# **Factors affecting trade competitiveness of BRICS countries**

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#### Abstract

**Objectives:** To examine the trade competitiveness of BRICS countries (Brazil, Russia, India, China and South Africa) and position of India among BRICS countries.

**Methods/Statistical analysis:** The paper has used secondary data for 12 indicators (i.e. trade balance-GDP, exports-imports and trade balance-total trade ratio, RCA, share of manufactured export, other manufactured goods, machinery & transport equipment and chemicals in total exports, share in world merchandise exports, intra industry trade and exports-GDP and trade-GDP ratio). Trade competitiveness of BRICS countries was examined by applying technique of factor-analysis and composite index for the three points of time 1995, 2005 and 2015.

**Findings:** 12 indicators of trade competitiveness found the relative position of India among BRICS countries. India has experienced increase in share in world exports in 2015 and India has competitiveness in the exports of manufactured goods, chemicals and other manufactured goods among the BRICS countries. But India is not globally open economy as compared to China and its trade was found to be in deficit in all the study points. Based on 12 indicator of trade competitiveness, composite index found China as the most competitive country followed by Russia, South Africa and Brazil. India was found to be the least competitive country among BRICS countries.

**Application/Improvements:** As India could not improve its position among BRICS countries, there is a need to adopt import liberalization strategy for promotion of exports to reduce trade deficit. Further, Export-led growth strategy should be followed to increase exports.

Keywords: Factor analysis, Trade, Competiveness, Composite Index, BRICS.

#### 1. Introduction

The BRICS is an abbreviation for Brazil, Russia, India, China and South Africa. This is an association of developing economies. South Africa joined in 2010. Prior to this the acronym was "BRICs". The term was formed by Jim O' Neill, who was chairman of Goldman Sachs in 2001, in his paper 'Building Better Global Economic BRICs'. All the BRICS nations are industrially developed and indicate rapid growth both at the regional and global level. Though the physical areas of the countries vary but the marked rise in their respective and global standards is significant. All the five member countries are also part of G-20. South Korea, Turkey and Mexico are also part of BRICS, though their initials do not reflect in the acronym.

Since its establishment BRICS has diversified into areas like National Security, Foreign Affairs, Economy, Trade, Labor and Employment, Finance, Science and Technology, Education, Culture, Health, Agriculture, Business and Disaster Management.

This, paper seeks to examine trade competiveness of BRICS countries by using factor analysis technique during the period 1995-2015.

To study trade competitiveness, data for exports and imports, GDP, exports of manufactures for BRICS countries have been obtained from UNCTAD Handbook of Statistics, UN Trade com and World Development Indicators for two points of time 1995 and 2015.

To measure the competitiveness of BRICS countries, 12 indicators have been considered. These are:

- 1. Export-GDP Ratio (X/GDP),
- 2. Trade-GDP Ratio (T/GDP),
- 3. Trade Balance-GDP Ratio (TB/GDP),
- 4. Export-Import Ratio (X/M),
- 5. Trade Balance-Total Trade Ratio (TB/TT),
- 6. Grubel-Lloyd Index (Intra-industry index) (IIT),
- 7. Share of Manufactured Exports in Merchandised Exports (MG/X)
- 8. Revealed Comparative Advantage (RCA) of Manufactured Exports
- 9. Share of Chemicals in Merchandised Exports (CX /X)
- 10. Share of Machinery & Transport Equipment in Merchandised Exports (MT/X)
- 11. Share of Other Manufactured Goods in Merchandised Exports (OMG /X)
- 12. Share in World Merchandise Exports (X/WX)

To examine the contribution of the above variables in export competitiveness of the BRICS countries, factor analysis technique has been used and on the basis of it composite index has been constructed to find relative positions of countries.

# 2. Factor analysis

To examine the contribution of the different variables in export competitiveness of the BRICS countries, technique of factor analysis has been used. In factor analysis, a given set of n variables is grouped into p number of groups called 'Factor' which are less in number than the set of original variables. The variables within a group (Factor) are of the same nature or are complementary with respect to the phenomenon under study but between two groups 'Factor' variables are independent. Thus, factors Fi and Fj are orthogonal. The data was first normalized using Nagar-Basu (2002) methodology.

In [1] the selected variables were normalized by subtracting the minimum value of the particular variable from its actual value and dividing it by the range, which is the difference between the maximum and minimum value of the selected variables. The formula is given below:

 $Z_{ij} = \frac{ActualValue_{ij} - MinimumValue_{ik}}{MaximumValue_{ik} - MinimumValue_{ik}}$ Where,  $Z_{ii}$  = Normalized value of i<sup>th</sup> variable for j<sup>th</sup> country;

i = variable;

j = country;

k = specific value.

The technique of Factor Analysis is given as under;  $\boldsymbol{X} = \boldsymbol{L}\boldsymbol{F} + \boldsymbol{U}$ 

Where X is vector of all the original variables.

$$X = [X_1 + X_2 + X_3, \dots, X_n]$$

F is vector of 'Factor' derived  $F' = [F_1, F_2, F_3, \dots, F_p]$ U is vector of error terms  $U' = [E_1, E_2, E_3, \dots, E_n]$ 

And X', F' and U' are the respective transposes.

L is matrix of Factor Loading (Loading Coefficient Matrix)

 $L = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \dots a_{1p} \\ a_{21} & a_{22} & a_{23} & a_{24} \dots a_{2p} \\ a_{31} & a_{32} & a_{33} & a_{34} \dots a_{3p} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & a_{n4} \dots a_{np} \end{bmatrix}$ 

The coefficient (Factor Loading)  $a_{ij}$  belongs to i<sup>th</sup> variable and j<sup>th</sup> factor, which is similar to simple correlation coefficient and shows the extent to which variable X<sub>i</sub> is related to F<sub>j</sub> factor. "A salient loading is one which is sufficiently high to assume that a relationship exists between the variable and the factor.

In addition, it usually means that relationship is high enough so that the variable can add aid in interpreting the factor and vice-versa." In [2] the sum of the square of factor loadings of  $X_i$  original variables under the derived p factor is called the communalities ( $C_i$ ) for  $X_i$  variables.

$$(a_{i1})^2 + (a_{i2})^2 + (a_{i3})^2 + \dots + (a_{ip})^2 = (C_i)^2$$

Communality in factor analysis is something like R<sup>2</sup> in the Regression Analysis and it shows the extent to which the derived factors explain the i<sup>th</sup> variables. Derived communality value generally should be larger (more than 70%) to be sure that each variable has been explained well. By definition, the communality of a variable is that proportion of its variance which can be accounted for the common factors [3].

The principal component analysis (Factor Analysis) produces components (Factors) in descending order of their importance and factor loadings which explain the relative importance of different variables in explaining variance in the phenomenon. Some studies using 'Factor Analysis' adopted 'First Principle Component' as guiding principle for determining individual indicator weights.

In the present study, all the 'Principle components' (Factor derived) are taken into account to determine relative weights of selected variables so as to reflect maximum possible variations in the export competitiveness. The method for determining the relative weights for the variables is explained below:

 $W_i = F_{ik}\lambda_k$ Where,

 $W_i = Weight of i^{th} variable$ 

 $F_{ik}$  = Factor loading of i<sup>th</sup> variable and k<sup>th</sup> factor which reflects the highest correlation

between v ariable  $(X_i)$  and factor  $(F_k)$ 

 $\lambda_{\mathbf{k}}$  = variation explained by K<sup>th</sup> factor

The weights for the variable determined by applying above-mentioned technique are in accordance with the contribution made by the variable in the inter-country variations.

#### 3. Composite index

The statistical technique employed to develop the weighted composite index involves finding out the 'Principle Components' of the groups consisting of these selected 12 variables and derive the implicit weights based thereon. The composite index is then constructed by combining various indicators whose implicit weights are already determined through the technique of 'Principle Component Analysis' [4], [5].

Where, Zij = Normalized value of the  $i^{th}$  variable for the  $j^{th}$  country WI = Weight of  $i^{th}$  variable

Table 1- 3 shows the 12 factors affecting trade competitiveness of BRICS countries for the year 1995, 2005 and 2015 respectively.

1995	X/M	TB/GDP	TB/TT	T/GDP	X/GDP	MT/X	CX/X	MG/X	OMG/X	X/WX	RCA	IIT
Brazil	0.87(4)	-0.52(3)	0.07(4)	7.15(5)	3.32(5)	19.02(2)	6.58(3)	52.77(3)	27.16(2)	0.90(3)	0.74(3)	0.93(3)
Russia	1.32(1)	2.25(1)	0.14(1)	16.50(3)	9.38(3)	6.66(5)	5.63(5)	24.76(5)	12.48(4)	1.59(2)	0.36(5)	0.86(5)
India	0.84(5)	-1.00(4)	0.09(5)	11.27(4)	5.13(4)	7.78(4)	8.42(1)	60.24(2)	44.03(1)	0.59(4)	1.02(2)	0.91(4)
China	1.13(2)	1.13(2)	0.06(2)	19.06(2)	10.10(2)	21.08(1)	6.07(4)	83.58(1)	0.69(5)	2.87(1)	1.17(1)	0.94(2)
South Africa	0.91(3)	1.16(5)	0.05(3)	25.10(1)	11.97(1)	17.30(3)	7.17(2)	43.55(4)	19.08(3)	0.54(5)	0.60(4)	0.95(1)
World	1.00	0.02	0.00	24.52	12.25	37.44	9.17	71.93	25.32	100	1	1.00

Table 1. Factors affecting trade competitiveness of BRICS countries in 1995

Source: World Bank, World Development Indicators (Various Issues) [6], U.N., UNCTAD Handbook of Statistics (Various Issues) [7]

Regarding the export share of BRICS countries in total world exports (X/WX) in the year 1995, the export share of China was found to be maximum (i.e.2.84%) followed by Russia (1.59%), Brazil (0.90%) and India (0.59%). The similar picture was found in 2005. As regards to share of exports (X/GDP) as well as share of total trade in GDP (T/GDP), all the BRICS countries were found at same position in 1995. South Africa was found at top position followed by China and Russia. It indicates that Brazil and India were globally less opened economies as compared to South Africa and China.

In terms of share of manufactured exports in total exports (MG/X) of BRICS countries, China was found with maximum shares (83.58%) in 1995. This is followed by India (60.24%), Brazil (52.77%) and South Africa (43.55%). Russia was found with least shares (24.76%). In 2005, position of BRICS countries had remained the same as in 1995. Furthermore, China showed highest revealed comparative advantage (RCA) in manufactured exports followed by India, Brazil, South Africa and Russia.

2005	X/M	TB/GDP	TB/TT	T/GDP	X/GDP	MT/X	CX/X	MG/X	OMG/X	X/WX	RCA	IIT
Brazil	1.61(2)	2.53(3)	0.23(2)	10.83(5)	6.68(5)	25.78(2)	6.16(3)	52.11(3)	20.17(2)	1.13(3)	0.75(4)	0.77(4)
Russian	1.95(1)	9.27(1)	0.32(1)	28.78(3)	19.03(2)	4.04(5)	4.15(5)	18.01(5)	9.83(4)	2.32(2)	0.27(5)	0.68(5)
India	0.71(5)	3.73(5)	0.17(5)	21.72(4)	9.00(4)	10.61(4)	11.48(1)	58.79(2)	36.70(1)	0.95(4)	1.01(2)	0.83(3)
China	1.15(3)	2.87(2)	0.07(3)	40.04(1)	21.46(1)	46.23(1)	4.69(4)	91.70(1)	0.38(5)	7.25(1)	1.31(1)	0.93(2)
South Africa	0.94(4)	1.06(4)	0.03(4)	33.10(2)	16.02(3)	18.55(3)	7.66(2)	45.50(4)	19.29(3)	0.49(5)	0.81(3)	0.97(1)
World	0.98	0.37	0.01	36.46	18.04	37.34	10.58	70.22	22.29	100	1	0.99

Table 2. Factors affecting trade competitiveness of BRICS countries in 2005

Source: World Bank, World Development Indicators (Various Issues) [6], U.N., UNCTAD Handbook of Statistics (Various Issues) [7]

Among the BRICS countries, India was at top position in terms of share of chemical exports (CX/X) in total exports in 1995. This is followed by South Africa, Brazil and China. Russia has least share among BRICS. Additionally, India was also found at top position in terms of share of other manufactured exports in total exports (OMG/X). China had least share of other manufactured goods among BRICS countries.

About the share of machinery and transport equipment (MT/X), China has maximum share of exports of machinery and transport equipment among other BRICS countries in 1995. Whereas, Russia has lowest exports share of machinery and transport equipment.

Regarding Export-Import Ratio (X/M), Trade balance-total trade ratio (TB/TT) and share of trade balance in GDP (TB/GDP), Russia was found to be most efficient country with surplus trade account among BRICS countries in 1995. However, India was found to be least efficient country with deficit trade account among BRICS countries. Intra-Industry Trade (IIT) was highest in South Africa and least in Russia.

In 2005, the position of all the BRICS countries more or less the same as in 1995. Table 3 shows that China remained at top position in terms of share of exports in world exports (X/WX)in 2015. All the BRICS countries (except South Africa) experienced increase in share in world exports as compared to 1995. South Africa could improve its export shares in world exports. Concerning, Export-Import ratio (X/M), Trade balance-total trade ratio (TB/TT) and trade balance in GDP ratio (TB/GDP), all the BRICS countries (except India) have improved their trade account in 2005, but India could not improve trade account in 2015.

In 2015, India remained at top position in terms of share of chemicals in total exports and share of other manufactured goods in total exports as in 1995. However, all the BRICS countries experienced decrease in share in other manufactured goods exports in 2015 as compared to 1995.

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2015	X/M	TB/GDP	TB/TT	T/GDP	X/GDP	MT/X	CX/X	MG/X	OMG/X	WMX	RCA	IIT
Brazil	1.11(3)	0.84(3)	0.05(3)	15.55(5)	8.20(5)	16.36(3)	5.99(3)	36.19(4)	13.85(2)	1.16(4)	0.55(4)	0.95(2)
Russia	1.87(1)	9.71(1)	0.30(1)	32.14(3)	20.92(2)	5.42(5)	5.84(4)	19.87(5)	8.61(4)	2.07(2)	0.30(5)	0.70(5)
India	0.68(5)	5.38(5)	0.19(5)	28.70(4)	11.66(4)	16.20(4)	13.44(1)	59.60(2)	29.96(1)	1.62(3)	1.02(2)	0.81(4)
China	1.35(2)	6.70(2)	0.15(2)	44.60(1)	25.65(1)	46.66(1)	5.70(5)	94.17(1)	0.17(5)	13.76(1)	1.36(1)	0.85(3)
South Africa	1.02(4)	0.44(4)	0.01(4)	38.49(2)	19.46(3)	19.15(2)	6.83(2)	38.79(3)	12.80(3)	0.49(5)	0.71(3)	0.99(1)
World	1.00	0.03	0.00	43.66	21.84	35.82	11.22	69.34	22.30	100	1	1.00

Table 3. Factors affecting trade competitiveness of BRICS countries in 2015

Source: World Bank, World Development Indicators (Various Issues)[6], U.N., UNCTAD Handbook of Statistics (Various Issues) [7]

#### 4. Factor analysis of trade competitiveness of BRICS countries

In order to find out the important variables leading to competitiveness of selected BRICS countries, the technique of factor analysis was used. The results of Rotated Factor Analysis (Keiser-Varimax) for the year 1995 are given in Table 4. The highest loading in each row are clubbed together to identify the variables falling in each of the factors. Three factors were derived from the selected 10 variables.

Factor 1 included variable like the ratio of trade balance to GDP (TB/GDP), ratio of exports to imports (X/M) and ratio of trade balance to total trade (TB/TT). This factor included those variables, which reflect competitiveness of countries in terms of efficiency.

	Factor 1	Factor 2	Factor 3	Communities	Weights
Export to Import ratio (X/M)	.968	.222	114	.999	43.70
Trade Balance to Total Trade Ratio (TB/TT)	.955	.273	103	.998	43.14
Trade Balance to GDP ratio (TB/GDP)	.909	.212	348	.991	41.02
Intra Industry Trade (IIT)	734	.553	.367	.979	16.45
Share in world Merchandised Exports (X/WX)	.451	.780	431	.998	23.21
Manufactured Exports (% of merchandised exports) (MG/X)	521	.726	407	.964	21.61
Machinery & Transport Equipment (% of total exports) (MT/X)	438	.703	.084	.693	20.93
Revealed Comparative Advantage (RCA)	572	.574	458	.867	17.09
Share of trade in GDP (T/GDP)	.295	.508	.783	.958	15.06
Share of Exports in GDP (X/GDP)	.471	.532	.681	.968	13.10
Percentage of Variance Explained	45.154	29.756	19.239		
Percentage of Cumulative Variance Explained	45.154	74.911	94.150		

Table 4. Trade competitiveness of BRICS countries: results of factor analysis for 1995

Factor 2 associated with share in world merchandise exports (X/WX), Revealed comparative advantage (RCA), share of manufactured exports in merchandise exports (MG/X), share of machinery & transport equipment in total exports (MT/X) and Intra Industry Trade (IIT).

This factor included those variables, which reflect competitiveness of countries in terms of structure of trade. Factor 3 included variables ratio of exports to GDP (X/GDP) and ratio of trade to GDP (T/GDP). This factor included openness and globalization related variables. Factor 1 explained 45.154% of the total variation, Factor 2 explained 29.756% of the total variation and Factor 3 explained 19.39% of the total variation. All the three factors together explained 94.150% of the total variation. Community values of the variables were high and varied largely between 0.99 and 0.749 (99.0% and 74.9%).

Results of Rotated Factor Analysis (Keiser-Varimax) for the year 2005 are given in Table 5of 10 variables considered, Factor 1 included 3 variables like Export to import ratio (X/M), Trade balance to total trade (TB/TT) and Trade balance to GDP (TB/GDP). These variables are related to efficiency of the economy.

Factor 2 included five variables like Intra industry trade (IIT), share of machinery & transport equipment in total exports (MT/X), share of manufactured exports in merchandised exports (MG/X), revealed comparative advantage (RCA) and share in world merchandise exports (X/WX). This factor shows the structure of trade of countries related variables. Factor 3 included variables related to openness and globalization such as ratio of exports to GDP (X/GDP) and ratio of trade to GDP (T/GDP).

Factor 1, 2 and 3 explained 40.175%, 32.085% and 24.366% variation respectively. All the three factors together explained 96.624% variation.

	Factor 1	Factor 2	Factor 3	Communities	Weights
Export to Import ratio (X/M)	.983	157	007	.991	39.5
Trade Balance to Total Trade Ratio (TB/TT)	.980	046	.018	.962	39.4
Trade Balance to GDP ratio (TB/GDP)	.940	100	.324	1.000	37.8
Intra Industry Trade (IIT)	.747	.396	.355	.842	12.7
Machinery & Transport Equipment (% of total exports) (MT/X)	.059	.956	.170	.947	30.7
Manufactured Exports (% of merchandised exports) (MG/X)	.403	.908	.072	.991	29.1
Revealed Comparative Advantage (RCA)	.599	.793	.051	.990	25.4
Share in world Merchandised Exports (X/WX)	.224	.769	.547	.940	24.7
Share of Exports in GDP (X/GDP)	.204	.133	.970	1.000	23.6
Share of trade in GDP (T/GDP)	.179	.196	.964	1.000	23.5
Percentage of Variance Explained	40.174	32.085	24.366		
Percentage of Cumulative Variance Explained	40.174	72.258	96.624		

Table 5. Trade competitiveness of BRICS countries: results of factor analysis for 2005

Table 6. Trade competitiveness of BRICS countries: results of factor analysis for 2015

	Factor 1	Factor 2	Factor 3	Communities	Weights
Manufactured Exports (% of merchandised exports) (MG/X)	.956	195	.202	.993	39.7
Machinery & Transport Equipment (% of total exports) (MT/X)	.949	.017	.230	.954	39.4
Share in world Merchandised Exports (X/WX)	.905	.344	.238	.995	37.6
Revealed Comparative Advantage (RCA)	.891	363	.261	.994	37.0
Trade Balance to Total Trade Ratio (TB/TT)	.074	.988	.119	.996	37.9
Trade Balance to GDP ratio (TB/GDP)	.058	.974	.217	1.000	37.3
Export to Import ratio (X/M)	.154	.973	.140	.990	37.3
Share of trade in GDP (T/GDP)	.402	.147	.904	1.000	17.4
Share of Exports in GDP (X/GDP)	.335	.517	.788	1.000	15.2
Percentage of Variance Explained	41.50	38. 32	19.30		
Percentage of Cumulative Variance Explained	41.50	79.82	99.12		

Results of rotated factor analysis (keiser-Varimax) for the year 2015 are given in Table 6 of 9 variables considered; Factor 1 included four variables like share of manufactured exports in merchandised exports (MG/X), revealed comparative advantage (RCA), and share of machinery & transport equipment in total exports (MT/X), share in world merchandise exports (X/WX). This factor is the mix of structure of trade of countries related variables. Factor 2 included 3 variables like ratio of trade balance to GDP (TB/GDP), ratio of exports to imports (X/M) and ratio of trade balance to total trade (TB/TT). This factor included those variables, which reflect competitiveness of countries in terms of efficiency.

Factor 3 associated with the variables ratio of exports to GDP (X/GDP) and ratio of trade to GDP (T/GDP). This factor included openness and globalization related variables. Factor 1 explained about 40.50% of the total variation, Factor 2 explained 38.32% of the total variation and Factor 3 explained 19.30% of the total variation. All the three factors together explained 99.12% of the total variation. Community values of all variables were high and varied largely between 1.000 and 0.954 (100% and 95.4%).

#### 5. Composite index of trade competitiveness of BRICS countries

Table 7 shows the composite indices and corresponding ranks of BRICS countries, as derived from Factor Analysis for the years of 1995, 2005 and 2015. In 1995, the most competitive country was found to be China followed by Russia, South Africa, Brazil and India. China is the most competitive country among BRICS countries considered in 2005 as well as in 2015.

Russia is at 2<sup>nd</sup> position followed by Brazil (3<sup>rd</sup>) and South Africa (4<sup>th</sup>). India is a least competitive country and stood at 5<sup>th</sup> position among BRICS countries. Position of India in world could not improve and its rank remained the same in 1995, 2005 as well as in 2015.

	1995		2005		2015		
Countries	Composite index	Rank	Composite index	Rank	Composite index	Rank	
Brazil	0.22	4	0.41	3	0.26	4	
Russian	0.61	2	0.55	2	0.43	2	
India	0.20	5	0.30	5	0.24	5	
China	0.77	1	0.73	1	0.89	1	
South Africa	0.38	3	0.31	4	0.33	3	

Table 7. Composite index of trade competitiveness of BRICS countries

#### 6. Conclusion

The study concludes that globally India's trade competitiveness is very low. Its share in world merchandise export was only 1.62 percent in 2015 and its position is 3<sup>rd</sup> among BRICS countries, but India has experienced increase in share in world exports from what it was in 1995. India was not globally opened economy as compared to China in 2015 and its trade was found to be in deficit in 1995, 2005 as well as in 2015. Whereas India showed competitiveness in the exports of manufactured goods, chemical, and other manufactured goods among BRICS countries. The results of factor analysis show that China is the most competitive country. Russia is at 2<sup>nd</sup> position followed by South Africa (3<sup>rd</sup>) and Brazil (4<sup>th</sup>).

India is at 5<sup>th</sup> position among the BRICS countries. As India could not improve its position in 2015 as compared to 1995, thus there is need to increase trade competitiveness in future. Hence, there is need to increase competitiveness in machinery and transport equipment.

Import liberalization strategy should be used for promotion of exports to reduce trade deficit. Exports should be increased by following export-led growth strategy. An integrated long-term national export policy should be formulated, to co-ordinate production, infrastructure and marketing activities.

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