

AN ANALYSIS OF REVEALED COMPARATIVE ADVANTAGE OF INDIA WITH CHINA, USA AND SAUDI ARABIA IN CHEMICAL SECTOR

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INTRODUCTION:

India has a significant presence in world chemicals and chemical products market. In the year 2022, it exported \$60441113.80 thousands in world market. The chemical sector of India covers 80,000 commercial products which are broadly classified as bulk chemicals, agrochemicals, polymers and fertilizers, contributing 7 percent to India's GDP. It provides employment to approximately 2 million people. Top ten trading partners of India in trade of chemicals and chemical products are China, USA, Saudi Arabia, Japan, Argentina, Russia, Indonesia, UAE, Netherlands and Belgium. The present study takes into account the top three trading partners for further analysis.

The chemical sector of China valued \$1.44 trillion approximately, it exported \$253255788.12 thousands in global market, indicating the largest chemical manufacturing country in the world. Sinopec, a Chinese company placed in world's top three chemical companies and has \$43.8 billion chemical sales in 2015. On the other hand, USA, the second largest trading partner of India in chemicals and chemical products, exported \$214694478.40 thousands in world market, marked the second highest contribution after China in global chemicals exports in 2022. The US chemical sector is made of four distinct components such as agriculture chemicals, basic chemicals, specialty chemicals, and consumer products, having worth \$768 billion supply 15 percent of world's chemicals. It is responsible for more than a quarter of its GDP, contributes in production of almost all commercial and household goods and has great relevance for economic growth, employees 8000,000. In the year 2016, ninety six percent of US goods were manufactured using chemical sector products.

Saudi Arabia, the third largest trading partner of India in chemicals and chemical products, exported \$14874060.38 thousands in the year 2021, acquired the significant place in world market, employs approximately 5 lakh people. It has been seen in Saudi Arabia that investment in specialty chemicals & plastic, rubber and inorganic chemicals in order to enhance the export in global market. The contribution of Saudi Arabia's chemical

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sector in global share in chemicals volume is 4.7 percent, with a portfolio concentration in basic and intermediate petrochemicals (not part of chemicals and chemical products defined by HS, 1996). Saudi Basic Industries Corporation (SABIC), a chemical manufacturing company, ranked fourth in the world among giant chemical companies by Fortune Global 500 in 2017. Explaining the significance of chemicals and chemical products of respective nations encouraged the trade in chemicals to evolve at a global level. The present study used the Balassa Index for calculating revealed comparative advantage (RCA) and for analyzing the structural change of India and trading partners, Pearson and Spearman Coefficients are used.

The outline of remaining paper as follows: Section 2 explores the review of literature. Section 3 elaborates the research methodology and data sources. Section 4 furnishes the empirical analysis. Section 5 presents the conclusion of the study.

2. REVIEW OF LITERATURE

In the past time, trade had been guided by the Barter system where presence of coincidence of wants or needs was essential feature. Exchange of goods and services for other goods and services without using the medium of exchange such as money. Here, the occurrence of trade took too much time. From 16th century trade has been guided by mercantilism, advocating the export and restricting the import for increasing the nation's gold reserves. In the year 1776, Adam Smith introduced the theory called, "Absolute Advantage Theory" postulated that a country can acquire the benefit from trade which he produced more efficiently implies his specialization.

On the other hand, comparative advantage theory states that a country is exported to other country, comparatively, it has low opportunity cost with trading partner (Ricardo, 1817). In Heckscher-Ohlin model states that a country will export those goods which produce by abundant factors and imported those goods which are made with scarce factors.

Based on comparative advantage theory, Balassa in 1975 formulated an index called Revealed Comparative Advantage (RCA). Akhtar et. al, (2008) analyzed the performance of footwear industry of Pakistan by applying Balassa Index at 2 & 4 digits HS 1996, classification and made comparison with India and China from 1996 to 2006. This study highlighted the shift in comparative advantage since 2003 of Pakistan footwear industry and continues over a period whereas India and China enjoyed the comparative advantage since 1990, however their RCA decreasing in terms of level since 2001. The shift of comparative disadvantage of Pakistan footwear industry to advantageous situation, implies there is trade potential in the sector for higher growth associated with higher export earnings.

Singh and Gautam (2019) examined the comparative advantage using Balassa and Lafay Index for the handloom industry from 2008 to 2017. This study found that cotton

showed excellent comparative advantage followed by carpet and other floor coverings. Lafay Index calculated for detecting the degree of specialization of each product along with its comparative advantage, silk and wool showed high positive Lafay Index value.

On the other hand, Batra and Khan (2005) systematically evaluate the similarity of the patterns of revealed comparative advantage at sector and commodity level of HS classification for India and China in world market and analyzed the comparative advantage according to factor intensity. Using Balassa index for RCA and Pearson and Spearman coefficient for structural changes, India and China benefited by maximum advantage in category of manufactures majorly material followed by agriculture and allied products. No significant structural changes found by the analysis of dynamic structures in category of manufacture over 2000-2003 for either India or China.

One of the most important and comprehensive study conducted by Ismail and Ahmed (2021) analyzed the static and dynamic RCA for India and China in global market using Spearman Rank correlation and Pearson coefficient to know the structural changes within country and structural changes between countries using RCA indices over a period of time for HS product group, HS chapters level and HS 6 digits products. In the years 200, 2010 and 2018, India enjoyed the comparative advantage in 2075 commodities out of total 4381 commodities, 41 chapters out of total 97 chapters and 9 product group out of 16. Marginal structural change found at product group level, chapter level and 6 digits classification level within country.

Jagdish et.al, (2024) investigated the export of coffee using Balasa index and gravity model where of India's coffee taken as dependent variable from 2014 to 2023 with 178 trading partners. This study revealed that export competitiveness of Indian coffee has a complex and diminutive position in global market and analysis of gravity model disclosed that larger economies import more as GDP coefficient of trading partners with Indian coffee exports are positively related while it showed negative relation with distance as closer the country to India more trade of coffee to partner country and vice-versa.

One more study related to RCA and manufacturing sector export conducted by Bender and Wai Li (2002) examined the manufacture exports performance in some of the Asian and Latin American economies over a period 1981-1997 and also investigated the RCA between economies in East Asia, Southeast Asia and Latin America. The major findings of study revealed that RCA across region during 1980s shifted significantly, influenced by trade liberalization, structural changes and regional dynamics. East Asia experienced a fell in RCA, reasons may be competition from ASEAN4, Latin America, and potentially mainland China, contributing the vulnerabilities that culminated in the 1997 Asian financial crisis.

By going through literature review, it is evident that most of the existing literature work used Balassa index to know the comparative advantage of manufactured goods between two or more entities. Other subjects which are related to analysis are Indian coffee, handloom sector, footwear industry at different levels of HS classification.

Limited literature is available related to trade in the chemical sector. Therefore, present study took forward, the trade in chemicals and chemical products of India with its trading partners using Balassa index for revealing comparative advantageous subsector and for exploring how RCA of chemicals and chemical products changes over time. The present study considers the years 2000, 2010 and 2022, for capturing the structural changes, Pearson and Spearman coefficients are used.

3. METHODOLOGY

The present study is based on secondary data of chemical sector from the United Nations Commodity Trade (UN COMTRADE) considers 2000, 2010 and 2022 years at 2-digit levels using harmonized system (HS) 1996 classification, which is extracted from the World Integrated Trade Solution (WITS) platform.

3.1 Revealed Comparative Advantage

Balassa's Revealed Comparative Advantage (RCA) index compares the export of country say India in a particular commodity say organic chemicals with the world's export of that commodity. The formula for the Balassa index is given below: -

$$RCA_{ik} = \frac{X_i^k / X_i}{X_w^k / X_w}$$

RCA_{ik} is the revealed comparative advantage of country i (say India) in commodity k (say organic chemicals)

X_i^k is the export of commodity k from the country i

X_i is the total exports from the country i

X_w^k are the total exports of commodity k from the world

X_w is the total exports from the world.

The present study follows the Wosiek Roman (2021), Deb and Sengupta (2017) and Hinloopen and Van Marrewijk (2001) to classify the degree of comparative advantage on the basis of magnitude of the RCA index as following:

- $RCA < 1$ No comparative advantage
- $1 < RCA < 2$ Weak Comparative advantage
- $2 < RCA < 4$ Moderate Comparative advantage
- $RCA > 4$ Strong comparative advantage

3.2 Pearson and Spearman Coefficients

To examine the structural alignment between India and each trading partner's RCA values, both Pearson and Spearman correlation coefficients are calculated for each of the

three years. The Pearson correlation coefficient measures the degree of linear association between India and each partner's RCA, offering insight into whether changes in India's comparative advantage move in tandem with those of its trading partners. Spearman's correlation coefficient, on the other hand, assesses the rank-order relationship, useful for capturing non-linear associations and revealing how closely the RCA ranks align between India and its partners across time.

The Pearson and Spearman coefficients are interpreted as follows:

Values close to +1 indicate strong positive alignment in comparative advantage.

Values close to -1 indicate strong divergence or inverse relationship in comparative advantage.

Values around 0 indicate no meaningful association in RCA patterns between India and its partner.

To measure the Carl Pearson Coefficient the following formula has been used:

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2}}$$

To measure the Spearman Rank Coefficient (SRC) the following formula has been used:

$$\rho = 1 - \frac{\sum D^2}{n(n^2 - 1)}$$

4. EMPIRICAL ANALYSIS

The present study computed the RCA of India and its top 3 trading partners namely China, USA and Saudi Arabia in chemical sector. In Harmonized System (HS) 1986 classification of Goods and Services in which chemicals and chemicals products are categorized in 11 sub sectors namely Inorganic chemicals, Organic Chemicals, Pharmaceutical products, Fertilizers, Tanning or dyeing extracts, Essential oils and resinoids, Soap, Albuminoidal substances, Explosives pyrotechnic products, Photographic goods and Miscellaneous chemical products, each subsector known by the numbers of chapter. There is total 96 chapters in which chemical sector categorized as "Chemicals and Chemical Products" from chapter 28 to chapter 38. RCA analysis of India and its trading partners reveals that India has comparative advantage in five subsectors, namely Organic Chemicals, Pharmaceuticals Products, Tanning or Dyeing Extracts, Explosives Pyrotechnic Products and Miscellaneous Chemical Products in 2022 as shown in table 1.

In the year 2022, China has comparative advantage in four subsectors. All the comparative advantageous subsectors of China have weak comparative advantage as the value of RCA lies between 1-2 as shown in table 1.

US has comparative advantage in all subsectors of chemicals and chemical products except Pharmaceuticals products. Saudi Arabia is in weak position in global market in export share of chemicals and chemical products as most of the subsectors of chemical

sector has no comparative advantage as shown in table 1.

Table 1: RCA of India and Trading Partners in 2022

| Chapter | Product Description | India | China | USA | Saudi |
|---------|------------------------------|-------|-------|------|-------|
| 28 | Inorganic chemicals | 0.75 | 1.18 | 1.00 | 0.73 |
| 29 | Organic Chemicals | 2.19 | 1.28 | 1.27 | 1.91 |
| 30 | Pharmaceutical products | 1.28 | 0.11 | 1.13 | 0.04 |
| 31 | Fertilisers | 0.06 | 0.75 | 0.88 | 1.34 |
| 32 | Tanning or dyeing extracts | 2.01 | 0.74 | 1.18 | 0.28 |
| 33 | Essential oils and resinoids | 0.73 | 0.28 | 1.02 | 0.07 |
| 34 | Soap | 0.62 | 0.60 | 1.42 | 0.44 |
| 35 | Albuminoidal substances | 0.52 | 0.72 | 1.50 | 0.06 |
| 36 | Explosives pyrotechnic | 1.59 | 1.49 | 1.72 | 0.14 |
| 37 | Photographic goods | 0.04 | 0.60 | 1.75 | 0.00 |
| 38 | Miscellaneous chemicals | 1.25 | 1.07 | 1.58 | 0.13 |

Source: Authors' Calculation using UNCOMTRADE data

4.1 Analysis of Dynamic Structural Change: Within Country

The analysis of dynamic structural changes is examined by applying the Spearman Correlation Coefficient (SRC) for India and top three trading partners, namely, China, USA and Saudi Arabia. This study calculated the SRC by using the revealed comparative index values (RCA) at 2 digits level classification of HS 1986 of whole chemical sector for the years 2000, 2010 and 2022 as the representative values of the variables used in SRC and Pearson Coefficient. The SRC for India is 0.90 same for RCA_2010-2022 and RCA_2000-2022, indicating the marginal structural change in 2022 over 2000 and 2010, the SRC for the time period RCA_2000-2010 is 0.84 as given in table 2. For the robustness of results of SRC, Carl Pearson Coefficient of correlation is going to be calculated which confirms the results. SRC for China is 0.91 and 0.78 for the time period RCA_2010-2022 and RCA_2000-2022 respectively, indicating the diminutive structural change in 2022 over 2000 and marginal structural change in 2022 over 2010, as SRC between 2000 and 2010 is 0.73 shown in table 2. These results are confirmed by Pearson Coefficient.

The SRC for USA is 0.64, 0.83 for the RCA_2010-2022 and RCA_2000-2022 respectively, indicating marginal structural change in 2022 over 2000 and small structural change in 2022 over 2010. These results are confirmed by Pearson Coefficient. The SRC for Saudi Arabia is 0.82 and 0.91 for the RCA_2010-2022 and RCA_2000-2022 respectively, reflecting the diminutive structural change in 2022 over 2000 and marginal structural change in 2022 over 2010, as the value of SRC for RCA_2000-2010 is 0.90, refers to the table 2.

Table 2: SRC and Pearson Coefficient of India and Trading Partners within Country

| Year | Country | Spearman Coefficient | Pearson Coefficient |
|-----------|---------|----------------------|---------------------|
| 2000-2010 | India | 0.84 | 0.82 |
| | China | 0.73 | 0.62 |
| | USA | 0.64 | 0.76 |
| | Saudi | 0.9 | 0.97 |
| 2010-2022 | India | 0.9 | 0.88 |
| | China | 0.91 | 0.86 |
| | USA | 0.83 | 0.82 |
| | Saudi | 0.82 | 0.95 |
| 2000-2022 | India | 0.9 | 0.9 |
| | China | 0.78 | 0.68 |
| | USA | 0.54 | 0.68 |
| | Saudi | 0.91 | 0.9 |

Source: Authors' Calculation using UNCOMTRADE data

4.2 Analysis of Dynamic Structural Change: Across the Country

The degree and nature of competition between India and top three trading partners evaluated by computing the SRC coefficient using the RCA indices of India and its partners in global market for the years 2000, 2010 and 2022, given in table 3. Positive and high value of SRC implies that India and partner countries are contesting for acquiring the global market which describes the competitive nature in export market, indicating the overlapping of specialization as India and partner countries are engaged in similar types of chemicals and chemical products trade. On other hand, a negative value of SRC coefficient indicates the complementarity of both nations in export market, describe the trade by India and trading partners are in different products leads to different different specialization of each nation. Here, the nature of trade is not competitive. (Ismail and Ahmed, 2021).

The SRC between India and China is 0.10, 0.29 and 0.41 for the years 2000, 2010 and 2022 respectively, indicating the competitive nature of trade which is continuously increasing over a period of time as the magnitude of the SRC increasing. These results are confirmed by Pearson coefficient.

The value of SRC between India and US is -0.35, 0.07 and -0.02 for the years 2000, 2010 and 2022 respectively. In the years 2000 and 2022, SRC reflects the no competitive relation between India and US. However, in the year 2010 the value of SRC is positive, implies the dinky competitive trade relation between both nations, not confirmed by Pearson Coefficient.

The discrepancy in SRC and Pearson coefficient suggests that despite the ranking alignment, which indicates overlapping focus area of chemicals and chemical products leading to competition in international markets of similar products, the actual level of specialization differ. This could mean that one country dominates certain products while the other one focuses on different ones, evolving an opportunity for trade complementarity. Therefore, based on it we can say that the relation between India and US in 2022 is known as "competitive-cum-cooperative", may be both the countries are targeting similar product categories. However, the actual levels of specialization diverge, offering opportunities for trade complementarity.

The SRC between India and Saudi Arabia is -0.16, -0.02 and 0.32 for the years 2000, 2010 and 2022 respectively. In the year 2000 and 2010, both the countries have complementarity in the trade share of chemicals and chemical products in global market, implying each nation has different specialization, confirms by Pearson coefficient. In the year 2022, the trade relation between India and Saudi Arabia in world market is competitive as the SRC value in this year is positive. Overall, the SRC coefficient moves towards the positive value, indicating the changing nature of trade between India and Saudi Arabia from complementary to competitiveness in world market, these results are confirmed by the Pearson coefficient.

Table 3: SRC and Pearson Coefficient between India and Trading Partners

| Country Pair | Year | Spearman Coefficient | Pearson Coefficient |
|---------------|------|----------------------|---------------------|
| India & China | 2000 | 0.11 | 0.04 |
| | 2010 | 0.29 | 0.3 |
| | 2022 | 0.42 | 0.39 |
| India & U.S. | 2000 | -0.35 | -0.14 |
| | 2010 | 0.07 | 0.25 |
| | 2022 | -0.03 | 0.03 |
| India & Saudi | 2000 | -0.16 | -0.17 |
| | 2010 | -0.03 | -0.12 |
| | 2022 | 0.33 | 0.22 |

Source: Authors' Calculation using UNCOMTRADE data

CONCLUSION OF THE STUDY

The present study underscores the untapped export potential of India with their trading partners, namely, China, USA and Saudi Arabia. The RCA analysis reveals that India has comparative advantage in 5 subsectors out of 11 while China and Saudi Arabia have weak position than India in global chemical export market in the year 2022, US has comparative advantage in most of the subsectors of chemical sector.

SRC analysis reveals that within country there is marginal structural changes from RCA of one year to another year in case of India and trading partners. On the other hand, SRC analysis of India with trading partners give information related to alignment of trade or not, reveals that India has competitive relation with China and Saudi Arabia in global market as the value of SRC coefficient increasing over a period of time. India has "competitive-cooperative" relation with USA as both the nations are targeting similar chemicals and chemical products, however, actual levels of specialization diverge.

Overall, SRC analysis reveals that India has competitive relation with their trading partners in chemicals and chemical products in global market. Lastly, the present study provides essential information which served as indispensable lead to the policy makers, they should formulate the policy to facilitate the trade in those subsectors where footprint of India is minimal in global subsectors such as Fertilizers, Essential Oil and Resinoids, Soap, Albuminoidal Substances and Photographic Goods

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