive and significant influence in bilateral trade. The results are according

to the findings of Dreher (2008). The results are extremely important for recent India's bilateral trade direction and for reduction of uncertainty.

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