The Determinants of India's Imports: A Gravity Model Approach

Wani, Mr. Nassir Ul Haq and Dhami, Dr. Jasdeep Kaur and Rehman, Dr. Afzal Ur

Bakhtar University and Lovely Professional University, CT Institute of management and Technology, Bakhtar University

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Mr. Nassir Ul Haq Wani
Professor & Doctoral Fellow
Bakhtar University, Kabul Afghanistan & Lovely Professional University, Punjab India
nassirtoiba786@gmail.com
0950080836, 09596115391

Dr. Jasdeep Kaur Dhami
Professor and Director
CT Institute of Management and Technology, Punjab India
bawa_mangat@yahoo.com
09988507007

Dr. Afzal Ur Rehman
Professor and Director Research
Bakhtar University, Kabul Afghanistan
afzal.indian@gmail.com

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Abstract

In order to understand the India's import trade with its partners, this paper applies the generalized gravity model to analyse the import structure by employing the panel data estimation technique. The results portray that India's imports are determined by the inflation rates, per capita income differentials and the overall openness of the countries involved in trade. It has been also found out that imports are influenced to a great degree by the common border, as the case is between India, China and Bangladesh. Furthermore, the country precise effects describe that the sway of neighbouring countries is more than that of distant countries on India's imports.

Keywords: *Gravity Model, Panel Data, India's Imports.*

JEL Classification: *C23, F10, F14.*

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I. Introduction:

For an economy to flourish in the global arena, foreign trade is considered as the fundamental part of the developmental effort and growth. In fact it is definitely a decisive mechanism for industrialization of the country in order to have access to valuable foreign exchange, as it is essential for sustained economic development of an economy. The trade relations of India with other countries, especially with SAARC countries, do not show any hopeful sign for the desirable contribution to country's economic development. The country's import payment is much higher than the export revenue and has thus become a great concern to policy makers in particular and the government of India in general. Although several studies have been done so far in regard to trade relations and trade policies of India, but there is not a comprehensive study which has explored and explained the determinants of India's import trade. In this regard, this paper is an endeavor to fill up this research gap.

In order to identify the major factors of India's imports, panel data estimation technique and generalised gravity model have been employed. The main output of this paper is to reaffirm a theoretical justification for using the gravity model in applied research of bilateral trade. In this connection this is the first sort of paper where panel data approach in a gravity model framework has been employed to identify the determinants of India's import trade.

The rest of the paper is organised as follows: In the next section II literature review is done in order to provide the theoretical justification of the gravity model; section III analyses the India's import trade using panel data and the gravity model; section IV provides understanding analysis of the model and finally section V concludes the paper.

II. Theoretical Justification of Literature Review:

As developed by Linneman (1966) gravity equation has been analysed in the light of a partial equilibrium model of export supply and import demand for the rationalization. The purpose of simplifying the model is to provide a base in a reduced form. Anderson (1979) also derives the gravity model which proposes identical Cobb-Douglas or constant elasticity of substitution (CES) preference functions for all economies and weakly separable utility functions between *traded* and *non-traded* goods. Furthermore, it is revealed that utility maximization with respect to income constraint gives *traded goods* shares that are functions of *traded goods* prices only. Prices are constant in cross-sections; so using the share relationships along with trade balance / imbalance identity, country j's imports of country i's goods are obtained. Then assuming log linear functions in income and population for traded goods shares, the gravity equation for aggregate imports is obtained. This method is also referred to trade share expenditure system.

Further rationalization for the gravity model approach is based on the Walrasian general equilibrium model, which states that each country has its own supply and demand functions for all goods. The factor of aggregate income determines the level of demand in the importing country and the level of supply in the exporting country (Oguledo and Macphee 1994). While Anderson's (ibid.) analysis is at the aggregate level, but Bergstrand (1985, 1989) develops a microeconomic foundation to the gravity model. He opines that a gravity model is a reduced form equation of a general equilibrium of demand and supply systems. Bergstrand argues that since the reduced form eliminates all endogenous variables out of the explanatory part of each equation, income and prices can also be used as explanatory variables of bilateral trade. Thus instead of substituting out all endogenous variables, Bergstrand (ibid.) treats income and certain price terms as exogenous and solves the general equilibrium system retaining these variables as explanatory variables. The resulting model is termed a "generalized" gravity equation (Krishnakumar 2002).

Eaton and Kortum (1997) have also derived the gravity equation from a Ricardian framework, while Deardorff (1998) derived it from a Hecksher-Ohlin (H-O) perspective. Deardorff opines that the H-O model is consistent with the gravity equations. As shown by Evenett and Keller (1998), the standard gravity equation can be obtained from the H-O model with both perfect and imperfect product specialization. Some assumptions different from increasing returns to scale, of course, are required for the empirical success of the model (Jakab *et al.* 2001). Economies of scale and technology differences are the explanatory factors of the comparative advantage instead of considering factor endowment as a basis of this advantage as in the H-O model (Krishnakumar 2002).

Hummels and Levinsohn (1993) used intra-industry trade data to test for the relevance of monopolistic competition in international trade. Their results show that much intra-industry trade is specific to country pairings. Thus their work supports a model of trade with monopolistic competition (Jakab *et al.* 2001).

Therefore, it is clear that the gravity equation can be derived assuming either perfect competition or a monopolistic market structure. Also neither increasing returns nor monopolistic competition is a necessary condition for its use if certain assumptions regarding the structure of both product and factor market hold (Jakab *et al*. 2001).

As trade theories just explain why countries trade in different products but they fail in explaining why some countries' trade links are stronger than others. Why the level of trade between countries tends to increase or decrease over time. This is the limitation of trade theories in explaining the size of trade flows. A remedy to the above problem is the gravity model as it allows more factors to be taken into account to explain the extent of trade as an aspect of international trade flows (Paas 2000).

III. Application of the Gravity Model in analyzing India's Import Trade

A. Sample Size and Data

The study covers a total of 35 countries. The countries are chosen on the basis of importance of trading partnership with India and availability of required data. Five countries of *SAARC* (out of seven countries) –Bangladesh, India, Nepal, Pakistan and Sri Lanka- are included. Bhutan and the Maldives are not included as these countries have no data for most of the years in our sample period. From the *ASEAN* countries, five countries- Indonesia, Malaysia, the Philippines, Singapore and Thailand- are included. From the *NAFTA*, three countries- Canada, Mexico and USA- are considered. Eleven countries are taken from the *EEC (EU)* group. These are Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Six *Middle East* countries such as Egypt, Iran, Kuwait, Saudi Arabia, Syrian Arab Republic and the United Arab Emirates are taken in the sample. Five *other* countries-Australia, New Zealand, Japan, China and Hong Kong- are also included in our sample for the analysis of India's trade.

The data collected is from 1995 to 2015 (20 years). All observations are annual. Data on GNP, GDP, GNP per capita, GDP per capita, population, inflation rates, total imports and CPI are obtained from the *World Development Indicators (WDI*) database of the World Bank. Data on exchange rates are obtained from the *International Financial Statistics (IFS),* CD-ROM database of International Monetary Fund (IMF). Data on India's imports of goods and services (country i's imports) from all other countries (country j) and India's total trade of goods and services (exports plus imports) with all other countries included in the sample are obtained from the *Direction of Trade Statistics Yearbook* (various issues) of IMF. Data on the distance (in kilometre) between New Delhi (capital of India) and other capital cities of country j has been assessed from indexmundi.com.

GNP, GDP, GNP per capita, GDP per capita are in constant 1995 US dollars. GNP, GDP, total exports, total imports, India's exports, India's imports and India's total trade are measured in million US dollars. Population of all countries are considered in million. Data on the exchange rates are available in national currency per US dollar for all countries. So these rates are converted into the country j's currency in terms of India's currency (country i's currency).

B. Methodology

The basic gravity model of trade simply describes that the trade flow between two countries is determined positively by each country's GDP, and inversely by the distance between them. This formulation can be generalized to

$$M_{ij} = K Y_i^{\beta} Y_j^{\gamma} D_{ij}^{\delta} \qquad (1)$$

where M_{ij} is the flow of imports into country i from country j , Y_i and Y_j are country i's and country j's GDPs and D_{ij} is the geographical distance between the countries' capitals.

The linear form of the model is as follows:

$$Log\,(M_{ij}) = \alpha + \beta \log (Y_i) + \gamma \log (Y_j) + \delta \log (D_{ij}) \qquad (2)$$

In classical gravity models, generally cross-section data was employed to estimate trade effects and trade relationships for a particular time period, for example one year. In reality, however, cross-section data observed over several time periods (panel data methodology) result in more useful information than cross-section data alone. The advantages of employing this method are: first, panels depict the relevant relationships among variables over time; second, monitor unobservable trading-partner-pairs individual effects. And if individual effects are correlated with the regressor's, OLS can be used for estimation, thus omitting individual effects.

The generalized gravity model of trade describes that the volume of imports between pairs of countries, M_{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,

$$Mij = \beta_0 Y_i^{\beta 1} Y_j^{\beta 2} N_i^{\beta 3} N_j^{\beta 4} D_{ij}^{\beta 5} A_{ij}^{\beta 6} U_{ij} \qquad (3)$$

Where Y_i (Y_j) indicates the GDP or GNP of the country i (j), N_i (N_j) are populations 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 βs are parameters of the model. Using per capita income instead of population, an alternative formulation of equation (3) can be written as

$$\boldsymbol{M_{ij} = \beta_0\, Y_i^{\beta 1}\, Y_j^{\beta 2}\, y_i^{\beta 3}\, y_j^{\beta 4}\, D_{ij}^{\beta 5}\, A_{ij}^{\beta 6}\, U_{ij}} \qquad \textbf{(4)}$$

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, model (4) in log-linear form in year t, is expressed as,

$$\boldsymbol{lM_{ijt} = \beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 lD_{ijt} + \sum \delta_h P_{ijht} + U_{ijt}} \qquad \textbf{\textit{(5)}}$$

Where *l* denotes variables in natural logs. P_{ijh} is a sum of preferential trade dummy variables. Dummy variable takes the value one when a certain condition is satisfied, zero otherwise.

In order to estimate gravity model of imports, Frankel (1993), Sharma and Chua (2000) and Hassan (2000, 2001 procedure has been employed. The model is:

$$\boldsymbol{lM_{ijt} = \beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 lD_{ijt} + \beta_6 lyd_{ijt} + \beta_7 lER_{ijt} + \beta_8 lIn_{it} + \beta_9 lIn_{jt} +}$$
$$\boldsymbol{\beta_{10}(EX/Y)_{jt} + \beta_{11}(TR/Y)_{it} + \beta_{12}(TR/Y)_{jt} + \sum \delta_h P_{ijht} + U_{ijt}} \qquad \textbf{\textit{(6)}}$$

Where, M = imports, Y=GDP, y = per capita GDP, D= distance, yd= per capita GDP differential, ER = exchange rate, In = inflation rate, EX/Y= export-GDP ratio, TR/ Y= trade-GDP ratio, P =preferential dummies. Dummies are: D1= j-SAARC, D2=j-ASEAN, D3= j-EEC, D4 = j-NAFTA, D5= j-Middle East, D6 = j- others and D7= $border_{ij}$, l= natural log.

Hypotheses

1. We expect positive signs for β_1, β_2, β_8, β_{10}, β_{11} and β_{12}.
2. We expect negative signs for β_5, β_7 and β_9
3. Signs may be positive or negative for β_3, β_4 and β_6. The reasons for ambiguity are: If there is higher per capita income and country i enjoys economies of scale effect, then β_3 would be negative; alternatively due to absorption effect if the country i imports more, then β_3 would be positive. Similarly, if country j demands more country j's goods due to higher income (absorption effect), β_4 would be negative; on the other hand, due to economies of scale effect in country j, if more goods are produced in country j, then β_4 would be

positive. β_6 would be positive if the H - O hypothesis holds and negative if the Linder hypothesis holds.(All these possibilities are probable because of the trade theories)

In the estimation, unbalanced panel data and individual effects are included in the regressions. Therefore, a decision is to be taken as whether they are treated as fixed or as random. From the regression results of the panel estimation, the results of LM test and Hausman test [in the REM of Panel estimation suggest that FEM of panel estimation is the appropriate model for the paper.

There is, of course, a problem with FEM. It is not possible to estimate variables directly that does not change over time because inherent transformation wipes out such variables. Distance and dummy variables in our aforesaid models are such variables. However, this problem can easily be solved by estimating these variables in a second step, running another regression with the individual effects as the dependent variable and distance and dummies as independent variables,

$$\mathbf{IE_{ij}} = \beta_0 + \beta_1 \mathbf{Distance_{ij}} + \sum \delta_h P_{ijh} + V_{ij} \qquad (7)$$

Where IE_{ij} are the individual effects.

C. Estimates of Gravity Equations, Model Selection and Discussion of results

Estimation and Model selection

The gravity model of India's imports, the equation (6) above, has been estimated taking all variables except distance and dummy variables. The model covers all countries of our sample constituting 1290 observations. In the estimation process only GDP_j, per capita GDP $differential_{ij}$, $inflation_i$, $inflation_j$, $trade/GDP_i$, and $trade/GDP_j$ are found to be significant. All other variables are found either insignificant or have wrong signs. While multicollinearity of these variables is being tested, GDP_j variable is found to have problem. So omitting this variable from the model, there are now only five explanatory variables, which are significant with the correct signs. Therefore, the preferred estimated gravity model of imports is:

$$lM_{ijt} = \beta_0 + \beta_6 lyd_{ijt} + \beta_8 lIn_{it} + \beta_9 lIn_{jt} + \beta_{11}(TR/Y)_{it} + \beta_{12}(TR/Y)_{jt} \qquad (8)$$

The detail results of the heteroscedasticity corrected model are shown in Table 1. The country specific effects of the heteroscedasticity corrected model are shown in Table 1(A). The estimation results of unchanged variables for equation (6) above -that is equation (7) - are noted in Table 2. The auto-correlated error structured model also gives similar results. All variables are tested for multicollinearity; the model does not have any multicollinearity problem.

Discussion of Results

In the model, the intercept terms α_{0i} and β_{0i} are considered to be country specific, and the slope coefficients are considered to be the same for all countries. Per capita GDP differential has positive sign which supports the H – O hypothesis (see Table 1). With 1 per cent increase of this variable, imports of India increase by 1.29 per cent. Imports of India are also positively responsive with the inflation of India and negatively responsive with the inflation of country j. The inflation elasticities of imports are 0.18 and –0.35 respectively for India and country j. The openness variables of India and country j are also major determining factors of India's imports. Both variables are highly significant and have positive influences on India's imports. The estimated results show that with 1 per cent increase of trade-GDP ratio of India, other things being equal, has an effect of 29.37 per cent increase of its imports [exp(3.38)=29.37]. An increase of 1 per cent increase trade-GDP ratio of country j leads to increase of 1.79 per cent imports of India [exp (.58) =1.79]. Thus it is clear that liberalization of trade barriers from both sides is essential.

Table 1: Hetero Corrected Fixed Effects Models with Group Dummy Variables.

Variables	**Import Model**
$(TR/GDP)_i$	5.38 (9.40)
$(TR/GDP)_j$	0.81 (6.97)
Log ($PCGDPD_{ij}$)	1.29 (6.87)
Log ($Infl_i$)	0.18 (2.46)
Log ($Infl_j$)	-0.35 (-3.24)
R^2	0.79
F	89.67[38,860]
Observations	899

Note: t- ratios are noted in parentheses.

Table 1 A: Country Specific Effects

Estimated Fixed Effects					
Country	**Coefficient**	**t-ratio**	**Country**	**Coefficient**	**t-ratio**
Bangladesh	0.59693	3.75412	Denmark	-2.84402	-6.40894
Nepal	-0.63586	-4.92411	France	-2.45038	-5.75066
Pakistan	-0.86768	-3.91459	Germany	-2.09445	-4.69577
Sri Lanka	-2.02300	-8.22451	Greece	-3.60681	-9.15776
Indonesia	-1.45216	-5.55482	Italy	-2.74619	-6.67274
Malaysia	-2.37158	-7.26383	Netherlands	-2.65128	-6.36544
Philippines	-2.73135	-9.42516	Portugal	-3.91391	-10.21942
Singapore	-3.59527	-8.33553	Australia	-2.04959	-4.92444
Thailand	-1.80805	-5.94157	New Zealand	-3.19077	-7.73325
Canada	2.07663	-5.04592	Japan	-1.55073	-3.50440
Mexico	-3.07308	-8.81888	China	0.00304	.02090
USA	-1.44102	-3.34354	Hong Kong	-3.13849	-2.53261
Belgium	-3.53605	- 8.49176	Iran	-2.04850	-6.52422
Spain	-3.30586	-8.21573	Kuwait	-3.12937	-7.74684
Sweden	-2.70006	-6.34331	Saudi Arabia	-2.16190	-5.74465
United Kingdom	-1.89176	-4.61686	Syrian A.R.	-2.85223	-9.91274
Egypt	-2.46892	-8.95812	U.A.E	2.45280	5.74590

Source: Calculations generated through E-Views 6.

In terms of country specific effects, all effects except Bangladesh and China are significant [From Table 1 (A)]. From the estimated results it is observed that India's import propensity is the lowest from Portugal followed by Greece, Singapore, Belgium, Spain, etc., and it is the highest from EU, NAFTA followed by China and ASEAN where as Nepal, Pakistan, USA, Indonesia etc are less (not significant), etc.

The goodness of fit of the model, R^2 = 0.79, and F [38, 860] = 87.37.There is no multicollinearity problem among the explanatory variables. The autocorrelated error structured model also gives more or less similar results with regards to magnitudes and signs.

Table 2 depicts the effects of distance and dummy variables on the India's imports. Only border dummy is found to be significant at 5 per cent level. The coefficient value is 1.68 which indicates that India's import trade with Bangladesh is 5.37 times higher and with China 1.87 times just because of common border [exp(1.68) = 5.37].

Table 2: Cross-Section Results of the Distance and Dummy Variables. Dependent Variable is Country Specific Effect.

Variables	**Import Model**
Distance	-0.56 (-0.71)

ij Border	1.68 (1.89)
J-SAARC	0.75 (0.30)
J-ASEAN	0.47 (0.02)
J-EEC	-0.27 (-0.09)
J-NAFTA	0.48 (0.15)
J-Middle East	-0.84 (-0.03)
J- others	0.53 (0.18)
R^2	0.47
F	3.24[7,26]
Observations	34

Note: t-ratios are shown in the parentheses.

IV. Understanding Analysis of the Model

For understanding the analysis of the gravity model the methodology of Yamarik and Ghosh (2005) has been employed. For testing the robustness of coefficient estimates, extreme bounds sensitivity analysis has been used. Sensitivity analysis includes three types of explanatory variables identified and labelled as ***I*** variables, ***M*** variables and ***Z*** variables. ***I*** represents a set of variables always included in the regression (set of core variables), ***M*** includes the variable of interest and ***Z*** are a subset of variables chosen from a pool of variables identified by past studies as potentially important explanatory variables. Thus, if T denotes bilateral import trade, the equation for the sensitivity analysis of the gravity model of trade would be as follows:

$$\mathbf{T = \beta_0 + \beta_i I + \beta_m M + \beta_z Z + u} \qquad \mathbf{(9)}$$

Where *u* is a random disturbance term.

To perform sensitivity analysis, first a "base" regression for each M variable is run including only the ***I*** –variables and the variable of interest as regressors. That is, the above equation is estimated for each ***M*** variable imposing the constraint $\beta_z = 0$. Then regression is made of **T** on I**,** ***M*** and all ***Z*** variables (or all estimating combinations of the ***Z*** variables taken two at a time) and identification is made of the highest and lowest values for the coefficient on the variable of interest, β_m, which is significant. Thus these are defined as the extreme upper and lower bounds of $\beta_{m..}$. If β_m remains significant and of the same sign at each of the extreme bounds, thus the result can be referred to as "robust" and if β_m does not remain significant or if it changes sign at one of the extreme bounds, then the result can be referred to as "fragile".

Estimation strategy and results of the Sensitivity Analysis

The estimation strategy must take into consideration the cross-sectional and time-series information in the data in order to make optimal use of the available data. One way could be that all the observations would be treated as equal and a pooled model would be estimated using OLS. The requirement for this strategy is a constant coefficient across time. Another approach could be to allow for country-pair heterogeneity in the regression, and then incorporating it either through bilateral country-specific effects or individual country-specific effects. However, the inclusion of country specific effects, one cannot estimate many time-invariant variables like distance, common border, etc. As the objective for sensitivity analysis is to test the robustness of the variables, including those that are time-invariant, the first estimation strategy was therefore chosen.

The results of the sensitivity analysis have been depicted in Table 3. There are 6 variables of interest in the Import Model. For each variable, three regression results are reported. These are the base model, the extreme upper bound and the extreme lower bound. The regression results include the estimated coefficient (estimated β_m), the t-statistics, the R-squared and the controlled variables, Z, included in each regression. The Extreme Bound Analysis result- fragile or robust- of each variable of interest is reported in the last column. It is found that all variables, except (Trade/GDP)i and $Border_{ij,}$ are robust .

Table 3: Results of the Extreme Bounds Sensitivity Analysis

Variables of Interest					
_Coefficient		t-statistic	R^2	Control Variable(s)	Results
log($PCGDPD_{ij}$)	High	0.3331	12.15	0.53 $Border_{ij}$, $(TR/GDP)_i$	
	Base	0.3033	11.45	0.53	robust
	Low	0.1476	4.64	0.57 log($Infl_j$), $(TR/GDP)_j$	
log($Infl_j$),	High	0.1011	2.13	0.50 $(TR/GDP)_i$, log($Infl_j$)	
	Base	0.0677	1.40	0.46	robust
	Low	0.0684	1.53	0.54 $Border_{ij}$, $(TR/GDP)_j$	
log($Infl_j$),	High	-0.3315	-6.80	0.57$(TR/GDP)_j$, log($PCGDPD_{ij}$)	
	Base	-0.4616	-9.02	0.50	robust
	Low	-0.4785	-9.28	0.51 $Border_{ij}$, log($Infl_j$)	
$(TR/GDP)_i$	High	0.9522	1.28	0.52 log($PCGDPD_{ij}$), log($Infl_i$)	
	Base	0.5000	0.64	0.46	fragile
	Low	0.0071	0.01	0.50 $Border_{ij}$, log($Infl_j$)	
$(TR/GDP)_j$	High	0.4191	12.60	0.54 $Border_{ij}$, $(TR/GDP)_i$	
	Base	0.4062	12.35	0.54	robust
	Low	0.2507	6.29	0.57 log($PCGDPD_{ij}$), log($Infl_j$)	
$Border_{ij}$	High	0.5910	4.41	0.56 log($PCGDPD_{ij}$), log($Infl_j$)	
	Base	0.0422	0.30	0.46	fragile
	Low	0.0422	0.30	0.46 $(TR/GDP)_i$, log($Infl_i$)	

Note: *Significant at 10% probability level

Source: Results generated through E Views 6.0

V. Conclusion

Thus the findings of this paper have established that the application of the gravity model in applied research of bilateral trade is theoretically justified. There are wide ranges of applied research where the gravity model is used to examine the bilateral trade patterns and trade relationships.

The results show India's imports are determined by the inflation rates, per capita income differentials and openness of the countries involved in trade. Exchange rate, on the other hand, has minimum influence on India's imports. The country specific effects imply that neighbouring countries have greater influences on India's imports. Also India's import is found to be influenced to a great extent by the border between China and Bangladesh. However, per capita income differential supports both the H-O hypothesis and Linder hypothesis. This is somewhat conflicting result obtained from the country specific effects. It may be the case that per capita income differential is not the proper representation of the factor endowment differential. Also the H-O hypothesis assumes zero transportation cost and perfect competition which are unrealistic.

The policy implications of the results obtained are that tight monetary and fiscal policy must be undertaken to reduce domestic inflation as it positively influences the country's imports. The country should be more open with regard to import of capital goods which in turn would increase the export capacity. Attempts must be undertaken to increase the India's exports especially to the neighboring countries like SAARC. To this end exports must be diversified and price competitive with improved quality to get access in these markets.

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