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India's Global Trade Potential: the Gravity Model Approach

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Abstract
Merchandise trade has always been a crucial determinant of the GDP. Despite having major offsets due to the Corona pandemic which contracted India's GDP by 7.8% in FY20-21. India had witnessed a growth of about 1.6% in Q4. Recently, India has put up a target of achieving $400 billion as merchandise exports for FY2021-22 as stated by the Commerce and Industry Minister, Piyush Goyal who stated " In collaboration with private industry, MSME sector, engineering, agriculture, automobile, and the steel sector, we have set an export target of USD 400 billion". In this paper I will carry out the estimation of trade potential for India in regards to its top 25 exporting nations and try to realistically calculate and estimate the possibility of India achieving this target of $400 billion using the Gravity Model approach. I plan to use data sets of the year 2020 and other factors which influence trade to predict the escalation trends of merchandise exports while taking into consideration all exogenous variables that might have offset the expected growth path of merchandise export. This shall further have policy implications which can be put to use as I will be able to clearly define and suggest as to which country's policies should particularly be modified to reach maximum potential and expectantly even break the $400 billion barrier for the FY2022-2023.This paper through the model focuses on the FY2020-2021 Data of India with its top 30 exporting countries and conclude to see if there is scope of increasing trade. (Since data for FY 2021-2022 hasn't yet been released) and try to predict trends for further expansion of trade exports of India.

Keywords*: India's global trade potential, Gravity model approach, India's exports , India's growing economy*

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I. Introduction:

Merchandise exports have been a major component in the GDP determination of India ever since 1991. Crucial programmes post 1991 have lead to an increase in overall trade. This can further be proven by an empirical increase in trade to GDP ratio in India. From a pre -reform ratio (1980-1991) of 14 per cent, trade to GDP ratio increased to 23 per cent in the period of reforms (1991-2003).Nonetheless, India's overall share in world trade is still low and appears unimpressive when compared with its surrounding/ neighbouring countries such as China, Bangladesh or even Vietnam which has significantly increased its trade in recent years . India's share in world trade in the year fell to 3.6% of the world per cent from a 3.9% in 2018. In comparison, China averages about 15 per cent of world trade and countries like Japan and Korea given their size contribute a significant per cent of share in the total world trade. There is, therefore, a very clear need to enhance the volume of India's trade with the rest of the world. In this context an estimation of India's trade potential is appropriate in order to see where there is still potential to improve India's trade.

The aim of this paper is to estimate trade potential for India using the gravity model approach. Gravity model is one the most widely used models for predicting for bilateral trade flows. We use the gravity model to first analyze the world trade flows for the year 2020.The remainder of the paper is organized as follows. Section Ⅰ gives a brief introduction about the model used and the methodology used to calculate the co-efficients. The coefficients thus obtained are applied in the formula and thus trade potential for India is estimated. This paper focuses on the top 25 importers of India and analyses if our exports to these countries in regards to the predicted value of trade analysed using the Gravity Model Approach. Section Ⅱ focuses on the methodology used to calculate the final output and the output obtained. Section Ⅲ focuses on policy implications given the outputs, post which the conclusion is presented given the top 25 nations India exports to.

II. Theoretical framework

In economic theory, Adam Smith, the English economist, gave the idea that countries should produce the goods they have an absolute advantage in and then all countries should indulge in trade as it would ensure a positive gain for all countries. This argument was however flawed as is failed to give a reason as to why countries which do not have an absolute advantage still get benefits from trade. This was however answered by David Ricardo who stated that a nation gets its gains from trade by exporting the goods in which it the highest comparative advantage in productivity and importing the goods in which it has the least comparative advantage" . Heckscher-Ohlin model which evolved from Ricardo's is enhanced by adding capital and land alongside labour and fundamental factors. The Heckscher-Ohlin model predicts that a country will export products which utilise materials which they have in abundance and import the products of which they have scarcity.

A major flaw of classical trade theories is that they indicate that countries which are less similar tend to trade more and is thus unable to explain why there is huge amount of trade between countries which have similar endowment and resources. Thus the new trade theories which have evolved focus on how the world trade is based upon the imperfect competition among nations , economies of scale and even product differentiation theories that can be found in modern day trade as more and more products are evolving.

This model is evolved from the physics gravitational equation which says that the gravitational attraction between two objects is proportional to their respective masses and is inversely proportional to the square of their distances.

The gravity model is represented as follow:

$$\textbf{Fij: } \frac{MiMj}{Dij}\textbf{G}$$

Where:

- Fij is the attraction between two objects (gravitational attraction)
- $Mi$and Mj refer to the mass of the two objects
- Dij is the distance
- G is the gravitational constant

Timbergen , a Dutch economist, was the first who applied gravity model to analyse trade flows between countries . In his model , his result showed that opposite to distance, the GDP variable has a rather positive effect on the trade flow between two countries, which means countries with larger economic sizes and closer distance tend to trade more with each other.

Krugman and Obstfeld (2005) also utilized the gravity model for trade activities and they provides a common model which we are going to follow:

$$\boldsymbol{Tij = A}\frac{YiYj}{Dij}$$

Where:

- Tij is the total trade from country 'i' to country 'j'
- Yi ,Yj are the economic size of two country 'i' and 'j'. Yi ,Yj is equal to the gross domestic product (GDP) of both countries
- Dij is the distance between the two countries
- A is a constant term.

After first research of Timbergen, a trend began where other economists started applying gravity model with similar purposes. Martínez-Zarzoso and NowakLehmann (2004) used the gravity model to assess the Mercosur-European Union trade and the trade potential following the agreements reached between both trade blocs. Their estimated results, a more complex version of the Timbergens model, indicate a number of variables, namely, infrastructure, income differences and exchange rates added to the standard gravity equation, are found to be important factors determining and affecting bilateral trade flows.

III. Methodology And Statistical Variables

In the model stated above, only two independent variables are used , GDP and distances. The model in this paper is further enhanced by adding the variables of contiguity, distance, trade and PTA's and common languages that affect bilateral trade between India and the partner countries. Based on the above theoretical explanation of the model, the following hypotheses are advanced:

1: There is a positive effect of economic size(GDP) on trade.

2: There is a negative effect of geographical distance(as costs increase) on trade.

The gravity model is estimated in a logarithm format in this model as follows:

$\log Tijt = \alpha 1 \log(Yit) + \alpha 2 \log(\text{Yjt}) + \alpha 3 \log(Dij) + + \alpha 4(Cij) + \alpha 5(Pijt) + eijt$

Where:

- i = 1 (India) j = 2, 3, 4,... (partner countries) t = 2020
- Tijt : India's potential trade with country j in year t
- Yit: India's GDP in year t
- Yjt : GDP of 'J' country in the year 't'
- Dij: Distance in kilometers between India and country j(capital of country J)
- Cij: Contiguity variable for the cultural gap between India and country j
- Pijt : Strategic partner dummy variable for the strategic partnership between India and country j in year t (PTA agreements in place)
- Eijt : common languages

Gross domestic product of India and partner countries are used as measure of economic size. Both these variables have a positive impact on the trade promotion. Data regarding the GDP's are sourced from the International Monetary Fund (IMF).
EX:ij is used to measure the existing trade India has done with that country.
P is used to estimate the PTA in place with India and that country. A PTA agreement in place is expected to turn out with positive sign
Distance in our case is done to keep in mind the transportation costs in international trade. It is calculated in kilometers from Delhi, the capital of India, to the capitals of other countries. Data on distance between capitals is taken from (Byers, 1997; website: www.chemical-ecology.net). This variable will have a a negative impact on trade flows because the farther the nation, the higher the transportation costs thus discouraging trade between the two nations.

The calculation is done using python libraries GEGRAVITY and PANDA libraries. Co-efficients calculated are presented in Appendix 1.0 at the end. Post which further calculation is done to calculate the percentage difference between the existing level of trade and the potential trade for each country individually. In cases where the percentage is negative, is shows that there is still room for improvement in the trade outflow of India and that country.

NOTE: Python code used for estimation can be provided if necessary

FINAL ESTIMATION RESULTS:

EXPORTER	IMPORTER	DIFFERENCE OF PREDICTED TRADE AND ACTUAL TRADE
INDIA	AUSTRALIA	-0.732%
INDIA	AUSTRIA	-1.1484%
INDIA	BELGIUM	-1.1948%
INDIA	BRAZIL	-1.67381%
INDIA	CANADA	-1.2313
INDIA	SWITZERLAND	+0.92221%
INDIA	GERMANY	+1.0377%
INDIA	DENMARK	+0.5902%
INDIA	SPAIN	-1.7965%
INDIA	FINLAND	-0.99708%
INDIA	FRANCE	-0.8065%
INDIA	GREAT BRITAIN	+0.1004%
INDIA	INDONESIA	-1.7765%
INDIA	IRELAND	+0.4449%
INDIA	ITALY	+1.1651%
INDIA	JAPAN	+0.95039%
INDIA	KOREA	-1.5326%
INDIA	MEXICO	-1.96522%
INDIA	MALAYSIA	-0.9691%
INDIA	NETHERLANDS	+1.001%
INDIA	POLAND	-0.7399%
INDIA	SINGAPORE	-1.10173%
INDIA	USA	-0.2321%

INDIA	CHINA	+0.9671%
INDIA	HONG KONG	+1.7765%

IV. Policy Implications(Discussion):

- As we can see from the table above, most countries infact have less than predicted trade with India. From a policy perspective India in the coming time is going to face more competition as RCEP came into force this year and it will seriously impact the trade volume India has with its neighbours. India as a nation has to now prioritise its trade relations especially with South American nation. Such an example can be seen above as there is a major lack in trade with countries like Mexico and Brazil (in India's top 25 exporting nations). This has to be done to counterbalance PTA's which will come into effect post RCEP. Specifically region wise, analysis shows that India has been able to utilise its good relations with EU and has been able to maximise its trade even above the predicted level. Such can be seen from countries like Italy, Netherlands , Switzerland , Germany etc. all of which have witnessed exports from India above the predicted level through the Gravity Model. If we are to analyse the overall list of the 25 countries, we find no Middle-Eastern or African country present in the list. Both these regions which are rich in resources really show an untapped region to generate more exports from India and certainly going to expand in the future as both these regions are currently witnessing major economic booms despite some externalities eg, civil wars and territorial disputes. On a macroeconomic level, India definitely has more potential to increase its exports to surpass its mark of $400 billion as was stated by the Commerce and Industry Minister , Piyush Goyal. On an estimate, India's export for FY2020-2021 should be $385 billion(estimated by Commerce and Industry Ministry) and may also just surpass the $400 billion mark, but as estimated if India increases its overall exports even by 4 percent in FY 2022- 2023 it will easily be able to surpass the $400 billion mark. The main policy that has to be focused in a summary is
- Expanding trade in 2 major regions : Middle East and Africa
- Create PTA's in Asia so as to combat the post RCEP trade direction changes.
- Expand trade in South American countries as most countries are trading much below their potential.

Making necessary changes along the 3 solutions mentioned above should be able to gurantee India an export amount of more than $400 billion.

V. Conclusion:

The main purpose of this study is to take into account the factors which affect the bilateral trade flows between India and partner countries around the world and review the untapped potential for trade growth between India and those countries. Gravity model in this paper was estimated with the data from 25 countries in the year 2020. Estimation results indicate that bilateral trade flows between India and partners are mainly affected by the economic size, geographical distance and national culture.

Our estimates of India's global trade potential reveal that the magnitude of India's trade potential is maximum in the EU region followed by Western Europe and North America. Potential for expansion of trade is highest with countries like Brazil and Mexico (in top 25 countries India exports to)

This study also has some limitations. It is limited in the data when some other areas in the world has not been observed and included in the research as we are limited to only 25 countries in this very analysis. Other than this, there are a lot of various other factors that affect bilateral trade that haven't been included due to external limitations.

In the future, a study with large scale data of space and time should be conducted, and will certainly give a universal result and fewer errors. However, this paper, in my opinion, provides an interesting result and may help policy makers to obtain the clearer view of trade improvements trend of India in the coming periods knowing what all regions to tap considering all externalities possible.

APPENDIX 1.0- data used in estimation

exporter	importer	year	trade	Y	E	pta	contiguity	common_language	lndist	internationa
IND	AUS	2020	2440	2660245	1327836	0	0	1	9.1455	1
IND	AUT	2020	442.9	2660245	49000	0	0	0	8.7407	1
IND	BEL	2020	763	2660245	521861	0	0	0	8.8615	1
IND	BRA	2020	7020	2660245	1444733	1	0	1	9.5554	1
IND	CAN	2020	1013	2660245	1664037	0	0	1	9.3976	1
IND	CHE	2020	3500	2660245	752248	0	0	1	8.8311	1
IND	CHN	2020	125700	2660245	14722730	0	1	0	8.2693	1
IND	DEU	2020	12080	2660245	3846413	0	0	0	8.8139	1
IND	DNK	2020	1400	2660245	356084	0	0	1	8.7956	1
IND	ESP	2020	5010	2660245	1281484	1	0	0	8.9599	1
IND	FIN	2020	687	2660245	269751	0	0	0	8.7021	1
IND	FRA	2020	9040	2660245	2630317	0	0	0	8.8974	1
IND	GBR	2020	12480	2660245	2764197	0	0	1	8.9149	1
IND	HKG	2020	7730	2660245	346585	0	0	1	8.2249	1
IND	IDN	2020	1740	2660245	1058423	1	0	1	8.4147	1
IND	IRL	2020	4200	2660245	425888	0	0	1	8.9619	1
IND	ITA	2020	5700	2660245	1888709	0	0	0	8.7805	1
IND	JPN	2020	75000	2660245	5057758	0	0	0	8.685	1
IND	KOR	2020	16900	2660245	1637895	1	0	1	8.5224	1
IND	MEX	2020	10150	2660245	1073915	1	0	0	9.6234	1
IND	MYS	2020	16140	2660245	337006	1	0	1	8.1536	1
IND	NLD	2020	13000	2660245	913865	0	0	0	8.8562	1
IND	POL	2020	1550	2660245	596624	0	0	0	8.7074	1
IND	SGP	2020	23669	2660245	339998	1	0	1	8.1948	1
IND	SWE	2020	964	2660245	541220	0	0	0	8.7665	1
IND	THA	2020	11087	2660245	501643	1	0	1	7.869	1
IND	TUR	2020	3640	2660245	304866	0	0	0	8.4756	1
IND	USA	2020	80550	2660245	20936692	0	0	1	9.4851	1
IND	ZAF	2020	1569	2660245	335442	0	0	1	8.9766	1

Appendix 1.1 - Coefficient Results

Generalized Linear Model Regression Results

Dep. Variable:	trade	No. Iterations:	7
Model:	GLM	Df Residuals:	3
Model Family:	Poisson	Df Model:	23
Link Function:	Log	Scale:	1.0000
Method:	IRLS	Log-Likelihood:	-10230.
Covariance Type:	HC1	Deviance:	20181.
No. Observations:	27	Pearson chi2:	2.28e+04

	coef	std err	t	P>|t|	[0.025	0.975]
pta	8.9321	2.258	3.956	0.000	1.746	16.118
common_language	-2.1010	1.010	-2.081	0.037	-5.314	1.112
lndist	6.7463	1.407	4.793	0.000	2.267	11.225
international	-50.6040	12.446	-4.066	0.000	-90.212	-10.996
importer_fe_AUS	-1.1933	0.462	-2.585	0.010	-2.662	0.276
importer_fe_BEL	-2.5408	0.465	-5.459	0.000	-4.022	-1.060
importer_fe_BRA	-11.8339	2.373	-4.986	0.000	-19.387	-4.280
importer_fe_CAN	-3.7731	0.108	-35.028	0.000	-4.116	-3.430
importer_fe_CHE	1.2885	0.904	1.425	0.154	-1.588	4.165
importer_fe_DNK	0.6117	0.954	0.641	0.521	-2.424	3.647
importer_fe_ESP	-10.2548	2.475	-4.143	0.000	-18.132	-2.377
importer_fe_FIN	-1.5704	0.501	-3.132	0.002	-3.166	0.025
importer_fe_GBR	1.9945	0.786	2.538	0.011	-0.507	4.496
importer_fe_HKG	6.1704	1.757	3.512	0.000	0.579	11.762
importer_fe_IDN	-5.5333	0.768	-7.205	0.000	-7.978	-3.089
importer_fe_IRL	0.5884	0.720	0.817	0.414	-1.703	2.879
importer_fe_ITA	0.0166	0.471	0.035	0.972	-1.482	1.515
importer_fe_JPN	3.2379	0.511	6.337	0.000	1.612	4.864
importer_fe_KOR	-3.9865	0.920	-4.335	0.000	-6.913	-1.060
importer_fe_MEX	-14.0249	3.397	-4.129	0.000	-24.836	-3.214
importer_fe_MYS	-1.5445	0.401	-3.856	0.000	-2.819	-0.270
importer_fe_NLD	0.3304	0.465	0.711	0.477	-1.149	1.810
importer_fe_POL	-0.7925	0.499	-1.589	0.112	-2.379	0.794
importer_fe_SGP	-1.4395	0.459	-3.139	0.002	-2.899	0.020
importer_fe_DEU	0.8187	0.882	0.929	0.353	-10.384	12.021
importer_fe_CHN	17.0111	0.590	28.836	0.000	15.853	18.169
importer_fe_USA	18.1149	0.563	32.188	0.000	17.010	19.220
importer_fe_AUT	-2.5378	0.431	-5.883	0.000	-4.394	-0.682
importer_fe_FRA	-0.5512	0.400	-1.377	0.168	-2.273	1.171

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