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Empirical Investigation of Exchange Rate and India's Agricultural Exports : Cointegration and Causality Analysis

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Abstract

The present paper is an attempt to identify the agricultural products in which India has comparative advantage and to analyze the trend of comparative advantage during the post reform period. The study has found that India enjoys comparative advantage in almost all the agricultural and allied products except meat. Though India gained comparative advantage recently in meat, however in other products the RCA indices have witnessed a declining trend during the reform period. Further the study has also estimated the cointegration relationship between exchange rate and exports of disaggregated agricultural products and found that there is long run cointegrating relationship between exchange rate and seven of the eleven agricultural products. The application of vector error correction model to examine causal relationship between exchange rate and export of different agricultural products reveals that exchange rate does cause change in export of all these seven products which manifests long run cointegrating relationship. Since we find cointegration and causal relationship between exchange rate and exports of several agricultural products, the country should devise such monetary and foreign exchange policy that the exchange rate should not appreciate in real terms and should be maintained at least at par with its competitors.

Key words: *Agricultural products, exchange rate, revealed comparative advantage, cointegration, Granger causality.*

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1. INTRODUCTION

During the last few decades, world has witnessed significant changes in composition and structure of foreign trade. Change in technology, growing trade liberalization, establishment of WTO and consequent change in foreign trade policies and more outward oriented economic policy of many of the countries has resulted in such kind of changes in world trade structure. These changes in world economic environment besides putting many challenges have also provided with good opportunities to the developing countries including India.

During the past several years the position of Indian agricultural commodities in the international market has experienced significant changes. In several commodities like tea, coffee, rice, spices etc, it occupies commanding position in global market. At the same time, on account of arrival of new players in the field, the competition has increased enormously posing great challenge to this sector. Most of these new entrants are from Asian countries like China; Thailand; Malaysia; Sri Lanka etc. who are similar in economic characteristics pose a big threat to Indian agricultural products.

With the establishment of WTO, liberalization of trade regime and consequent economic changes that have taken place in the world economy; there has been rapid transformation in the demand and supply conditions of several countries. Many countries like Vietnam, Turkey etc have emerged as new powers with considerable potential in agricultural trade. India's approval of Agreement on Agriculture (AoA) with WTO has also affected India's agricultural trade.

Besides such development in international perspective, various changes have also taken place in domestic policies. These changes have also affected India's exports of different agricultural commodities. One such development is adoption of floating exchange rate system whereby the exchange rate is determined by market demand and supply of the currency. India has adopted floating exchange rate system since 1993. Since then the rupee has depreciated for over a decade. But during 2003-04 to 2007-08 it has manifested an upward movement in nominal terms. However, in real terms the exchange rate has shown an upward trend and exchange rate has appreciated by about 24 percent from 2004-05 to 2010-11. Rupee has been depreciating since then. During the period, various agricultural commodities exported from India have responded differently and their levels of comparative advantage in the global markets have altered significantly. Hence, it is important to have an in-depth analysis to find alterations in the comparative advantage of India and the effect of exchange rate on exports of different agricultural products in India.

2. OBJECTIVES OF THE STUDY

The present study has the following objectives:

1. To identify the agricultural products in which India has comparative advantage.
2. To examine the effect of exchange rate variation on different agricultural products.

The paper is structured as follows. Next section 3 presents a brief review of literature. In section 4, an overview of agricultural exports has been given. This is followed by description of methodology and data source. In following section results have been discussed. The final section presents the conclusion.

3. LITERATURE REVIEW

Since the method to estimate the Revealed Comparative Advantage (RTA) developed by **Balassa** (1965), RCA indices have widely been used to assess comparative advantage of export commodities.

Richardson and Zhang (1999) used RCA index to analyse the trade performance of USA with 38 of its large trading partners for the period 1980 to 1995. The study found that there has not been much change in comparative change in US's comparative advantage for the products classified at one digit SITC. **Ferto and Hubbard (2003)** used the index to estimate the comparative advantage of Hungary foreign trade for agricultural products vis a vis the EU for the period ranging from 1992 to 1998. The study found that Hungary has comparative advantage in 11 of 22 products.

Mahmood (2004) conducted a study on Pakistan using Balassa method. He divided all the commodities into four categories; competitive positioned products, threatened positioned products, emerging products and weakly positioned products on the basis of RCA index. He observed that in Pakistan there are some non-agricultural sectors which have gained competitive advantage. However, such advantage is not uniform throughout the sectors. Also Pakistan has not been able to succeed in moving from low value added unskilled labour intensive products to technology intensive and high value added commodities.

Comparative advantages was measured by **Batra and Khan (2005)** for commodities groups sectors in 97 chapters of HS- 1996 using RCA index for both India and China for 2000 and 2003. The analysis revealed that there are differences in comparative advantage at different level of commodity disaggregation. Some commodities which are at higher level of ranking as per RCA index do not manifest same level of ranking at six digit classification. In the case of India, only cotton could retain it ranking at disaggregate level. Simultaneously in some sectors, either of the countries have comparative disadvantage at disaggregate level, but enjoy comparative advantage at disaggregate level.

Burrange and Chaddha (2008) studied comparative advantage of India's exports for the period 1996 to 2005. They concluded that labour intensive sector textile and scale intensive sector iron and steel enjoyed comparative advantage in export while technology intensive products suffers comparative disadvantage during the period.

Ghani et al. (2000) using Balassa's RCA index tried to compare the competitiveness of footwear industry of Pakistan with that of India and China. He observed that at two digit classification the footwear industry of Pakistan has entered into advantageous position in 2003 and since then continuously moving upward. As against this the competitiveness of China and India started declining since 2001. At four digit classification, Pakistan experienced strong growth in three of its products. A similar study was done by **Shah et al. (2009)** related to Pakistani fruits as compared to major exporters of the world for the period 1995 to 2005. He concluded that in relation to its competitors Pakistan has higher comparative advantage in dates and mangoes and lowest comparative advantage in oranges except USA.

There are few studies which have examined the relationship between exchange rate and agricultural exports. For example, **Huges and Penson (1985)** studies have shown that volume of agricultural exports have increased remarkably over the years, however, the fluctuation and instability in exchange rate is a point to be concerned. **Vellianitis-Fidas (1976)** have examined and

found significant relationship between exchange rate and demand for U.S. agricultural exports. **Johnson, Grennes, and Thursby (1977)** compared the impact of exchange rate versus the impact of foreign commercial policy in the pricing of U.S. wheat. **Chambers and Just (1991)** observed that there are differences in findings of different researchers about the effect of exchange rate on agricultural exports. Some researchers have found that exchange rate has a significant role in promoting agricultural exports, while others do not find such important role for exchange rate. **Paarlberg et al. (1994)** detail the economic theory behind the impact of exchange rates on prices, production, and consumption. The authors report the research of other studies that have measured the effects of exchange rate movements on agriculture. **Schwartz (1986)** compared the effects of changes in exchange rate (and other macroeconomic variables) in a simple competitive versus a non-competitive market for wheat. **Bradshaw and Orden (1990)** applied Granger causality test to examine the effect of exchange rate on agricultural prices and exports. **Alkhateeb and Sultan (2015)** using bound test analysis have also found that there is long run cointegration relationship between REER and agricultural exports and change in REER besides other factors does cause change in total agricultural export of India.

4. OVERVIEW OF AGRICULTURAL EXPORT

Since green revolution, Indian agricultural sector has witnessed a significant growth. It has transformed from deficit to surplus countries in many of the food products. As a result the export of agricultural and allied sector has increased significantly. The economic reforms since 1991 has further given boost to agricultural exports from India. The export from agriculture sector has increased from Rs. 6317 crores ($3521 million) in 1990-91 to Rs. 28582 crores ($6256 million) in 2000-01 at an annual compound rate of about 6 percent per annum. Then it increased at the rate of 13.2 percent per annum from 25852 crore rupees ($6256 mn) in 2000-01 to 111393 crore rupees ($24448 mn) in 2010-11 and then to 260953 crore rupees ($43133 mn) in 2013-14 at an annual rate of 23.7 percent per annum. However, in 2014-15 the agriculture export experienced a negative growth of about 4 percent and declined to 240642 crore rupees ($39357 mn) owing to global economic slowdown and declining commodity prices.

Despite increase in export of agricultural products, its share in India's total exports increased from 17.9 percent in 1991-92 to 20.7 percent in 1996-97. Thereafter, it declined continuously and reached to 12.7 percent in 2014-15. The decline in share of agricultural exports is due to faster growth of non-agricultural exports of India.

During the period, the relative importance of different commodities of India's agricultural and allied export items changed considerably. For example, the share of tea and mate decreased from 20 percent in 1980-81 to about 2 percent in 2013-14. The share of coffee fell from 10 percent to 2 percent in corresponding period. Similarly, the share of tobacco and cashew and kernals also declined from about 6 percent to 2 percent in the same period. As against this, the share of rice, spices and meat has substantially increased. For rice, cotton, sugar, and beef (buffalo), India's share in global market has become very significant. In addition to these products, India is also exporting significant amount of soybean meal, guar gum, corn, and wheat, as well as a diverse range of other products.

The credit for this shift within the traditional item category goes to economic reform measures. A number of restrictions like export prohibitions, announcement of minimum export price, fixing of

rigid ceilings for maximum possible export quantities and requirement of export licensing for certain type of agricultural exports that were earlier in vogue, have been removed under the new policy. Not only this a number of facilities and export promotion measures that were limited to a few agricultural commodities only have been extended to all commodities in this group. It is precisely these factors that might have resulted in the structural shift whereby the export of high value added agricultural products have started recording high growth rates.

5. DATA AND METHODOLOGY

In order to identify the products in which India has comparative advantage in exporting to the world, a conventional concept of Revealed Comparative Advantage developed by **Balassa (1965)** has been used. Balassa was of the view that comparative costs are determined by both price and non-price factors much before the countries are engaged in trade which is difficult to observe. Hence, he developed another criteria or method which he called as revealed comparative advantage index. Since pattern of international trade broadly reflects inter country difference in relative costs and difference in non-price factor, index of revealed comparative advantage (RCA) is widely used as a measure of country's comparative advantage or disadvantage as compared to another country or group of countries with respect to different commodities a country exports. Various factors like economic, structural, world demand and trade specialization cause change in RCA for a product of a country. The RCA index is simply the ratio of the share of country 'i' in world exports of commodity 'k' to its share of total commodity exports. This index is represented as :

$$\mathbf{RCA = (X_{ki} / X_{kw})/(X_i / X_w)}$$

Where,

X_{ki} = exports by country i of commodity k;

X_{kw} = world exports of commodity k;

X_i = total exports of country i;

X_w = total world exports.

The weighted average of RCAs of all commodities equals unity. Commodity with RCA value higher than one implies that the country has comparative advantage in exporting that commodity. Index with less than one shows comparative disadvantage in that commodity. We may also estimate the indices for different product groups. However, some people criticize the method as it considers only one side of trade flows, i.e. exports or imports.

As noted, the RCAs are estimated for India to estimate comparative advantage in agricultural products. The RCAs have been computed at the 2-digit and 3-digit product level. The indices are worked out for the years starting from 1995 to 2014. The data source is the various issues of Economic Survey of India.

Since different products have manifested different rates of growth over different period of time, the paper tries to explore the response of different products to exchange rate variation. Exchange rate is supposed to influence the export of a commodity by making it cheaper in international market when country's currency depreciates with respect to other currencies and vice-versa. To verify such effect of exchange rate variation in exchange rate on export of different agricultural products the paper has applied Johansen method of cointegration and Granger causality test. Since Johansen test requires that the variables should be integrated of same order. First of all we

examine the order of integration of the variables under consideration to examine the influence of exchange rate on exports of agricultural products. For the purpose, Augmented Dicky-Fuller (ADF) unit root test will be used. It consists of auto regressing first difference of the concerned variable on one time lagged level variable and lagged difference variable (suitably selecting number of lag period) and optionally a constant and trend variable (Dickey and Fuller, 1979). This can be expressed as follows:

$$\Delta Y_t = \rho_0 + \rho_1 t + \rho_2 Y_{t-1} + \sum_{j=1}^{n} \partial_j \Delta Y_{t-j} + \varepsilon_t \qquad \ldots(1)$$

The zero coefficient of lagged level variable (ρ_2) implies that the variable is having unit root and the variable is non stationary. But if ρ_2 is negative and significant, then we will say that the variable is stationary or integrated of zero order I(0). When the coefficient is zero, we take first difference of the series and then apply the ADF test. After taking first difference of the series if the coefficient is estimated to be significantly negative, the variable is said to be integrated of order one I(1).

If the variables happen to be non stationary but are integrated of same order, Johansen's method of cointegration can be applied to estimate the existence of long run correlation between exchange rate and amount of export of agricultural products.

According to this approach, there are two methods (and corresponding test statistics) for determining the number of cointegration relations, and both involve estimation of the matrix Π. This is k × k matrix with rank r. One method is maximum eigenvalue statistics and the second is trace statistics. In both the cases we test exactly r number of cointegration against r + 1 number of cointegarting vectors.

6. MAXIMUM EIGENVALUE TEST STATISTICS

The test statistics are based on the characteristic roots (also called eigenvalue) obtained from the estimation of the matrix Π. The test consists of ordering the largest eigenvalues in descending order and considering how many of them are significantly different from zero on the basis of following test statistics:

$$\lambda_{\max}(r,\, r+1) = -T \ln(1-\lambda_{r+1})$$

6.1 Trace Statistics Test

The second method is based on a likelihood ratio test about the trace of the matrix. The trace statistics considers whether the trace is increased by adding more eigenvalues beyond the rth eigenvalue. The trace statistics is calculated by

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(I - \lambda_{r+1})$$

The usual work is to work downwards and stop at the value of r which is associated with a test statistics that exceeds the displayed critical value. Critical values for both statistics are provided by Johansen and Juselius (1990).

6.2 Vector Error Correction Model

Once the cointegration relationship is found, long run causality between exchange rate and export growth is examined by estimating VECM. When the variables are cointegrated, some kind of causal relationships are also expected among them (Maddala, 1992). Engle and Granger (1987)

suggested that when the variables are cointegrated, multivariate vector error correction model (VECM) is more appropriate approach than the first difference VAR model to estimate causality test among the variables. The VECM can be expressed in following way:

$$\Delta lX_{it} = \alpha_0 + \delta ECT_{it-1} + \sum \sigma \Delta lREER_{t-m} + \varepsilon_t \quad \ldots(3)$$

Where, X_i refers to India exports of i agricultural products; REER is real effective exchange rate; l denotes natural log. Δ is the first difference operator; ECT_{it-1} is lagged error correction term of i products. 'i' refers to different agricultural products.

If the coefficient of error correction term is negative and significant we may infer that there is causal relationship between the variables in the long run (**Granger, 1988**) and exchange rate Granger causes export growth of i^{th} agricultural product. Annual data on these variables from 1995 to 2014 has been taken from various issues of Economic Survey of India and UNCTADSTATS.

7. RESULTS AND ANALYSIS

Over the years the agricultural products of India has occupied an important position in world market. Since economic reforms, different agricultural products have responded differently to various measures taken by government of India and also on account of growing competition from different countries into the field. As a result the indices of RCA have also changed. The indices of RCA of major agricultural products have been given in table 1.

Table 1: Indices of Revealed Comparative Advantage

Years	meat	fish	cereals	Rice	veg	sugar	coffee	Tea	spices	Animal feed	tobacco	Oilseeds
1995	0.6	3.2	3.8	26.9	1.3	1.2	4.0	20.8	14.0	5.0	0.7	1.8
1996	0.7	3.7	3.8	26.7	1.5	2.1	4.5	26.9	18.1	5.0	1.0	1.8
1997	0.8	4.3	2.5	20.9	1.8	6.6	4.4	30.9	20.3	6.4	1.6	2.5
1998	0.6	3.5	4.0	24.8	1.4	0.1	4.0	24.6	17.7	3.6	0.9	1.2
1999	0.8	4.0	5.0	34.1	1.6	0.1	5.7	31.9	20.3	4.7	1.1	1.7
2000	1.1	4.1	2.2	15.4	1.9	1.3	3.4	21.0	15.5	3.5	1.0	2.6
2001	0.8	3.6	2.7	14.6	1.6	3.6	3.9	20.0	13.8	3.5	0.9	2.0
2002	0.8	3.5	3.6	23.9	1.5	3.1	3.1	16.6	11.2	1.9	1.0	1.3
2003	0.8	2.6	2.8	14.6	1.2	1.9	2.8	12.7	9.0	3.3	0.9	2.0
2004	0.6	2.2	3.1	17.5	1.2	0.4	1.9	11.1	8.7	2.6	0.9	1.4
2005	0.8	2.1	2.3	14.8	1.3	0.8	2.4	9.0	0.0	3.5	0.9	1.3
2006	0.8	2.0	2.0	13.0	1.2	2.3	2.1	8.2	11.9	3.4	0.9	1.5
2007	0.9	1.9	2.5	17.0	1.1	3.4	1.8	8.2	14.4	3.7	1.1	1.7
2008	0.9	1.5	2.4	12.5	1.1	4.2	1.8	7.9	12.7	4.5	1.4	1.4
2009	0.7	1.3	1.8	8.8	0.9	0.2	1.2	6.5	9.7	2.3	1.8	0.8
2010	1.0	1.6	1.7	7.7	0.9	1.6	1.3	6.8	10.6	2.5	1.7	1.1
2011	1.2	1.7	2.8	9.9	0.8	2.3	1.3	6.6	10.5	2.4	1.2	1.4
2012	1.4	1.7	4.5	15.2	0.8	2.5	1.4	5.4	11.0	2.1	1.4	1.2
2013	5.1	5.6	13.4	49.3	2.4	3.5	3.7	14.7	24.0	6.8	3.8	2.6
2014	2.0	2.3	4.8	17.8	0.8	1.6	1.3	4.5	9.5	1.4	1.3	1.3

Note: Calculated from various issues of Economic Survey of India.

The indices presented in table 1 reveal that over the period different products manifested different responses. In the case of most of the agricultural and allied commodities included in the study, India enjoys comparative advantage over the world, but decline in the index is a matter of great concern. In the case of meat and tobacco however, India did not have comparative advantage during the initial years of the economic liberalization period. From the table we find that most of the agricultural products have shown upward trend in comparative advantage until 1999. The trend was reversed since then and we find declining trend in comparative advantage index of all these products during 2000 to 2010. This is due to the fact that many of the competitors of Indian agricultural products are doing better than India and has improved their position in international market. However, in the case of meat, India gained comparative advantage since 2010 while in the case of tobacco since 2007.

In order to examine the long run association between real effective exchange rate (REER) and India's agricultural exports and the effect of depreciation on export growth of agricultural products, cointegration and causality tests have been applied. To confirm the fulfillment of conditions required for application of cointegration and causality test, augmented Dicky-Fuller (ADF) method of unit root tests have been applied. The results are shown in (table 2).

Table 2: Augmented Dicky-Fuller (ADF) unit root test (MacKinnon (1996) one-sided p-values)

	REER	Coffee	Rice	Fish	Meat	Spices	Sugar	Tea	Tobacco	Vegetables	Animal Feed	Oilseeds
Level	0.5908	0.8199	0.9145	0.9965	0.8702	0.9699	0.8691	0.6051	0.8674	0.9424	0.8977	0.9969
First Difference	0.0010	0.0061	0.0022	0.0115	0.0370	0.1275	0.0013	0.0039	0.0086	0.0005	0.0001	0.0001

The results show that all these variables under consideration except spices are integrated of order one I(1) thus, confirming the conditions for the application of cointegration and causality tests. The result of Johansen cointegartion test shows that seven of the eleven products under study, e.g. rice; tea; coffee; sugar; meat and fish, animal feed are cointegrated at least at 10 percent level of significance on the basis of trace statistics and Maximum Eigenvalue. The products like tobacco, spices and vegetables do not show any evidence of long run cointegration relationship with REER.

Table 3a: Cointegarion Test (P value of Trace Statistics)

	Coffee	Rice	Oilseeds	Fish	Meat	Spices	Sugar	Tea	Tobacco	Vegetables	Animal Feed
None	0.0766	0.0860	0.2148	0.0433	0.0227		0.0012	0.0399	0.1856	0.1155	0.0816
At most one	0.4255	0.6887	0.2416	0.2660	0.0964		0.3201	0.0525	0.5966	0.1084	0.4089

Table 3b: Cointegarion Test (P value of Max Eigen value)

	Coffee	Rice	Oilseeds	Fish	Meat	Spices	Sugar	Tea	Tobacco	Vegetables	Animal Feed
None	0.0634	0.0606	0.3532	0.0564	0.0674		0.0009	0.0971	0.1418	0.3840	0.0777
At most one	0.4255	0.6887	0.2416	0.2660	0.0964		0.3201	0.0525	0.5966	0.1084	0.4089

For the products which witnessed presence of cointegration relationship with the exchange rate, causal relationship has been examined using VECM. The result of VECM shows that the lagged error correction terms, for all the products having cointegration relationship, are negative and statistically significant (table 4). This implies that REER does cause change in exports of all these seven agricultural products and depreciation of rupee leads to increase in exports of these individual agricultural products in India. The result is in line with earlier findings of Alkhateeb and Sultan (2015) that depreciation promotes agricultural exports. Further the study does not find long run cointegration relationship between exchange rate and export of three products; spices, vegetables and tobacco.

Table 4: Granger Causality Test (VECM)

	Coffee	Rice	Oilseeds	Fish	Meat	Spices	Sugar	Tea	Tobacco	Vegetables	Animal Feed
Coefficient of ECT(-1)	-0.482567	-0.845867		-0.326257	-0.161344		-1.566042	-1.011315			-0.492158
t-value	(0.15695) [-3.07466]	(0.29225) [-2.89431]		(0.08773) [-3.71902]	(0.04437) [-3.63652]		(0.26553) [-5.89786]	(0.36838) [-2.74530]			(0.23260) [-2.11588]

8. CONCLUSION AND POLICY RECOMMENDATIONS

The paper has examined the revealed comparative advantage of different agricultural products in post reform period. The study has found that India enjoys comparative advantage in almost all the agricultural and allied products except meat. However, the comparative advantage has shown a declining trend over the period. Further, of the eleven products seven products have manifested long run cointegration relationship with exchange rate. Further, the study has also found that exchange rate does Granger cause change in exports of these products. Despite the fact that during most of the post reform period in India, real effective exchange rate declined and export of different agricultural products have also increased. India is losing its comparative advantage, may be due to strong competition from its competitors. This raises concern and more effective policy needs to be formulated to not only to survive in global market but need to outperform its competitors and reverse the downward trend in RCA indices.

Since variation in exchange rate affects the competitiveness of exports of a country, and appreciation of currency in real terms makes the exports less competitive in international market and depreciation has favorable effect on exports. India should formulate its monetary and foreign exchange policy such that rupee should not appreciate in real terms. Second, since higher inflation in relation to its trading partner and its competitors raise the exchange rate in real term and makes our exports less competitive, India should control the level of inflation so that its currency should not appreciate in comparison to its competitors.

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