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# ANALYSIS OF INDIA'S REVEALED COMPARATIVE ADVANTAGE IN AGRO-PROCESSED PRODUCTS

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**Abstract**

*The paper attempts to assess India's revealed comparative advantage (RCA) in agro-processed products. It also analyses the structure of comparative advantage in India and its change from 2003 to 2013. We have followed the scheme of commodity aggregation adopted in the World Integrated Trade Solution (WITS) for the purpose of analysis. Accordingly, 116 agro- processed products were grouped into three categories namely processed animal, vegetable and food products. The four variants of indices of RCA were used to get the products having comparative advantage to exports. The consistency and stability tests were also conducted for the indices over the years.*

***Key words:*** *Revealed Comparative Advantage, Agro-Processing, Exports, India.*

***JEL classification:*** *F14, Q17, Q18.*

## INTRODUCTION

Agriculture being the primary sector of Indian economy and has got a prime role in the economy. It provides an employment to over 50 percent of the rural workforce and is the single largest private sector occupation. It is also an important source of raw materials to industries like sugar, cotton and jute textile that depends directly on the same. India's foreign trade is also deeply connected with the agriculture sector. Despite its fall in contribution towards country's GDP, it accounts for about 14.7 per cent of the total export earnings in the country, where agro-processed products contribute significantly. This outlines the role of agro-processed products in India's export, having a multiplier effect on the economy.

According to FAO [1997], "Agro-processing is a subset of manufacturing that processes raw materials and intermediate products derived from the agricultural sector. Agro-processing thus means transforming products originating from agriculture, forestry and fisheries." Thus, the study of agro-processed products is

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important as it adds value to the raw material, which will boost the domestic employment in the country thereby contributing towards the India's foreign trade. Adding value to agricultural commodities has been identified as the important step towards achieving the objective of increment in exports, which further calls for the focus of the governmentpolicy.

Present study is based on India's revealed comparative advantage (RCA) in agro-processed products. The study analyses the structure of comparative advantage in India and its changes over a period of 11years from 2003 to 2013. Total numbers of 116 agro- processed products were grouped into three categories namely processed animal products, processed vegetable products and processed food products. Analysis has been done by using the four variants of indices of revealed comparative advantage. The study has also conducted various tests for consistency and stability for the indices over the years.

Chapter scheme begins with the study on trends and composition of agro-processed products' exports, along with its statistics, percentage share to the total agricultural exports and imports and its percentage share to the total national exports and imports. A substantial amount of review work has also been done to support the findings. Further, the paper has proposed a concrete methodology on which the entire analysis is based on. Last part of the paper contains the information about empirical findings and analysis, interpreting the results of the study. At the end the conclusion sums up the whole work along with the suitable policy implications.

## Trends and Composition of Agro-Processed Products Exports.

**Table 1a**
**Trends in Agro Processed Products' Trade**

| Year | Agro-processed products (APP) exports (Million USD) | Agro-processed products imports (Million USD) | Trade balance of Agro-processed products (Million USD) | % share of APP exports to total Agri. Exports | % share of APP imports to total Agri. Imports | % share of APP trade balance to total agri. Trade balance |
|---|---|---|---|---|---|---|
| TE 2005 | 4324.2 | 4034.09 | 8358.28 | 58.74 | 78.04 | 66.7 |
| TE 2009 | 7463.7 | 6964.09 | 14427.78 | 45.67 | 74.59 | 56.19 |
| TE 2013 | 16206.15 | 15356.17 | 31562.32 | 43.28 | 84.18 | 56.68 |

*Source:* Calculation based on the HS four digit level data from UNCOMTRADE database

From table 1a, we can observe that there is a substantial increase in agro processed product's exports and imports over time. The value of export has increased tremendously from 4324.20 million USDin 2005 to 16206.15 million USDin 2013. The imports also increasedtremendously from the year 2009but there is a gradual decrease in the percentage share of agro-processed products (APP) exports to the total agricultural export. Percentage share of APP imports to the total agricultural exports decreased in the year 2009 but it again increased in the year 2013.

**Table 1b**
**Table of Percentage Share of APP to National Trade**

| *Year* | *% share of APP exports to total national exports* | *% share of APP imports to total national imports* | *% share of APP trade balance to total national trade balance* |
|---|---|---|---|
| TE 2005 | 5.51 | 3.88 | 4.58 |
| TE 2009 | 4.44 | 4.14 | 4.29 |
| TE 2013 | 5.24 | 4.97 | 5.1 |

*Source:* Calculation based on the HS four digit level data from UNCOMTRADE database.

Table 1b shows that there is a decrease in percentage share of APP exports to the total national trade exports from 5.5 percent in the year 2005 to 4.5 percent in the year 2009 but after that there is a gradual increase in the share to 5.25 percent in the year 2013. Percentage share of APP imports to the total national trade imports have increased considerably from the year 2005. There is a slight decrease in the percentage share of APP trade balance to the total national trade balance from 4.5 percent in the year 2005 to 4. 3 per cent in the year 2009 but there is a sudden increase in the percentage to 5.10 per cent in the year 2013.

## LITERATURE REVIEW

Comparative advantage is the useful tool discovered by the David Ricardo [1817] in his book -Principles of Political Economy and Taxation. It determines the pattern of international trade, that is a country having comparative advantage exports and other having comparative disadvantage imports. This is a basic theoretical understanding of comparative advantage but it is always difficult to apply theoretical concept of comparative advantage in empirical analysis, especially when we have to measure the trade performance.

Ballance, Forstner and Murray [1987] draw a relationship between theoretical idea of comparative advantage and practical measurement of comparative advantage that we obtain through revealed comparative advantage method (RCA). They have given the following relation-

EC- CA- TPC- RCA.

This relation shows that the economic condition (EC) that determines country's international pattern of comparative advantage (CA) which depends on the country's pattern of international trade, production, consumption (TPC) which will evaluate the actual measure of comparative advantage(RCA).

Balassa [1965] first introduced the concept of Revealed Comparative Advantage (RCA). It had been transformed several times by Balassa [1977, 1979, and 1986]. Formula defined as a country's share of world exports of a commodity divided by its share of total world exports. The RCA of a commodity is greater than one indicates that India is efficient in exporting that commodity in world market. RCA has been used widely to analyse the changes in trading pattern [Yeates 1992; Amity 1999; Proudman and Redding 2000; Ferto and Hubbard 2003; Klasra and Fidan 2004; Batra and Khan 2005; Kannan 2010].

Ferto and Hubbard [2002]investigate the competitiveness of Hungarian agriculture in relation to that of the EU for the period 1992 to 1998 by using four indices of RCA namely the relative trade advantage which includes relative import advantage, the logarithm of the relative export advantage and revealed competitiveness. These indices are suggested by Vollrath [1991].They used 4-digit level of SITC classification. The paper has found that though there are significant changes in Hungarian agriculture during the 1990s, the pattern of revealed comparative advantage has remained stable.

Similarly by using the modified RCA indices namely RTA and ln REA,Gopal [2007] analysed the export performance and studied the revealed comparative advantage of finfish export from India for the period 2001 to 2005.They found that the finfish exports from India have not revealed any comparative advantage among the total marine products export in the period of study.

Oduro, Offei [2013] investigated the Ghana's revealed comparative advantage in agro- processed products. Their objective of the study is to find out the RCA index of agro- processed products and to check their stability and consistency by applying various tests like cardinal test, ordinal test and dichotomous test. They found the four various RCA indices as we discussed above for Ghana's trade in agro- processed products with the rest of the world from 2004- 2011. The data for the study was sourced from UN COMTRADE at four digit HS level of classification. A total 69 agro- processed product groups used as sample for this study. They found that nine agro- processed product groups have comparative advantage however the share of agro processed products in which Ghana has comparative advantage declined over the period 2004 to 2011.

Serin and Civan [2008] worked on 'Revealed Comparative Advantage and Competitiveness: A Case Study of for Turkey towards EU.' It investigated that Turkey's comparative advantage in the tomato, Olive oil and fruit juice industries and how this has changed over the period 1995-2005 in the EU market. They used the two important indexes for the analysis namely, revealed comparative advantage (RCA) and Comparative export performance (CEP) index. They have estimated the

import demand function of EU for rival countries. Their hypothesis was that if Turkey is competitor for these countries, its price has significant effect on export demand functions. Their results indicate that Turkey has high comparative advantage in the fruit juice and olive oil in the EU market, but tomato has comparative disadvantage in the market.

Using the similar techniques of indices and regression analysis of import and export demand function, Bhattacharyya [2011] investigated the revealed comparative advantage and competitiveness: A case study for India in horticultural products. This study shows the India's comparative advantage in vegetable, fruits, and flowers trade in the Asian, EU, and North American (USA and Canada) markets as compared to other south East Asian countries.They used the two important indexes for the analysis namely, RCA and Comparative Export Performance (CEP) index. They estimated the import demand function of EU for rival countries for the commodities like onion, mango and fresh flowers. This paper shows that India has a high comparative advantage in vegetable and fruits markets in the EU but this is not the case of flower market.

## DATA AND METHODOLOGY

This paper has sourced its data from UN COMTRADE database at HS four digit level of classification for the period 2003 to 2013. The study uses the World Integrated Trade Solution (WITS) for identifying and grouping the products for the purpose of analysis. Accordingly, 116 agro-processed products were analysed and grouped into three categories. These categories are

(1) Processed Animal Products.

(2) Processed Vegetable Products.

(3) Processed Food Products.

There is analysis of 32 products in the category of processed animal products, whereas 40 products were analysed in the processed vegetable products and 44 products analysed in the processed food products.Balassa (1965) developed the most widely used approach to analysing revealed comparative advantage known as the Balassa Index. This index is essentially an index of revealed export advantage (RXA) which can be expressed as:

$$RCA_{ij}^{1} = \frac{\left(\frac{Xij}{Xi}\right)}{\left(\frac{Xwj}{Xw}\right)} \qquad (1)$$

Where

$RCA^{1}_{ij}$ = first measure of revealed comparative advantage for country $i$ in product $j$;

$Xij$ = value of country $i$'s export of product $j$;

$Xi$ = value of country $i$'s total exports;

$Xwj$ = value of world exports of product $j$;

$Xw$ = value of world exports.

It measures the ratio of the share of a j[th] product in the i[th] country's total exports to the share of that product in world exports. When the value of the index is greater than one, it is the indication of revealed comparative advantage and value is less than one, it means revealed comparative disadvantage.There are several comments made on this index. Some of them are-

A) $RCA^1_{ij}$ is biased due to the omission of imports, particularly when country-size is important, [Greenaway and Milner 1993].

B) Export subsidies and other protectionist measures of governments may to an extent, distort RCA index hence there were some measures taken by the researcher to remove these biasness.

Vollrath [1991] proposed three alternative measures of a country's revealed comparative advantage.

1) The relative trade advantage (RTA) is expressed as the differencebetween the revealed export advantage (RXA) and revealed import advantage (RMA)

$$RCA^2_{ij} = RTA_{ij} = RXA_{ij} - RMA_{ij} \quad (2)$$

Where,

$$RXA = \frac{\left(\frac{Xij}{Xi}\right)}{\left(\frac{Xwj}{Xw}\right)}, \; RMA = \frac{\left(\frac{Mij}{Mi}\right)}{\left(\frac{Mwj}{Mw}\right)}$$

$RCA^2$ = second measure of comparative advantage

M = imports, X = exports.

2) The second alternative measure proposed by Vollrath is the logarithm of the relative export advantage and is defined as:

$$RCA^3 = ln\,(RXA_{ij}) \quad (3)$$

Where

$RCA^3$ = third measure of comparative advantage.

3) The third alternative measures proposed by Vollrath is revealed competiveness (RC) which is expressed as the difference between the logarithm of relative export advantage and the relative import advantage. This final measure is expressed as

$$RCA^4 = RC = ln(RXA_{ij}) - ln(RMA_{ij}) \quad (4)$$

Where,

$RCA^4$ = fourth measure of comparative advantage.

The positive value of RTA, ln(RCA), RC indicates the revealed comparative advantage whereas negative value gives revealed comparative disadvantage. This study will employ all the revealed comparative advantage indices specified above (equation 1 to 4) to estimates the India's revealed comparative advantage in agro processed products.

Ballance [1987] pointed out that the RCA indicators can provide information on the degree of comparative advantage a product has compared to other products. This is referred to as the cardinal interpretation. Products may be ranked on the basis of their revealed comparative advantage, thus providing an ordinal interpretation of the indices. Finally, in the dichotomous interpretation, product can be classified into two groups based on their comparative advantage or disadvantage. The consistency test of the indices as cardinal measures of comparative advantage is based on the correlation coefficient between paired indices over the period. The consistency test of the indices as ordinal measures of comparative advantage is based on rank correlation coefficient between paired indices over the years. The dichotomous test is simply the share of product groups in which both of the paired indices suggest comparative advantage or comparative disadvantage. Cardinality, ordinalityand dichotomous tests were used to check the consistency of the indices.

There are various measures used to check the stability of the indices. The coefficient of variation presented for the three categories of the products suggest that RCA indices are fairly stable over the years. A second indicator of stability in RCA which is used in the study is the correlation between the index in a period and the index in subsequent periods. Using TE2005 as a base year, the correlation coefficient for the four indices for India over the years (TE2009, TE2013) is calculated.

The distribution of the $RCA^1$ index (Balassa index) over the period as suggested by Hinloopen and Van Marrewijk[2001] is used to check whether the India's RCA has weakened or improved over the years.

## EMPIRICAL FINDINGS AND ANALYSIS

### (A) Revealed Comparative Advantage-

***(1) Processed Animal Products***: The study has analysed 32 processed animal products of which 7 products have revealed comparative advantage. These are the products in which all the four indices show a revealed comparative advantage. Table (2) shows the four indices of RCA values for processed animal product along with the average value and coefficient of variation. The result shows that the RCAs for meat of bovine animals, frozen (202) have increased during the studies and still manage to maintain their high rank among the processed animal products. Results

also show that, the RCAs of fish frozen excluding fish fillet (303) has stabled over the years. Crustaceans chilled or frozen, dried (306) has declined tremendously whereas, molluscs chilled or frozen, dried (307), birds' eggs (407,408), Natural honey (409) has declined slightly over the years. It is interesting to observe that the meat of bovine animals gaining high comparative advantage to export.

Overall Average value ($RCA^1$) shows that there is comparative advantage for exports in TE2005, but this value decline over the years and there is comparative disadvantage for exports in TE2009 and TE2013.

**Table 2**
**Processed Animal Products**

| | | *TE2005* | | | | *TE2009* | | | | *TE2013* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Product Code* | *Product Description* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* |
| 201 | Meat of bovine animals, fresh or ch | 0.07 | 0.07 | -2.8 | -2.8 | 0.05 | 0.05 | -3.07 | 0.08 | 0.11 | 0.11 | -2.3 | -2.3 |
| **202** | **Meat of bovine animals, frozen.** | **5.96** | **5.96** | **1.78** | **4.05** | **6.73** | **6.73** | **1.9** | **1.9** | **8.43** | **8.43** | **2.12** | **2.12** |
| 203 | Meat of swine, fresh, chilled or fr | 0 | 0 | -7.23 | 1.16 | 0 | 0 | -6.09 | 0.88 | 0 | 0 | -8.06 | -1.55 |
| 204 | Meat of sheep or goats, fresh, chil | 0.61 | 0.61 | -0.53 | 7.15 | 1.41 | 1.41 | 0.17 | 6.84 | 0.59 | 0.58 | -0.54 | 5.95 |
| 205 | Meat of horses, asses, mules or hin | 0 | 0 | -6.83 | -6.83 | 0 | 0 | -1.83 | -1.83 | 0 | 0 | -3.54 | -3.54 |
| 206 | Edible offal of bovine animals, swi | 0.05 | 0.05 | -2.98 | 3.05 | 0.09 | 0.09 | -2.43 | -0.41 | 0.58 | 0.58 | -0.75 | -0.75 |
| 207 | Meat and edible offal, of the poult | 0.03 | 0.03 | -3.82 | 4.96 | 0.01 | 0.01 | -4.87 | 4.38 | 0.02 | 0.02 | -4.02 | 5.08 |
| 208 | Other meat and edible meat offal, f | 0.13 | 0.13 | -2.02 | 0.99 | 0.04 | 0.04 | -4.35 | -4.35 | 0 | 0 | -6.79 | -5.29 |
| 209 | Pig fat, free of lean meat, and pou | 0 | 0 | -2.75 | -2.75 | 0.03 | 0.03 | -4.93 | -1.77 | 0 | 0 | -2.6 | -2.6 |
| 210 | Meat and edible meat offal, salted, | 0.07 | 0.07 | -2.65 | 4.18 | 0.06 | 0.06 | -2.92 | 3.6 | 0.03 | 0.03 | -4.17 | 4.67 |
| 302 | Fish, fresh or chilled, excluding f | 0.3 | 0.23 | -1.21 | 1.5 | 0.23 | 0.11 | -1.49 | 0.72 | 0.23 | 0.11 | -1.5 | 1.19 |
| **303** | **Fish, frozen, excluding fish fillet** | **1.96** | **1.95** | **0.61** | **6.3** | **1.68** | **1.67** | **0.49** | **5.93** | **1.89** | **1.89** | **0.64** | **5.96** |
| 304 | Fish fillets and other fish meat (w | 0.2 | 0.19 | -1.6 | 3.85 | 0.33 | 0.32 | -1.12 | 4.67 | 0.5 | 0.48 | -0.71 | 3.32 |
| 305 | Fish, dried, salted or in brine; sm | 0.38 | 0.37 | -0.99 | 3.67 | 0.23 | 0.22 | -1.46 | 2.88 | 0.25 | 0.24 | -1.42 | 3.28 |
| **306** | **Crustaceans, whether in shell or no** | **8.9** | **8.87** | **2.18** | **5.87** | **4.97** | **4.95** | **1.59** | **5.45** | **5.79** | **5.78** | **1.75** | **6.14** |
| **307** | **Molluscs, whether in shell or not,** | **3.33** | **3.31** | **1.2** | **4.96** | **2.7** | **2.68** | **0.98** | **4.75** | **3.27** | **3.26** | **1.18** | **5.31** |
| 401 | Milk and cream, not concentrated no | 0.01 | 0.01 | -4.36 | 0.79 | 0.05 | 0.05 | -2.95 | 3.62 | 0.03 | 0.03 | -3.48 | 3.36 |
| 402 | Milk and cream, concentrated or con | 0.64 | 0.55 | -0.64 | 2.47 | 0.6 | 0.58 | -0.61 | 3.48 | 0.4 | 0.26 | -1.58 | 1.07 |
| 403 | Buttermilk, curdled milk and cream, | 0.02 | 0.01 | -4.25 | 1.5 | 0.11 | 0.1 | -3.31 | 1.67 | 0.01 | 0.01 | -4.37 | 1.56 |
| 404 | Whey, whether or not concentrated o | 0.09 | -0.01 | -2.47 | -0.19 | 0.14 | 0.06 | -2.36 | 0.27 | 0.01 | -0.14 | -4.93 | -3 |
| 405 | Butter and other fats and oils deri | 0.27 | 0.14 | -1.36 | 0.93 | 0.54 | 0.37 | -0.69 | 2.08 | 0.29 | 0.23 | -1.26 | 2.34 |
| 406 | Cheese and curd. | 0.01 | 0 | -4.93 | -0.53 | 0.03 | 0.02 | -3.66 | 0.9 | 0.02 | 0.01 | -3.84 | 0.73 |
| **407** | **Birds' eggs, in shell, fresh, prese** | **2.79** | **2.75** | **1.02** | **4.24** | **1.8** | **1.79** | **0.49** | **5.09** | **0.59** | **0.58** | **-0.58** | **3.81** |
| **408** | **Birds' eggs, not in shell, and egg** | **5.76** | **5.74** | **1.75** | **6.08** | **3.98** | **3.98** | **1.32** | **8.51** | **2.1** | **2.1** | **0.74** | **8.75** |
| **409** | **Natural honey.** | **2.12** | **1.96** | **0.75** | **3.03** | **1.52** | **1.38** | **0.3** | **2.32** | **2.25** | **2.22** | **0.8** | **4.23** |
| 410 | Edible products of animal origin, n | 0.05 | 0.05 | -5.06 | -5.06 | 0.04 | 0.04 | -3.91 | -3.91 | 0.01 | 0.01 | -5.28 | -5.28 |
| 1501 | Pig fat (including lard) and poultry | 0.08 | 0.08 | -2.59 | -0.53 | 0 | 0 | -5.42 | -5.42 | 0 | 0 | -8.62 | -8.62 |
| 1502 | Fats of bovine animals, sheep or go | 0.88 | 0.88 | -1.21 | 0.86 | 0 | 0 | -8.06 | -3.64 | 0 | 0 | -8.47 | -8.47 |
| 1503 | Lard stearin, lard oil, oleostearin | 0.25 | 0.25 | -1.41 | 1.04 | 0 | -0.01 | -7.23 | -6.07 | 0.02 | 0.02 | -1.01 | -1.01 |
| 1504 | Fats and oils and their fractions, | 0.21 | 0 | -1.57 | -0.03 | 0.49 | 0.42 | -0.76 | 1.9 | 1.03 | 0.98 | 0 | 2.94 |
| 1505 | Wool grease and fatty substances de | 0.63 | -0.21 | -0.48 | -0.3 | 0.63 | 0.15 | -0.46 | 0.3 | 0.71 | 0.42 | -0.35 | 0.91 |
| 1506 | Other animal fats and oils and thei | 0.1 | 0.1 | -3.59 | 2.19 | 0.02 | 0.02 | -4.2 | -1.68 | 0 | 0 | -8.59 | -8.59 |
| | **Avg.** | **1.12** | **1.07** | **-1.88** | **1.74** | **0.89** | **0.85** | **-2.22** | **1.35** | **0.91** | **0.88** | **-2.55** | **0.68** |
| | **Coefficient of Variation** | **1.87** | **1.98** | **-1.27** | **1.85** | **1.8** | **1.88** | **-1.17** | **2.69** | **2.02** | **2.09** | **-1.22** | **6.74** |

*Source:* UNCOMTRADE

***(2) Processed Vegetable Products***: India has interestingly a relatively high comparative advantage on the export of processed vegetable products. Out of 40 processed vegetable products, 12 have comparative advantage in all the four indices of RCA over the period. Table (3) shows the four indices of RCA values for processed vegetable products along with the average value and coefficient of variation.

Vegetables provisionally preserved (711), coconuts, Brazil nuts and cashew nuts fresh or dried (801), fruits and nuts provisionally preserved (812), Tea, whether or not flavoured (902), Ground-nut oil and its fractions (1508) having relatively high comparative advantage in TE2005, but it gradually decreases over the years. Coconuts, Brazil nuts and cashew nuts fresh or dried (801) had very high RCA[1] value of 37.50 in TE2005 but it decreases to 10.30 in TE2013. Pepper of the genus piper dried (904), vanilla (905), other fixed vegetable fats and oils(1515) show ups and down in their RCA values. These values increase from the year TE2005 up to the year 2009 and then it gradually decreases in TE2013.

It is interesting that, the values of RCA of flour, meal and powder of the dried leguminous vegetables of heading (1106) gradually increasing over the years. Average value of processed vegetable products shows a decreasing trend of RCA values. Value of RCA[1] for TE2005 is 3.27 and thereafter it became 1.72 in TE2013

**Table 3**
**Processed Vegetable Products**

| | | TE2005 | | | | TE2009 | | | | TE2013 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| products Code | Product Description | RCA [1] >1 | RCA [2] >0 | RCA [3] >0 | RCA [4] >0 | RCA [1] >1 | RCA [2] >0 | RCA [3] >0 | RCA [4] >0 | RCA [1] >1 | RCA [2] >0 | RCA [3] >0 | RCA [4] >0 |
| **711** | **Vegetables provisionally preserved** | **8.08** | **8.04** | **2.07** | **5.61** | **7.78** | **7.74** | **2.05** | **5.21** | **3.16** | **4.76** | **0.32** | **3.8** |
| **712** | **Dried vegetables, whole, cut, slice** | **2.11** | **2.06** | **0.72** | **3.56** | **2.09** | **2.01** | **0.61** | **3.14** | **1.25** | **2.29** | **-0.5** | **3.31** |
| 713 | Dried leguminous vegetables, shelle | 5.05 | -11.34 | 1.57 | -1.2 | 1.71 | -12.04 | 0.41 | -2.2 | 3.95 | -7.24 | 1.02 | -1.68 |
| 714 | Manioc, arrowroot, salep, Jerusalem | 0.1 | 0.1 | -2.41 | 4.11 | 0.08 | 0.08 | -2.6 | 4.37 | 0.04 | 0.07 | -4.33 | 1.74 |
| **801** | **Coconuts, Brazil nuts and cashew** | **37.5** | **20.64** | **3.6** | **0.79** | **17.26** | **8.72** | **2.84** | **0.69** | **10.3** | **3.32** | **2.26** | **0.33** |
| 802 | Other nuts, fresh or dried, whether | 0.58 | -1.83 | -0.55 | -1.43 | 0.43 | -1.48 | -0.86 | -1.49 | 0.23 | -1.59 | -1.49 | -2.08 |
| 805 | Citrus fruit, fresh or dried. | 0.22 | 0.21 | -1.55 | 3.72 | 0.13 | 0.1 | -2.08 | 1.79 | 0.1 | 0.04 | -2.35 | 0.47 |
| 806 | Grapes, fresh or dried. | 0.72 | 0.52 | -0.35 | 1.32 | 1.02 | 0.89 | 0.01 | 2.07 | 1.02 | 0.92 | -0.03 | 2.28 |
| 811 | Fruit and nuts, uncooked or cooked | 0.08 | 0.07 | -2.68 | 2.37 | 0.17 | 0.16 | -1.81 | 4.22 | 0.37 | 0.68 | -0.99 | 4.04 |
| **812** | **Fruit and nuts, provisionally prese** | **9.58** | **9.57** | **2.09** | **6.04** | **2.47** | **2.46** | **0.89** | **6.89** | **0.5** | **0.91** | **-1.57** | **2.58** |
| 813 | Fruit, dried, other than that of he | 0.48 | 0.15 | -0.74 | 0.41 | 0.47 | 0.19 | -0.77 | 0.53 | 0.55 | 0.71 | -0.71 | 0.98 |
| **901** | **Coffee, whether or not roasted.** | **2.34** | **2.21** | **0.83** | **3.05** | **1.4** | **1.28** | **0.31** | **2.38** | **1.06** | **0.94** | **0.06** | **2.14** |
| **902** | **Tea, whether or not flavoured.** | **12.84** | **12.14** | **2.55** | **2.95** | **8.38** | **8.11** | **2.14** | **2.9** | **8.95** | **8.00** | **2.18** | **3.41** |
| 903 | Maté. | 0.26 | -0.23 | -1.79 | 0.16 | 0.03 | 0.03 | -3.58 | -1.06 | 0 | 0 | -5.73 | -5.73 |
| **904** | **Pepper of the genus Piper; dried** | **13.21** | **11.26** | **2.58** | **1.92** | **15.99** | **14.77** | **2.75** | **2.56** | **10.86** | **9.78** | **2.38** | **2.31** |
| **905** | **Vanilla.** | **1.69** | **1.68** | **0.43** | **5.43** | **4.87** | **4.8** | **1.55** | **4.26** | **2.01** | **1.81** | **0.61** | **2.29** |
| 1101 | Wheat or meslin flour. | 2.8 | 2.7 | 0.73 | 3.05 | 0.22 | 0.2 | -1.7 | 2.31 | 0.79 | 0.77 | -0.35 | 3.73 |
| 1102 | Cereal flours other than of wheat o | 1.44 | 1.41 | 0.33 | 4.01 | 2 | 1.97 | 0.67 | 4.26 | 0.95 | 0.93 | -0.12 | 3.79 |
| 1103 | Cereal groats, meal and pellets. | 1.62 | 1.58 | 0.1 | 3.94 | 0.58 | 0.55 | -0.61 | 2.82 | 0.83 | 0.77 | -0.19 | 2.76 |
| 1104 | Cereal grains otherwise worked (for | 0.06 | 0.02 | -2.91 | 0.57 | 0.07 | -0.15 | -2.72 | -1.15 | 0.17 | -0.35 | -1.9 | -1.22 |
| 1105 | Flour, meal, powder, flakes, granul | 0.11 | -0.12 | -2.43 | -0.86 | 0.26 | 0.23 | -1.46 | 1.82 | 0.47 | 0.43 | -0.76 | 2.53 |
| **1106** | **Flour, meal and powder of the dried** | **2.7** | **2.56** | **0.98** | **3.5** | **3.81** | **3.67** | **1.33** | **3.25** | **4.38** | **4.22** | **1.44** | **3.3** |
| 1107 | Malt, whether or not roasted. | 0.01 | 0.01 | -4.72 | 1.33 | 0.03 | -0.02 | -3.72 | -0.51 | 0.05 | 0.01 | -3.18 | 0.12 |
| 1108 | Starches; inulin. | 0.48 | 0.36 | -0.8 | 1.38 | 0.47 | 0.34 | -0.8 | 1.41 | 0.92 | 0.81 | -0.1 | 2.2 |
| 1109 | Wheat gluten, whether or not dried. | 0.07 | 0.44 | 3.92 | 3.23 | 0.07 | 0.2 | 3.25 | 1.73 | 0.01 | 0.13 | 4.47 | 2.45 |
| 1507 | Soya-bean oil and its fractions, wh | 0.11 | -11.26 | -2.38 | -4.8 | 0.06 | -3.66 | -3.15 | -4.32 | 0.03 | -5.02 | -4.29 | -5.9 |
| **1508** | **Ground-nut oil and its fractions, w** | **10.73** | **10.72** | **1.98** | **7.4** | **4.93** | **4.93** | **0.2** | **6.66** | **3.12** | **3.1** | **0.86** | **4.54** |
| 1509 | Olive oil and its fractions, whether | 0 | -0.08 | -7.16 | -4.58 | 0 | -0.09 | -7.37 | -4.93 | 0.01 | -0.17 | -5.35 | -3.63 |
| 1510 | Other oils and their fractions, obt | 0.24 | 0.24 | -2.25 | 4.43 | 0.13 | 0.1 | -2.49 | 1.69 | 0.01 | -0.27 | -4.98 | -3.45 |
| 1511 | Palm oil and its fractions, whether | 0.01 | -14.82 | -5.62 | -8.27 | 0 | -5.8 | -7.24 | -8.98 | 0 | -7.86 | -7.66 | -9.71 |
| 1512 | Sunflower-seed, safflower or cotton | 0.02 | -1.54 | -3.83 | -3.96 | 0.09 | -1.82 | -3.1 | -3.47 | 0.02 | -4.4 | -4.17 | -5.65 |
| 1513 | Coconut (copra), palm kernel or bab | 0.99 | -1.55 | -0.02 | -0.94 | 0.39 | -1.44 | -0.96 | -1.55 | 0.15 | -1.23 | -1.96 | -2.23 |
| 1514 | Rape, colza or mustard oil and frac | 0.09 | 0.09 | -2.41 | 2.2 | 0.05 | -0.08 | -3.19 | 2.12 | 0.02 | -0.28 | -3.71 | -2.2 |
| **1515** | **Other fixed vegetable fats and oils** | **10.87** | **10.65** | **2.38** | **3.87** | **11.63** | **11.44** | **2.45** | **4.21** | **10.74** | **10.52** | **2.37** | **3.89** |
| 1516 | Animal or vegetable fats and oils a | 1.25 | -2.68 | 0.16 | -1.04 | 0.72 | -0.79 | -0.32 | 0.06 | 0.65 | 0.51 | -0.45 | 1.51 |
| 1517 | Margarine; edible mixtures or prepa | 0.17 | 0.04 | -1.8 | 0.4 | 0.03 | -0.12 | -3.42 | -0.78 | 0.04 | 0.03 | -3.41 | 1.39 |
| **1518** | **Animal or vegetable fats and oils a** | **2.26** | **1.41** | **0.81** | **1.54** | **1.99** | **1.96** | **0.23** | **3.83** | **0.48** | **0.37** | **-0.93** | **1.46** |
| 1520 | Glycerol, crude; glycerol waters an | 0.05 | -1.67 | -3.19 | -3.72 | 0.19 | -1.61 | -1.92 | -2.45 | 0.05 | -0.45 | -3.09 | -2.38 |
| 1521 | Vegetable waxes (other than triglyc | 0.17 | -0.31 | -1.83 | -1.37 | 0.27 | -0.27 | -1.32 | -0.08 | 0.24 | -0.27 | -1.43 | -0.73 |
| 1522 | Degras; residues resulting from the | 0.01 | 0.01 | -1.36 | -1.36 | 0.03 | 0.03 | -3.72 | -3.72 | 0.39 | 0.39 | -1.37 | 0.82 |
| | **Avg.** | **3.27** | **1.3** | **-0.82** | **1.07** | **2.31** | **1.18** | **-1.14** | **0.91** | **1.72** | **0.71** | **-1.45** | **0.32** |
| | **Coefficient of Variation** | **2.06** | **4.819** | **-2.95** | **3.16** | **1.83** | **3.791** | **-2.1** | **3.69** | **1.791** | **5.032** | **-1.68** | **10.51** |

*Source:* UNCOMTRADE

***3) Processed Food Products***: Processed food products consist of 44 products of which only 7 have all the four indices which show a revealed comparative advantage. Table (4) shows the four indices of RCA values for processed food products along with the average value and coefficient of variation.

Cane or beet sugar and chemically pure sucrose, in solid form (1701), Molasses resulting from the extraction or refining of sugar (1703), and substitutes prepared from starch (1903) had relatively high value of RCAs in TE2005 but there after it decreased in TE2013. The products like Mushrooms and truffles prepared or preserved (2001) and Extracts, essences and concentrates, of coffee, tea or mate (2101) show decreasing value of RCA over the years.

**Table 4**
**Processed Food Products**

| | | TE2005 | | | | TE2009 | | | | TE2013 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Product Code* | *Product Description* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* | *$RCA^1$ >1* | *$RCA^2$ >0* | *$RCA^3$ >0* | *$RCA^4$ >0* |
| 1601 | Sausages and similar products, | 0 | 0 | -5.61 | -0.8 | 0.01 | -0.02 | -5.13 | -1.27 | 0.01 | 0 | -4.77 | -0.39 |
| 1602 | Other prepared or preserved meat, | 0.02 | 0.02 | -3.82 | 2.28 | 0.01 | 0 | -5.1 | 0.61 | 0 | 0 | -5.79 | -0.17 |
| 1603 | Extracts and juices of meat, | 0.54 | 0.42 | -0.89 | 1.46 | 1.86 | 1.78 | 0.37 | 2.93 | 3 | 2.93 | -0.64 | 2.06 |
| 1604 | Prepared or preserved fish; caviar | 0.3 | 0.3 | -1.26 | 5.84 | 0.35 | 0.34 | -1.11 | 5.87 | 0.17 | 0.17 | -1.89 | 5.14 |
| 1605 | Crustaceans, molluscs and other aqua | 1.79 | 1.79 | 0.57 | 7.4 | 1.76 | 1.75 | 0.56 | 5.92 | 0.4 | 0.4 | -0.94 | 5.28 |
| **1701** | **Cane or beet sugar and chemically preserved** | **1.97** | **1.09** | **-0.05** | **0.76** | **4.1** | **3.37** | **0.46** | **3.08** | **2.65** | **2.29** | **0.87** | **2.29** |
| 1702 | Other sugars, including chemically | 0.54 | 0.19 | -0.61 | 0.44 | 0.51 | 0.2 | -0.69 | 0.5 | 0.69 | 0.38 | -0.38 | 0.79 |
| **1703** | **Molasses resulting from the extract** | **1.19** | **-1.93** | **-0.1** | **-0.75** | **5.37** | **5.17** | **0.99** | **2.8** | **2.59** | **2.57** | **0.88** | **4.84** |
| 1704 | Sugar confectionery (including whit | 0.29 | 0.22 | -1.26 | 1.45 | 0.34 | 0.27 | -1.08 | 1.55 | 0.36 | 0.29 | -1.04 | 1.71 |
| 1801 | Cocoa beans, whole or broken, raw o | 0 | -0.11 | -7.64 | -5.43 | 0.01 | -0.13 | -7.8 | -5.82 | 0.01 | -0.23 | -5.21 | -3.72 |
| 1802 | Cocoa shells, husks, skins and othe | 0.02 | 0.01 | -5.49 | -4.2 | 0.06 | 0.06 | -3.57 | -3.57 | 0 | -0.04 | -1.67 | 0.39 |
| 1803 | Cocoa paste, whether or not defatte | 0.01 | -0.01 | -6.02 | -1.37 | 0 | -0.09 | -8.62 | -6.19 | 0 | -0.24 | -6.43 | -4.96 |
| 1804 | Cocoa butter, fat and oil. | 0.06 | 0.01 | -4.01 | -0.64 | 0.07 | 0.03 | -2.85 | 0.66 | 0.24 | 0.17 | -1.46 | 1.25 |
| 1805 | Cocoa powder, not containing added | 0 | -0.26 | -5.67 | -4.36 | 0.01 | -0.27 | -5.45 | -4.17 | 0.01 | -0.29 | -5.15 | -3.9 |
| 1806 | Chocolate and other food preparatio | 0.04 | -0.02 | -3.23 | -0.45 | 0.05 | -0.02 | -3.03 | -0.35 | 0.09 | -0.02 | -2.55 | -0.32 |
| 1901 | Malt extract; food preparations of | 0.33 | 0.28 | -1.12 | 1.94 | 0.37 | 0.36 | -0.99 | 3.04 | 0.35 | 0.33 | -1.05 | 2.73 |
| 1902 | Pasta, whether or not cooked or stu | 0.07 | -0.05 | -2.61 | -0.49 | 0.1 | 0.02 | -2.27 | 0.28 | 0.13 | 0.1 | -2.01 | 1.29 |
| **1903** | **Tapioca and substitutes therefor pr** | **2.92** | **2.35** | **1.05** | **1.8** | **3.45** | **3.03** | **1.15** | **2.7** | **1.3** | **1.1** | **0.13** | **1.93** |
| 1904 | Prepared foods obtained by the swel | 0.55 | 0.19 | -0.62 | 0.41 | 0.4 | 0.34 | -0.92 | 2.05 | 0.32 | 0.3 | -1.15 | 3.11 |
| 1905 | Bread, pastry, cakes, biscuits and | 0.39 | 0.36 | -0.96 | 2.69 | 0.46 | 0.43 | -0.8 | 2.8 | 0.49 | 0.46 | -0.72 | 2.98 |
| **2001** | **Vegetables, fruit, nuts and other e** | **5.32** | **5.25** | **1.66** | **4.78** | **6.34** | **6.32** | **1.84** | **6.11** | **4.58** | **4.57** | **1.52** | **5.51** |
| 2002 | Tomatoes prepared or preserved othe | 0.01 | -0.08 | -4.82 | -2.38 | 0.01 | -0.07 | -4.98 | -2.34 | 0.01 | -0.06 | -4.27 | -1.68 |
| **2003** | **Mushrooms and truffles, prepared** | **2.03** | **2.03** | **0.68** | **6.14** | **0.74** | **0.73** | **-0.5** | **4.21** | **0.89** | **0.88** | **-0.16** | **4.45** |
| 2004 | Other vegetables prepared or presser | 0.18 | 0.1 | -1.69 | 0.75 | 0.14 | 0.07 | -2.03 | 0.71 | 0.15 | 0.11 | -1.87 | 1.2 |
| 2005 | Other vegetables prepared or presser | 0.06 | 0.04 | -2.79 | 1.19 | 0.21 | 0.2 | -1.55 | 2.55 | 0.17 | 0.16 | -1.77 | 2.55 |
| 2006 | Vegetables, fruit, nuts, fruit-peel | 0.34 | 0.32 | -1.07 | 2.89 | 0.07 | 0.06 | -2.83 | 1.34 | 0.17 | 0.07 | -1.91 | 0.47 |
| **2007** | **Jams, fruit jellies, marmalades, fr** | **1.05** | **0.96** | **0.02** | **2.4** | **1.8** | **1.75** | **0.58** | **3.76** | **1.66** | **1.61** | **0.5** | **3.51** |
| 2008 | Fruit, nuts and other edible parts | 0.19 | 0.16 | -1.69 | 1.92 | 0.21 | 0.17 | -1.61 | 1.76 | 0.32 | 0.29 | -1.17 | 2.2 |
| 2009 | Fruit juices (including grape must) | 0.1 | 0.01 | -2.36 | 0.08 | 0.05 | -0.02 | -3.09 | -0.38 | 0.05 | -0.03 | -3.2 | -0.67 |
| **2101** | **Extracts, essences and concentrates** | **3.52** | **3.49** | **1.26** | **4.56** | **2.57** | **2.54** | **0.94** | **4.47** | **2.02** | **2** | **0.69** | **4.42** |
| 2102 | Yeasts (active or inactive); other | 0.4 | 0.26 | -0.96 | 1.07 | 0.17 | 0.08 | -1.8 | 0.59 | 0.07 | -0.07 | -2.62 | -0.69 |
| 2103 | Sauces and preparations therefor; m | 0.09 | 0.05 | -2.47 | 0.88 | 0.13 | 0.06 | -2.08 | 0.6 | 0.14 | 0.09 | -1.97 | 1.12 |
| 2104 | Soups and broths and preparations t | 0.03 | -0.02 | -3.55 | -0.19 | 0.09 | 0.07 | -2.48 | 1.61 | 0.11 | 0.1 | -2.32 | 2.16 |
| 2105 | Ice cream and other edible ice, whe | 0.02 | 0.02 | -4.1 | 1.62 | 0.01 | 0.01 | -4.23 | 0.77 | 0.02 | 0 | -4.06 | -0.05 |
| 2106 | Food preparations not elsewhere spe | 0.31 | 0.24 | -1.19 | 1.48 | 0.24 | 0.17 | -1.42 | 1.27 | 0.26 | 0.16 | -1.34 | 0.95 |
| 2201 | Waters, including natural or artifi | 0.04 | -0.03 | -3.23 | -0.42 | 0.01 | -0.01 | -4.43 | -0.54 | 0.01 | 0 | -4.93 | -0.07 |
| 2202 | Waters, including mineral waters an | 0.04 | -0.16 | -3.18 | -1.56 | 0.03 | -0.14 | -3.66 | -1.83 | 0.03 | -0.13 | -3.49 | -1.67 |
| 2203 | Beer made from malt. | 0.09 | 0.08 | -2.4 | 1.77 | 0.07 | 0.06 | -2.64 | 1.87 | 0.14 | 0.12 | -2 | 2.4 |
| 2204 | Wine of fresh grapes, including for | 0 | -0.01 | -5.53 | -1.37 | 0.01 | -0.01 | -4.61 | -0.88 | 0.01 | -0.02 | -4.72 | -1.05 |
| 2205 | Vermouth and other wine of fresh | 0.04 | 0.04 | -3.62 | 2.04 | 0.01 | 0 | -5.2 | -0.29 | 0.01 | -0.01 | -6.15 | -2.1 |
| 2206 | Other fermented beverages (for exam | 0.01 | 0 | 5.74 | 0.3 | 0.11 | 0.11 | 2.59 | 3.19 | 0.01 | 0.01 | 5.28 | 1.85 |
| 2207 | Undenatured ethyl alcohol of an alc | 0.29 | -3.31 | -1.39 | -2.22 | 0.22 | -0.49 | -1.67 | -0.92 | 0.82 | 0.67 | -0.21 | 1.71 |
| 2208 | Undenatured ethyl alcohol of an alc | 0.14 | 0.02 | -1.96 | 0.21 | 0.26 | 0.08 | -1.37 | 0.35 | 0.29 | 0.03 | -1.25 | 0.1 |
| 2209 | Vinegar and substitutes for vinegar | 0.05 | -0.92 | -2.95 | -2.9 | 0.18 | -0.29 | -1.85 | -1.04 | 0.04 | -0.1 | -3.18 | -1.26 |
| | **AVG.** | **0.58** | **0.3** | **-2.33** | **0.71** | **0.75** | **0.64** | **-2.25** | **0.92** | **0.56** | **0.48** | **-2.19** | **1.08** |
| | **Coefficient of Variation** | **1.87** | **4.12** | **-0.9** | **3.75** | **1.95** | **2.23** | **-1** | **3.01** | **1.75** | **2.05** | **-0.95** | **2.242** |

*Source:* UN COMTRADE

Extracts and juices of meat, fish or crustaceans, molluscs or other aquatic invertebrates (1603) had comparative disadvantage till TE2005 and thereafter it improved with $RCA^1$ value of 3.00 in TE2013. Crustaceans, molluscs and other aquatic invertebrates, prepared or preserved.(1605) had comparative advantage till TE2005 but it shows comparative disadvantage in TE2013. Average value of processed food products shows comparative disadvantage for India over the years.

## (B) Consistency of Revealed Comparative Advantage

***(1) Cardinality Test***: The correlation coefficient which has used to examine the consistency of cardinal measure. The result of the consistency tests for cardinality of the four alternative revealed comparative advantage indices from TE2005 to TE2013 are presented in table (5A).The critical cut-off point to indicate consistency is >0.70.

Test for consistency for processed animal products shows that six possible pairing for each of the three years (TE2005, TE2009, and TE2013) only 6 out of 18 paired indices or 33.33percent show a high level of correlation (>0.70). For processed vegetable products, six possible pairing for each of the three years, only 5 out of the 18 paired indices or 27.77 percent show a high level of correlation, and for processed food products, only 6 out of 18 paired indices or 33.33 percent show a high level of correlation.

The results show that only two of the six possible pairings ($RCA^1$ and $RCA^2$) and (RCA3 and RCA4) show a high level of correlation. Similar results were obtained for the Hungarian agro-food sector [Imreferto, Lionel J. Hubbard, 2002] and Ghana's Agro- processed sector [Oduro, Offei, 2013].Thissuggests that the indices are not consistent as cardinal measures ofcomparative advantage.

**Table 5: Tables of Consistency Tests**

**Table 5a**
**Cardinal Test**

| | *Processed Animal Products.* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *TE 2005* | | | *TE 2009* | | | *TE 2013* | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.997391 | | | 0.998351 | | | 0.999442 | | |
| $RCA^3$ | 0.710447 | 0.692729 | | 0.694984 | 0.678492 | | 0.599152 | 0.591644 | |
| $RCA^4$ | 0.50404 | 0.509533 | 0.653607 | 0.485327 | 0.484136 | 0.736723 | 0.39461 | 0.392463 | 0.784655 |
| | Processed Vegetable Products | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.764254 | | | 0.81392 | | | 0.718515 | | |
| $RCA^3$ | 0.6395 | 0.633807 | | 0.694552 | | | 0.692647 | 0.661221 | |
| $RCA^4$ | 0.261266 | 0.620643 | 0.635403 | 0.348317 | 0.57545 | 0.710499 | 0.355399 | 0.686953 | 0.791304 |
| | Processed Food Products | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.821454 | | | 0.993253 | | | 0.99523 | | |
| $RCA^3$ | 0.682408 | 0.473339 | | 0.650025 | 0.644644 | | 0.670455 | 0.670808 | |
| $RCA^4$ | 0.525757 | 0.598348 | 0.718228 | 0.522627 | 0.554198 | 0.8471 | 0.544564 | 0.591663 | 0.793406 |

***(2) Ordinality Test***: The consistency test of the indices as ordinal measures are similar but it is basedon the rank correlation coefficient for each pairing.Table (5B) gives the results, which shows that, for processed animal products,16 out of 18 pairing or 88.88 percent show a high level of correlation (>0.70), whereas for processed vegetable products, 14 out of 18 pairing or 77.77 percent show a high level of correlation. Processed food products show 16 out of 18 pairing or 88.88 percent products having high level of correlation. These results interpret that the indices are more consistent in rankingproduct groups by revealedcomparative advantage.

**Table 5b**
**Ordinal Test**

| | *Processed Animal Products.* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *TE 2005* | | | *TE 2009* | | | *TE 2013* | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.83 | | | 0.99 | | | 0.97 | | |
| $RCA^3$ | 0.97 | 0.78 | | 0.94 | 0.94 | | 0.91 | 0.91 | |
| $RCA^4$ | 0.61 | 0.71 | 0.6 | 0.74 | 0.76 | 0.72 | 0.77 | 0.76 | 0.72 |
| | *Processed Vegetable Products* | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.72 | | | 0.75 | | | 0.81 | | |
| $RCA^3$ | 0.97 | 0.72 | | 0.99 | 0.74 | | 0.99 | 0.79 | |
| $RCA^4$ | 0.58 | 0.8 | 0.55 | 0.66 | 0.82 | 0.66 | 0.75 | 0.85 | 0.75 |
| | *Processed Food Products* | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 0.76 | | | 0.88 | | | 0.93 | | |
| $RCA^3$ | 0.99 | 0.75 | | 0.99 | 0.88 | | 0.95 | 0.9 | |
| $RCA^4$ | 0.65 | 0.86 | 0.66 | 0.79 | 0.9 | 0.8 | 0.79 | 0.88 | 0.79 |

(***3) Dichotomous Test:*** This test is based on the share of product groups in which both of the paired indices suggest comparative advantage or comparative disadvantage. Table (5C) gives the results, which shows that, for processed animal products, only 6 out of 18 or 33.33% show a high level of correlation(>70) whereas, for processed vegetable products, only 10 out of 18 pairing or 55.56% show a high level of correlation. Processed food products shows only 6 out of 18 pairing or 33.33% products having high level of correlation. These results show that the only processed vegetable products are consistent according to the dichotomous test criterion.

**(C) Stability of Revealed Comparative Advantage-**

There are various stability tests available in literature. Here we applied two measures to check the stability of the indices. The coefficient of variation (CV) presented in the table 1 to 3, suggest that RCA indices are fairly stable over the years.

**Table 5c**
**Dichotomous Test- Share (Per cent) of Matching Indices**

| | *Processed Animal Products.* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *TE 2005* | | | *TE 2009* | | | *TE 2013* | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 34.38 | | | 28.13 | | | 31.25 | | |
| $RCA^3$ | 100 | 34.38 | | 100 | 28.13 | | 96.88 | 28.13 | |
| $RCA^4$ | 50 | 84.38 | 50 | 53.13 | 75 | 53.13 | 59.38 | 71.88 | 56.25 |
| | *Processed Vegetable Products* | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 65 | | | 70 | | | 57.5 | | |
| $RCA^3$ | 100 | 65 | | 100 | 70 | | 95 | 52.5 | |
| $RCA^4$ | 65 | 95 | 65 | 70 | 90 | 70 | 60 | 97.5 | 55 |
| | *Processed Food Products* | | | | | | | | |
| | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ | $RCA^1$ | $RCA^2$ | $RCA^3$ |
| $RCA^2$ | 45.45 | | | 47.73 | | | 50 | | |
| $RCA^3$ | 95.45 | 45.45 | | 100 | 47.73 | | 97.73 | 47.73 | |
| $RCA^4$ | 50 | 95.45 | 50 | 50 | 97.73 | 50 | 50 | 95.45 | 47.73 |

*Source: UN COMTRADE*

A second indicator of stability in RCA which is used in the study is the correlation between the indexin a period and the index in subsequent periods (table 6). Using the base year as TE2005, we have calculated the correlation coefficient between the indices. The results indicate that 19 out of 24 paired indices are greater than cut-off point (>.70). This shows that there is good stability amongst the paired indices of RCA.

Examining the changes in the distribution of the $RCA^1$ (Balassa Index) over the period as suggested by Hinloopen and Van Marrewijk [2001] shows that India's RCA for three categories of agro-processed products has weakened somewhat i.e. the distribution has tended to shift to the left, yielding a higher proportion of lower value indices. This has shown in the table (7). The mean value of the $RCA^1$ index for processed animal product has decreased from 1.12 to 0.91 over the period and maximum value decreased from 8.90 to 8.43. Further more in TE2005, 81.25 percent of the $RCA^1$ values were less than 2 and by TE2013 this share had risen to 84.38 percent.

The mean value of the $RCA^1$ index for processed vegetable products has decreased from 3.27 to 1.72 over the period and maximum value decreased from 37.50 to 10.86. Furthermore in TE2005, 67.5 percent of the $RCA^1$ values were less than 2 and by TE2013 this share had risen to 77.5 percent. Whereas interesting results were found for the processed food products, the mean value of the $RCA^1$ index for processed food products has decreased from 0.58 to 0.56 over the period and maximum value decreased from 5.32 to 4.58. Furthermore in TE2005, 90.9 percent of the $RCA^1$ values were less than 2 and by TE2013 this share had decreased

to 88.6 percent. It is interesting to observed that the mean value were relatively stable for processed food products and $RCA^1$ value of less than 2 were decreased over the years.

The overall result shows that there is apparent weakening of comparative advantage as revealed by the $RCA^1$ index, accords with the relative fall in the India's agro-processed products to the world.

**Table 6**
**Stability Test**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Processed Animal Products* | | | | | | | |
| | $RCA^1_{TE2005}$ | | $RCA^2_{TE2005}$ | | $RCA^3_{TE2005}$ | | $RCA^4_{TE2005}$ |
| $RCA^1_{TE2009}$ | 0.93671 | $RCA^2_{TE2009}$ | 0.936716 | $RCA^3_{TE2009}$ | 0.658925 | $RCA^4_{TE2009}$ | 0.713499 |
| $RCA^1_{TE2013}$ | 0.865117 | $RCA^2_{TE2013}$ | 0.863542 | $RCA^3_{TE2013}$ | 0.69324 | $RCA^4_{TE2013}$ | 0.675052 |
| *Processed Vegetable Products.* | | | | | | | |
| | $RCA^1_{TE2005}$ | | $RCA^2_{TE2005}$ | | $RCA^3_{TE2005}$ | | $RCA^4_{TE2005}$ |
| $RCA^1_{TE2009}$ | 0.879637 | $RCA^2_{TE2009}$ | 0.868642 | $RCA^3_{TE2009}$ | 0.925918 | $RCA^4_{TE2009}$ | 0.938261 |
| $RCA^1_{TE2013}$ | 0.801364 | $RCA^2_{TE2013}$ | 0.832895 | $RCA^3_{TE2013}$ | 0.853123 | $RCA^4_{TE2013}$ | 0.777328 |
| *Processed Food Products.* | | | | | | | |
| | $RCA^1_{TE2005}$ | | $RCA^2_{TE2005}$ | | $RCA^3_{TE2005}$ | | $RCA^4_{TE2005}$ |
| $RCA^1_{TE2009}$ | 0.844666 | $RCA^2_{TE2009}$ | 0.57634 | $RCA^3_{TE2009}$ | 0.903886 | $RCA^4_{TE2009}$ | 0.857751 |
| $RCA^1_{TE2013}$ | 0.806149 | $RCA^2_{TE2013}$ | 0.540904 | $RCA^3_{TE2013}$ | 0.852099 | $RCA^4_{TE2013}$ | 0.72366 |

*Source: UN COMTRADE*

**Table 7**
**Distribution of RCA1 Index**

| | *Processed Animal Products.* | | | *Processed Vegetable Products.* | | | *Processed Food Products.* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *TE2005* | *TE2009* | *TE2013* | *TE2005* | *TE2009* | *TE2013* | *TE2005* | *TE2009* | *TE2013* |
| **MEAN** | 1.12 | 0.89 | 0.91 | 3.27 | 2.31 | 1.72 | 0.58 | 0.75 | 0.56 |
| **MAXIMUM** | 8.9 | 6.73 | 8.43 | 37.5 | 17.26 | 10.86 | 5.32 | 6.34 | 4.58 |
| **Percent of $RCA^1$ Index** | | | | | | | | | |
| **<1** | 78.13 | 75 | 78.13 | 57.5 | 62.5 | 70 | 81.82 | 81.82 | 84.09 |
| **<2** | 81.25 | 87.5 | 84.38 | 67.5 | 75 | 77.5 | 90.91 | 88.64 | 88.64 |
| **<4** | 90.63 | 93.75 | 93.75 | 80 | 82.5 | 87.5 | 97.73 | 93.18 | 97.73 |
| **<8** | 96.88 | 100 | 96.88 | 82.5 | 90 | 90 | 100 | 100 | 100 |

*Source: UN COMTRADE*

## CONCLUSION

The paper has estimated the India's comparative advantage in agro-processed products with the rest of the world for the period of 2003 to 2013. Using the four variants of indices of revealed comparative advantage, it was found that India has comparative advantage to exports in 7 out of 32 processed animal products, 12 out of 40 processed vegetable products and 7 out of 44 processed food products.

Consistency test results show that the four indices of revealed comparative advantages are less consistent as cardinal measures but ordinal measure is relatively consistent. It means that product may be ranked on the basis of their RCA. Dichotomous test is relatively consistent than cardinal measure but it is relatively less consistent than ordinal measure. Therefore, the RCA measure is useful indicator in determining whether India has a comparative advantage or disadvantage in agro-processed products. Stability test shows that 79 percent indices are greater than the cut-off point (>.70). This shows that indices are fairly stable over the years.

Careful examination of Ballasa index ($RCA^1$) showed that India's RCA in processed animal product and processed vegetable product has somewhat weakened over time, whereas interesting result were found for processed food products though it contributes less proportion of the product, which has revealed comparative advantage. It was observed that the distribution of Ballasa index was stable over time and share of the products having RCA less than 2 decreased over time.

It may prove beneficial for the policy makers to use this information in order to focus on the products, which have comparative advantage to exports. This would help the producers and traders to know the specific products to export with maximum advantage in the international market. Processed agriculture products should be the special attention for the policy makers as they have multiplier effects on the economy.

## *Bibliography and References*

Ballassa (1965), "Trade Liberalisation and "Revealed" Comparative Advantage", Manchester school of Economics and Social Studies, 33: 99-123.

Ballance (1987), "Consistency Tests of Alternative Measures of Comparative Advantage." *Review of Economics and Statistics*, 69, 157-161.

Batra (2005), "Revealed comparative advantage: An analysis of India and China", Working Paper 168, Indian Council for research on international economics relations, New Delhi, August.

Burange (2008), "India's Revealed Comparative Advantage in Merchandise Trade, Working paper UDE28/6/2008.

FAO (1997), The State of Food and Agriculture. FAO (The Food and Agriculture Organization of the United Nations), Rome.

Ferto, I. (2003), "Revealed Comparative Advantage and Competiveness in Hungarian Agri-food Sector", World Economy, 26 (2): 247-259.

Gopal (2009), "Indian Finfish Exports – An Analysis of Export Performance and Revealed Comparative Advantage" *Agricultural Economics Research Review,* Vol. 22 July-December 2009, pp 291-297.

Hinloopen, J. (2001), "On the Empirical Distribution of the Balassa Index. *Weltwirtschaftliches Archiv"*, 137, 1-35.

Kannan. E. (2010), "Post- Quota Regime and Comparative advantage in Export of India's Textile and Clothing," *Journal of International Economics*, 1(2): 14-30.

Lorde,T. (2010), "An Assessment of Barbados' Competitiveness within the EU Market 1992-2006." *Global Economy Journal*, 10, 99-123.

Oduro (2013), "Investigating India's Revealed Comparative Advantage in Agro-processed products," Scientific research publication Inc, 385-390.

Serin (2008), " Revealed Comparative Advantage and Competitiveness: A case study of for Turkey towards EU", *Journal of Economic and Social Research* 10(2), 2008, 25-41.

Shahab S. (2013), "Comparative Advantage of Leather Industry in Pakistan with Selected Asian Economies," *International Journal of Economics and Financial Issues*, 3, 133-139.

Vollrath, T. (1991), "A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage." *Review of World Economics*, 127, 265-280.