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## A study of the relation between the logistic performance index on India's trade

Dhairya Panchal

[dhairyapanchal1991@gmail.com](mailto:dhairyapanchal1991@gmail.com)

Parul University, Vadodara, Gujarat

Krupa Gadhavi

[gadhvikrupa00@gmail.com](mailto:gadhvikrupa00@gmail.com)

Parul University, Vadodara, Gujarat

Ashishkumar Bhatt

[Ashishkumar.bhatt@paruluniversity.ac.in](mailto:Ashishkumar.bhatt@paruluniversity.ac.in)

Parul University, Vadodara, Gujarat

### ABSTRACT

*Logistics and transport increasingly influence international trade. The Logistics Performance Index (LPI) compares customs procedures, logistics costs, and overland and maritime transport infrastructure between countries. This article uses a gravity model to analyze how these components affect trade in emerging economies. The study also compares 2007 and 2012 LPI data from developing countries in five regions (Africa, South America, the Far East, the Middle East, and Eastern Europe) to find logistics improvements. The results show that improving any LPI component can boost trade flows.*

**Keywords:** Logistics Performance Index, Trade, Gravity Model, India

### 1. INTRODUCTION

International trade is an old phenomenon that has become more common in modern times due to its ability to maximize mutual benefits. The growth of world trade has been driven by technological advancement in transportation and communication, political and economic cooperation between countries, and cost reduction in international shipping. This has led to a more integrated and interdependent global economy through globalization of production and markets. Specific causes for the growth include income growth, tariff rate reduction and preferential trade agreement, and transportation cost reduction.

In the period of 1960 to 1990, countries export share increased from 12 to 20 percent in industrial countries, from 16 to 28 percent in middle-income countries, and from 7 percent to 18 percent in low-income countries. Between 1995 and 2011, world trade increased due to the contribution of global supply chains to the global economy, entrance of new protagonist in global trade such as China, India, and diversification of export products. Trade is recognized as one of the means to meet sustainable growth and poverty reduction in developing countries, but Africa's export has experienced stagnation due to political and economic crisis. Transaction cost and quality of basic transport and communication infrastructures have a paramount contribution. Logistics is a part of Supply Chain Management, responsible for coordinating and optimizing logistics activities such as transport management, materials handling, warehousing, inventory management, as well as integrating logistics operations with other functions.

Improved trade logistics performance will increase trading countries' ability to respond to international orders at the right time with lower costs, leading to higher productivity gains.

International LPI is not a complete measure of trade logistics performance, so operational trade logistics cost measure and indicators proposed by World Bank are included. Third-party logistics service providers' selection criteria for international shipments include cost, relationship, services, and quality.

### 2. LITERATURE REVIEW

Government policy should consider analysis and management of the logistics infrastructure of the country as an aspect of its participation in international trade. The most relevant and accurate existing logistics-measuring tool is the LPI, AEMLI and GCII, and the accuracy of the GCII and LPI was determined through a statistical correlation check.

The size of the logistics sector is not clearly known, but Shepherd's (2011) analysis of 45 countries revealed that it accounts for 5% of GDP. Recent initiatives by the World Bank have made it possible to get a reasonable understanding of achievements in logistics at the national level. The World Bank's Overall Logistics Performance Index (LPI) is a weighted average of country scores covering six sub-dimensions of logistics performance.

It measures on-the-ground trade logistics performance, helping national leaders, key policymakers, and private sector traders understand the challenges they and their trading partners face in reducing logistical barriers to international commerce. There are significant gaps in logistics performance between the high-income group countries and the low and middle-income group of countries.

The logistics gap between the high-income and low-income economies has worsened since 2007, but the volume of world trade has increased more significantly than the rate of improvement in logistical infrastructure and services. This is due to the rise of developing economies trade due to their shift towards outward looking economic policies and advancements in new transport and communication technologies.

### **3. RESEARCH METHODOLOGY**

The methodology best suited to study the influence of logistics on trade flows is based on gravity equations. Tinbergen (1962) and Pöyhönen (1963a, b) pioneered the use of gravity models in international trade, and Bergstrand (1985, 1989) found theoretical grounds for bilateral trade.

Helpman and Krugman (1985) justified the gravity model by introducing nonuniform goods with increasing returns to scale. Otsuki et al. (2000) used a gravity equation to explain trade patterns between countries.

Anderson and Wincoop (2003) and Martínez- Zarzoso and Suárez-Burguet (2000) developed a theoretical model in which supply-side differences among countries determine international trade flows. Recent research has incorporated variables representing improvements in logistics into these models.

A gravity model considers that bilateral trade flows depend positively on the volume of income in both economies and negatively on the distance between them.

The gravity model used in this study for each area analyzed is structured as follows:

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist \\ + \beta_4 \ln(LPI_i) + \beta_5 \ln(LPI_j) + \beta_6 Dummy Variable + \delta$$

Where

*i* represents India and *j* represents partner country

$\ln GDP_{ij}$  = Natural logarithm of GDP of country *i* and *j*

$\ln Dist$  = Natural logarithm of bilateral distance between countries *i* and *j*

#### **Dummy Variables**

Comlang = Binary variable that takes the value 1 if countries have common official language, and 0 otherwise

Comborder = Binary variable that takes the value 1 if both countries share border, otherwise 0

Colony = Binary variable that takes the value 1 if countries were under the same colonizer, otherwise 0

Landlocked = Binary variable that takes the value 1 if both the country is landlocked, otherwise 0

Agreement = Binary variable that takes the value 1 if countries have trade agreement, otherwise 0

Exchange rate = Annual average of the national currency unit of India per US dollar /

Annual average of the national currency unit of country *j* per US dollar

Logistics performance index: Binary variables that takes the value 1 if partner countries LPI is greater than India (ie3.18), otherwise 0

According to Equation 1, exports depend on economic, geographic and demographic variables together with logistics variables. This approach is based on the hypothesis that the variables included in the model have a significant impact on trade and signs are coherent with economic theory. The distance variable is an approximate indication of trading costs.

The gravity model assumes that transport costs are independent of the medium used and that capital cities are a good approximation of economic centres. As a result, the following equations have been formulated:

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist \\ + \beta_4 \ln(customsi_i) + \beta_5 \ln(customsi_j) + \beta_6 Dummy Variable + \delta$$

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist + \beta_4 \ln(infrastructure_i) + \beta_5 \ln(infrastructure_j) + \beta_6 Dummy Variable + \delta$$

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist + \beta_4 \ln(international shipments_i) + \beta_5 \ln(international shipments_j) + \beta_6 Dummy Variable + \delta$$

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist + \beta_4 \ln(competence_i) + \beta_5 \ln(competence_j) + \beta_6 Dummy Variable + \delta$$

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist + \beta_4 \ln(LPI_i) + \beta_5 \ln(LPI_j) + \beta_6 Dummy Variable + \delta$$

$$T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Dist + \beta_4 \ln(tracking_i) + \beta_5 \ln(tracking_j) + \beta_6 Dummy Variable + \delta$$

Heckman (1979) proposed the Heckman two-step procedure to deal with zero bilateral trade, which can lead to selection bias if the gravity model is estimated by OLS. The inverse Mills ratio is used to measure the extent of the selection bias, and the estimated Mills ratio is included as another regressor in the original model.

#### 4. ANALYSIS

The three main models used to estimate panel data are pooled, random effects model (REM) and fixed effects model (FEM). FEM is selected if there is a correlation between individual effects and explanatory variables, while REM is more effective if individual effects are random and not correlated with explanatory variables. FEM cannot estimate invariant factors such as distance, so this study used pooled and random effects models for estimation.

#### Estimation of Result

Study had noted that most gravity models estimated over pairs of countries often for major portions of the world have an R2 of .60 or above. OLS estimates showed that the core gravity model can explain 65% of India's direction of trade, since all coefficients are significant. Overall, the gravity model performs well for India and both size and distance play important roles in shaping its direction of trade.

#### Coefficients

Table 1	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-30.690560	0.823525	-37.27	<2e-16 ***
GDPi	1.307004	0.034361	38.04	<2e-16 ***
GDPj	0.495824	0.006764	73.30	<2e-16 ***
DIST	-0.590906	0.039881	-14.82	<2e-16 ***
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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.699 on 4586, degrees of freedom Multiple R-squared: 0.6506, Adjusted R-squared: 0.6504 F-statistic: 2847 on 3 and 4586 DF, p-value: < 2.2e-16

#### Gravity Model with Dummy variables

As Study had noted that the value of R2 is 0.72 which increased from 0.65. Dummy variables included in the study have significant impact on India's trade except foreign exchange as FX is insignificant.

#### Coefficients

Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-2.928e+01	7.620e-01	-38.431	< 2e-16
*** GD	1.338e+00	3.068e-02	43.602	< 2e-16

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*** GDP 4.471e-01 7.115e-03 62.847 < 2e-16
*** DIST -8.024e-01 4.226e-02 -18.987 < 2e-16
*** LNG -2.320e-01 7.233e-02 -3.207 0.00135
** CONT -7.128e-01 1.388e-01 -5.135 2.94e-07
*** COL 1.028e+00 6.437e-02 15.974 < 2e-16
*** LL -9.910e-01 5.867e-02 -16.893 < 2e-16
*** AGR 2.174e-01 5.355e-02 4.059 5.01e-05
***
FX -4.638e-10 2.478e-09 -0.187 0.85152
LPI 1.149e+00 5.717e-02 20.094 < 2e-16 ***
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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
    
```

Residual standard error: 1.511 on 4579 degrees of freedom  
 Multiple R-squared: 0.7241,  
 Adjusted R-squared: 0.7235  
 F-statistic: 1202 on 10 and 4579 DF,  
 p-value: < 2.2e-1

### 5. FIXED EFFECT

Use fixed-effects (FE) whenever you are only interested in analyzing the impact of variables that vary over time. FE explores the relationship between predictor and outcome variables within an entity. Each entity has its own individual characteristics that may or may not influence the predictor variables.

Table 2: Fixed Effect

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-35.25831	5.234047	-6.736339	0.0000
GD	1.234117	0.037181	33.19246	0.0000
GDP	0.607228	0.045750	13.27277	0.0000
DIST	-0.046475	0.598692	-0.077628	0.9381

#### Effects Specification

Cross -section fixed (dummy variables)

R-squared	0.858438	Mean dependent var	-0.874339
Adjusted R-squared	0.852558	S.D. dependent var	2.872965
S.E. of regres sion	1.103165	Akaike info criterion	3.073506
Sum squared resid	5361.986	Schwarz criterion	3.331332
Log likelihood	-6869.696	Hannan-Quinn criter.	3.164262
F-statistic	146.0009	Durbin-Watson stat	0.832333
Prob(F-s tistic)	0.000000		

The study concluded that the best fitted model to measure India's trade direction after LPG policy (after1990) would be Random Effect model rather than Fixed or pooled effect model. Market size, logistics performance index, colonial heritage, reduction in cost and time involved in export and import transactions, and higher costs involved in import transactions are all important factors. India is one of the leading importers of the world and if we reduce the cost and motivate importers, India can perform better in re-export.

	Coefficien t	GDP India	GDP Partner	Dist.	R2	Adjusted R2
<b>Basic Model- OLS</b>	-30.69056	1.307004	0.495824	- 0.590906	0.6506	0.6504
<b>Augmented - OLS</b>	-2.93E+01	1.34E+00	4.47E-01	-8.02E-01	0.7241	0.7235
<b>Fixed Effect Model</b>	-35.25831	1.234117	0.607228	- 0.046475	0.8584 38	0.852558

<b>FGLS</b>	- 31.564703	1.343612	0.513591	- 0.609916	0.6896	0.6894
<b>Random Effect Model</b>	- 33.631605	1.329034	0.532867	- 0.366065	0.5662 6	0.566

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