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Competitiveness and Trade Complementarity in India–China Agricultural Trade: Evidence from RCA and TCI Analysis

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Abstract:

This study examines the structure, competitiveness and complementarity of agricultural trade between India and China during 2000-2004 using Revealed Comparative Advantage (RCA), and Trade Complementarity Index (TCI). Using agricultural trade data from UNCOMTRADE, WITS and ITC Trade Maps, the study evaluates the comparative strengths of both countries across 24 agricultural product categories at HS 2-digit level. The results reveal a clear structural asymmetry in agricultural trade. RCA results indicate that India possesses strong comparative advantage in primary and semi-processed agricultural commodities, particularly cereals, spices, coffee, fish products, sugar and natural resins, whereas China demonstrates competitiveness in processed agricultural and food products. The TCI indicates that India's agricultural export structure is more strongly aligned with China's import demand than the reverse, suggesting stronger trade complementarity for India. The comparative analysis of the three indices confirms that the two countries exhibit largely complementary rather than competing agricultural trade structures. The findings suggest significant opportunities for expanding India's agricultural exports to China, particularly in sectors characterized by strong comparative advantages and growing China's demand.

Keywords: Comparative Advantage, competitiveness, trade complementarity.

1. Introduction

India and China have undergone profound structural transformations in their agricultural sectors over the past decades, with agriculture forming the foundation of both economies historically (Singh, 2008). Agriculture has largely contributed to food security, employment generation and rural income and even though the relative contribution of agriculture to national output has declined with industrialization and urbanization, the sector continues to play a strategic role in socio-economic development of both the economies (Arora, 2013) (Bingshen & Wan, 2003).

A systematic examination of India–China agricultural trade is critical for identifying areas of competitive strength, exploring complementarities, and assessing unrealised trade potential. Analysing the areas of strength and trade potential will help in designing more effective export strategies, strengthening domestic value chains, and facilitating evidence-based trade diplomacy (Qureshi & Wan, 2008). China has been actively seeking to diversify sources of food imports to strengthen food security and build resilience in agricultural supply chains (Hejazi & Marchant, 2017) (Zhu, Liu, & Cao, 2025). Meanwhile, India's 2018 Agriculture Export Policy explicitly aims to expand and upgrade its agricultural exports through product diversification and new market access strategies (MoCI, 2018; (Arora, 2013) Therefore, the scope for mutually beneficial agricultural engagement between the two countries is growing.

Therefore, quantitative measures of competitiveness and complementarity are indispensable to undertake an assessment of the bilateral trade. The Revealed Comparative Advantage (RCA) index proposed by Balassa (1965) remains one of the most widely used metrics for evaluating a country's export strengths relative to the world (Balassa, 1965). In addition to RCA, the Trade Complementarity Index (TCI) initially developed by Drysdale (1969) formalized statistically in the work of Michaely (1996) and further formalised in UNCTAD–WTO analytical frameworks measure how closely one country's export profile matches another country's import profile.

Together, RCA and TCI provide a powerful, multidimensional lens for evaluating India and China agricultural trade. While RCA highlights India's areas of competitive strength, TCI identifies where these strengths align with China's demand. By integrating these measures with long-run trade data, the present study aims to map opportunities, constraints, and strategic priorities for deepening bilateral agricultural engagement and enhance India's agricultural presence in the Chinese market.

For calculations of the trade indices, the study employs trade statistics from WITS and International Trade Statistics (ITC) trade maps for India and China total trade while UNCOMTRADE data is used for agricultural data at HS2 digit product level. For a detailed overview of trade relations, the study focuses on data for 25 years i.e, 2000 till 2024, for which the indices are calculated for both countries. The agriculture products used in the study is as per the classification used by the World Trade Organization and includes HS Code 1-24.

2. Revealed Comparative Advantage

Comparative advantage is a key idea in theories of international trade introduced by neo-classical economists Eli Heckscher (1919) and Bertil Ohlin (1933) in a model based on variations in resource endowments. However, since comparable prices under autarky are not observable, calculating comparative advantage and evaluating the Hecksher Ohlin theory present certain challenges. In consideration of this, Balassa (1965) suggests that it might not be required to include every factor influencing a country's comparative advantage. Rather, Balassa contends that observable trade patterns "reveal" comparative advantage using the formula:

$$RCA_{ik} = \left(\frac{x_{ik}/X_i}{x_{wk}/X_w}\right)$$

wherein the RCA of country i in product k is the share of value of country i's export of product k to the total value of country i's exports divided by the share of value of world exports of product k to the total value of world exports.

RCA measures the relative export specialisation of a country in a specific product compared to the world. If RCA>1, then the country has a revealed comparative advantage in exporting that product since the product makes up a larger share of the country's total exports than it does in world exports. The greater is the value of RCA, the higher is the revealed comparative advantage of trade.

Table 2.1and 2.2 shows the RCA (revealed comparative advantage) indices of agricultural product categories of India and China calculated for the period 2000-2024. The numbers in bold indicates the cases where RCA is greater than one, which indicates that India has a comparative advantage in the export of these products.

Table 2.1. Revealed Comparative Advantage of India on Agriculture Products

Product Code (HS)	2000	2005	2010	2015	2020	2024	Mean	Max
1	0.02	0.04	0.05	0.03	0.01	0.04	0.04	0.11
2	**1.03**	0.94	**1.25**	**2.37**	**1.47**	**1.27**	**1.38**	**2.37**
3	**5.01**	**2.62**	**1.81**	**2.82**	**2.92**	**2.38**	**2.76**	**45.01**
4	**0.19**	0.55	0.23	0.28	0.22	0.36	0.31	0.55
5	**1.84**	0.82	0.7	0.56	0.62	**1.3**	0.94	**1.84**
6	0.43	0.51	0.24	0.24	0.21	0.18	0.32	0.77
7	**1.91**	**1.67**	**1.17**	**1.09**	**1.01**	**1.12**	**1.20**	**1.91**
8	**3.22**	**1.84**	0.99	0.89	0.62	0.56	**1.25**	**3.22**
9	**7.07**	**4.84**	**3.71**	**3.76**	**4.45**	**3.82**	**4.57**	**9.28**
10	**2.89**	**4.45**	**2.37**	**4.09**	**4.62**	**4.25**	**3.98**	**5.52**
11	0.54	0.4	0.37	**1.01**	**1.2**	**1.49**	0.89	**1.67**
12	**2.32**	**1.39**	**1.09**	**1.21**	**1.06**	0.89	**1.26**	**2.32**
13	**18.71**	**11.78**	**7.92**	**9.57**	**5.78**	**6.11**	**10.96**	**32.65**
14	**5.71**	**5.17**	**4.99**	**3.82**	**2.1**	**1.45**	**3.81**	**5.71**
15	**1.81**	0.85	0.6	0.67	0.88	0.72	0.76	**1.81**
16	0.05	0.63	0.52	0.29	0.71	0.62	0.44	0.75
17	0.83	0.34	**1.59**	**2.14**	**4.06**	**2.06**	**2.41**	**5.93**
18	0.03	0.03	0.05	0.23	0.18	0.14	0.11	0.23
19	0.34	0.4	0.35	0.48	0.44	0.43	0.40	0.48
20	0.40	0.45	0.39	0.52	0.67	0.71	0.49	0.71
21	**1.11**	0.58	0.46	0.55	0.65	0.79	0.63	**1.12**
22	0.12	0.09	0.13	0.2	0.18	0.16	0.14	0.22
23	**3.71**	**2.84**	**2.52**	0.93	**1.16**	**1.18**	**2.21**	**4.61**
24	**1.23**	**1.22**	**1.71**	**1.46**	**1.28**	**1.65**	**1.34**	**1.79**

Source: Computed

The RCA analysis in table 2.1 shows that India possesses strong revealed export specialization in 12 product categories including HS-13 (lac,gum,resins), HS-09 **(**spices, tea, coffee), HS-14(Vegetable plaiting materials) and HS-10 (cereals) with additional strength in HS-17 (sugar), HS-23 (food & animal feed residues), HS-02 (meat & offal), HS-3 (fish, crustaceans, aquatic invertebrates) and HS-24 (tobacco). These sectors constitute India's strongest agricultural export pillars.

In contrast, several categories including HS-4 (dairy), HS-01 (live animals), HS-06 (live plants & floriculture), HS-18 (cocoa and cocoa preparations), HS-22 (beverages, spirits and vinegar) consistently register RCA values close to zero, indicating structural constraints and limited export possibility. Notably, niche sectors such as HS-16 (meat preparations) display gradual improvement, signaling India's slow transition toward value-added agricultural exports. Overall, the RCA trends of India highlights that India's strength relies on traditional commodity and underlines the need for diversification, increasing productivity and upgradation of quality to take advantage of its export asset and maintain global competitiveness.

Meanwhile, the RCA values calculated for China's agricultural exports at the HS-2 level (table 2.2) indicate a structural pattern of persistent comparative disadvantage across most primary agricultural products which

consistently records values below 1 throughout the period 2000–2024. The categories showing strong mean comparative advantage as shown in table 2.2 are HS-05 (animal-origin products), HS-7 (edible vegetables), HS-13 (Lac, gums, resins), HS-14 (vegetable plaiting materials) and HS-16 (meat preparations) with additional strength lies in processed agricultural goods such as HS-20 (vegetables preparations) and HS-21 (miscellaneous food preparations).

Table 2.2. Revealed Comparative Advantage of China on Agricultural Products

Product code (HS)	2000	2005	2010	2015	2020	2024	Mean	Max
1	**1.10**	0.34	0.24	0.2	0.18	0.11	0.31	**1.10**
2	0.49	0.16	0.1	0.07	0.04	0.05	0.13	0.49
3	**1.41**	**1.02**	**1.03**	0.95	0.65	0.49	0.94	**1.42**
4	0.17	0.08	0.05	0.06	0.04	0.04	0.07	0.17
5	**5.61**	**2.69**	**1.83**	**1.44**	**1.23**	**1.07**	**2.16**	**5.61**
6	0.10	0.08	0.11	0.11	0.14	0.15	0.11	0.15
7	**1.98**	**1.25**	**1.27**	0.99	0.85	0.82	**1.14**	**1.98**
8	0.38	0.3	0.34	0.36	0.36	0.3	0.34	0.38
9	0.77	0.66	0.43	0.38	0.52	0.32	0.53	**1.00**
10	**1.26**	0.43	0.06	0.02	0.05	0.04	0.24	**1.26**
11	0.44	0.32	0.37	0.23	0.23	0.21	0.31	0.46
12	**1.14**	0.62	0.29	0.24	0.18	0.18	0.39	**1.14**
13	0.61	0.44	**1.09**	**1.33**	**1.39**	**1.52**	**1.06**	**1.72**
14	**2.54**	**1.33**	0.67	0.91	0.84	**1.08**	**1.16**	**2.54**
15	0.17	0.1	0.04	0.06	0.1	0.18	0.09	0.18
16	**3.19**	**2.33**	**1.5**	**1.31**	**1.16**	**1.16**	**1.78**	**3.19**
17	0.32	0.24	0.23	0.28	0.27	0.32	0.26	0.35
18	0.07	0.07	0.05	0.07	0.04	0.04	0.06	0.08
19	0.56	0.34	0.23	0.17	0.17	0.17	0.26	0.56
20	**1.69**	**1.34**	**1.11**	0.91	0.8	0.67	**1.13**	**1.73**
21	0.55	0.32	0.32	0.34	0.37	0.38	0.38	0.55
22	0.35	0.16	0.11	0.14	0.11	0.14	0.16	0.36
23	0.33	0.22	0.33	0.27	0.24	0.27	0.29	0.37
24	0.36	0.29	0.28	0.24	0.12	**1.01**	0.36	**1.03**

Source: Computed

Most of the categories including HS-02 (meat & offal), HS-04 (dairy products), HS-06 (live plants & floriculture), HS-18 (cocoa and cocoa preparations) record RCA values far below unity throughout 2001–2024, with a clear downward trajectory, indicating that China's export performance in these sectors is weak relative to the global export basket. This aligns with China's growing reliance on imports for protein and dairy products and consumption-driven agriculture strategy (Gale, Hansen, & Jewison, 2015). The results suggest that China's export structure is not oriented toward raw agricultural commodities, but rather toward value-added manufactured goods, which aligns with China's long-run industrialisation trajectory.

Overall, the mirror competitiveness analysis indicates that India and China do not compete extensively in agricultural trade. Instead, the relationship is characterised by distinct comparative-advantage profiles with highly differentiated comparative advantage structures across the agricultural sector.

3. Trade Complementarity between India and China

The Trade Complementarity Index (TCI) measures how well the export structure of one country matches the import structure of another. A high complementarity score implies strong potential for mutually beneficial trade expansion. The Balassa-based TCI formula, which weights trade shares by revealed comparative advantage, is used as below:

$$TCI_{ijk} = RCA^{x}_{ik} * RCA^{m}_{jk}$$

wherein the TCI of country i with j in product k is the product of RCA of country i in export of product k and RCA of country j in import of product k. There is trade complementarity between two countries when one country's export advantage in a product is complemented by an import advantage or export disadvantage of the partner country. If the value of TCI for a product is $0 \leq TCI_{ijk}<1$, it indicates a low degree of import and export compatibility and weak complementarity between the two countries. But if TCI of a product k is $TCI_{ijk} \geq 1$, it indicates the presence of complementarity of trade between the two countries and the potential for improving trade. The greater is the value of TCI, the higher is the complementarity of trade.

Trade Complementarity Index of India's exports to China's imports are calculated for India from 2000-2024 for the 24 agricultural product categories. The mean index value analysis from calculations in table 3.1 shows India's exports to be complementary with China's imports for 6 products out of the 24-product category. The sectors in which the mean values of TCI of India show trade complementarity with China are HS-3 (Fish and crustaceans), HS-10 (Cereals), HS-12 (Oil seeds), HS-13 (Lac, gums, resins), HS-14 (Vegetable plaiting materials) and HS 23(Residues and wastes of Food industries, animal fodder). While HS-15 (Animal or vegetable fats and oils), HS-23(food & animal feed residues) loses its complementarity, HS-2(Meat and meat offal), HS-10(Cereals) and HS-17(Sugars and sugar confectionery) has gained complementarity over the years.

Table 3.1 Trade Complementarity Index of India Exports with China Imports

HS Code	2000	2005	2010	2015	2020	2024	Mean	Max
1	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.02
2	0.47	0.14	0.33	**1.44**	**2.79**	**1.58**	0.99	**2.79**
3	**3.85**	**1.91**	**1.01**	**1.79**	**2.71**	**2.85**	**2.12**	**3.85**
4	0.04	0.09	0.07	0.12	0.15	0.21	0.12	0.26
5	**2.02**	0.55	0.45	0.3	0.42	**1.33**	0.75	**2.02**
6	0.03	0.04	0.02	0.03	0.02	0.02	0.03	0.06
7	0.21	0.4	0.34	0.42	0.22	0.2	0.31	0.46
8	**1.07**	0.36	0.28	0.46	0.46	0.61	0.46	**1.07**
9	0.27	0.16	0.17	0.31	0.92	**1**	0.40	**1.00**
10	**1.35**	**1.99**	0.43	**3.31**	**2.85**	**3.52**	**1.94**	**4.39**
11	0.19	0.14	0.12	0.51	0.7	**1.14**	0.44	**1.29**
12	**9.53**	**5.32**	**4.39**	**4.96**	**3.53**	**3.51**	**4.80**	**9.53**
13	**7.43**	**3.21**	**2**	**3.12**	**2.27**	**2.59**	**3.43**	**7.43**
14	**25.83**	**9.02**	**12.1**	**6.47**	**1.52**	**1.22**	**7.40**	**25.83**
15	**2.74**	**1.13**	0.73	0.58	0.8	0.54	0.89	**2.74**
16	0.00	0.01	0.02	0.02	0.05	0.06	0.02	0.07
17	**0.30**	0.09	0.4	**1.06**	**1.99**	**1.08**	0.94	**3.20**
18	0.01	0	0.01	0.04	0.02	0.02	0.02	0.04

19	0.04	0.05	0.1	0.29	0.34	0.22	0.17	0.34
20	0.03	0.04	0.04	0.08	0.12	0.19	0.07	0.19
21	0.27	0.09	0.07	0.15	0.29	0.45	0.18	0.45
22	0.02	0.01	0.03	0.08	0.06	0.06	0.04	0.08
23	**4.63**	**1.85**	**1.48**	0.53	0.55	0.69	**1.25**	**4.63**
24	0.35	0.26	0.38	0.64	0.28	0.64	0.40	0.64

Source: Computed

Meanwhile, the calculation of TCI index at Table 3.2 shows China's exports to have trade complementarity in only 3 products out of the 24 categories. The TCI values reveal that aggregate complementarity between China's agricultural exports and India's agricultural imports remains structurally low and China's agricultural export structure does not complement India's agricultural import profile in most categories. The vast majority of HS codes exhibit extremely low TCI with near zero (0) values. The only sectors which show mean positive complementarity values are HS-07 (edible vegetables), HS-13(lac, gums, resins) and HS-14 (Vegetable plaiting materials).

Table 3.2. Trade Complimentary Index of China exports with India imports

Product code	2000	2005	2010	2015	2020	2024	Mean	Max
1	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.01
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.05
4	0.01	0.00	0.01	0.00	0.00	0.00	0.00	**0.01**
5	**2.2**	0.44	0.33	0.27	0.19	0.15	0.50	**2.2**
6	0.00	0.00	0.00	0.00	0.01	0.01	0.00	**0.01**
7	**1.01**	**1.58**	**1.82**	**2.28**	0.88	**1.42**	**1.86**	**5.55**
8	0.63	0.32	0.24	0.41	0.39	0.27	0.33	**0.63**
9	0.29	0.50	0.17	0.25	0.39	0.18	0.33	**1.06**
10	0.07	0.00	0.00	0.00	0.00	0.00	0.02	0.31
11	0.16	0.02	0.03	0.03	0.03	0.03	0.04	0.16
12	0.15	0.09	0.03	0.04	0.06	0.05	0.06	**0.15**
13	**0.73**	0.49	**1.07**	**1.63**	**2.12**	**2.12**	**1.26**	**2.63**
14	**2.12**	0.49	0.28	0.96	**2.85**	**2.13**	**1.01**	**2.85**
15	**1.48**	0.46	0.15	0.28	0.46	0.68	0.44	**1.48**
16	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01
17	0.15	0.19	0.23	0.17	0.21	0.29	0.14	0.29
18	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
19	0.05	0.02	0.01	0.01	0.01	0.01	0.02	0.06
20	0.1	0.06	0.06	0.05	0.05	0.04	0.07	0.11
21	0.19	0.02	0.02	0.03	0.04	0.02	0.04	0.21
22	0.01	0.05	0.01	0.03	0.03	0.04	0.03	0.05
23	0.05	0.05	0.05	0.05	0.09	0.06	0.06	0.11
24	0.01	0.01	0.01	0.01	0.01	0.07	0.02	0.07

Source: Computed

Mirror Competitiveness Analysis: India Vs China TCI

a) **India advantage- China Disadvantage:** The sectors revealing asymmetric complementarity favouring India are HS-02 (meat & offal), HS-03 (fish & fish products), HS-05 (animal-origin products), HS-10 (cereals), HS-11 (milling products), HS-12 (oilseeds), HS-17 (sugar) and HS-23 (food & animal feed residues). India's export specialization closely matches China's import requirements which suggests significant potential for export expansion and deeper agricultural trade integration.
b) **China Advantage- India Disadvantage:** HS-07 (edible vegetables) is the only sector where China's export specialization is aligned with India's import dependence.
c) **Mutual Advantage:** HS-13 (lac, gums, resins) and HS-14 (vegetable plaiting materials) demonstrate strong complementarity in both directions, indicating that the export structures of both countries correspond well with each other's import demand. Both countries possess export capabilities in these sectors highlighting the possibility of two-way trade and value-chain integration.
d) **Mutual Disadvantage:** The sectors that exhibit weak complementarity are HS-01(live animals), HS-04 (dairy products), HS-06 (live plants & floriculture), HS-08 (edible fruits & nuts), HS-09 (coffee, tea, spices), HS-15 (animal or vegetable fats and oils), HS-16 (meat preparations),HS-18 (cocoa and cocoa preparations), HS-19 (cereals, milk preparations and products), HS-20 (vegetables preparations), HS-21 (miscellaneous food preparations) and HS-22 (beverages, spirits and vinegar). These sectors indicate limited correspondence between the export profiles and import requirements of each other. Therefore, they offer relatively weaker prospects for bilateral trade expansion.

5. Summary & Conclusion

This chapter analysed the structure, direction, and potential of India–China agricultural trade using the Revealed Comparative Advantage (RCA) Index and the Trade Complementarity Index (TCI).

a) The RCA results show a clear structural divergence in the agricultural competitiveness of the two economies. India exhibits strong and persistent RCA in primary and semi-processed agricultural goods. China, by contrast, reveals RCA primarily in processed or industrial agro-products. This asymmetric global competitiveness structure forms the foundation of the observed bilateral trade patterns.
b) The TCI results show that the alignment between export supply and import demand is much stronger for India exporting to China than for China exporting to India. Strong complementarity is concentrated in primary agricultural commodities such as fish products, cereals, milling products, sugar, coffee, tea, spices whereas China's complementarity advantage is limited mainly to edible vegetables.
c) Cross-comparison of the two indicators reveals that only a narrow subset of agricultural products shows simultaneously positive RCA and TCI for India in the China market. Among these, meat, fish & fish products, cereals, oilseeds, lac, gums, resins, vegetable plaiting materials, sugar, food & animal feed residues are the core strategic pillars where India enjoys global competitiveness (RCA) and structural market alignment (TCI). These products represent the most promising trade expansion for India since India is globally competitive with its export aligning with import demand of China. Therefore, prioritization in bilateral trade negotiation, SPS cooperation, logistics improvement and export promotion strategies in these sectors is vital.
d) Several products exhibit strong global competitiveness for India but weak complementarity with China such as edible vegetables, fruits & nuts, coffee, tea, spices and tobacco. This suggests that competitiveness alone does not guarantee market penetration which may be affected by SPS and quarantine restrictions, tariff and non-tariff barriers, China's import sourcing from alternative

suppliers, differences in product standards and change in consumer preferences etc (Yang, Huang, & Rozelle). These sectors possess untapped trade potential since India is globally competitive but has not fully translated its advantage into China's market

e) Some sectors demonstrate strong trade complementarity for India with China despite lack in global competitiveness such as animal-origin products, animal or vegetable fats and oils possibly due to product-specific demand in China, specialized bilateral trade relationships and various factors created by geographical proximity, historical trade links or industry requirements (Carter & Rozelle, 2002).

f) Taken together, the RCA and TCI results clearly demonstrate that India–China agricultural trade is structurally asymmetric, selectively complementary, and minimally competitive**.** India specializes in primary agricultural commodities for which China has significant and growing import demand, while China specializes in agro-processed products that occupy only a marginal position in India's import basket.

g) The collective indices suggest that India's agricultural export strategy toward China needs to be targeted and product-specific as India is best positioned to expand exports in a limited set of agricultural product groups. Therefore, SPS alignment, improving logistics, enhancing export infrastructure and increasing diplomatic engagement in the specified sectors is essential for converting India's natural comparative advantage into long-term bilateral trade gains.

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