Agricultural exports and the growth of agriculture in India

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Abstract: The study empirically investigates the causality between agricultural exports and gross domestic product (GDP) agriculture in India using the Granger causality test via Vector Error-Correction Model over the period 1970–1971 to 2009–2010. The results of unit-root tests suggest that the series of India's GDP agriculture and farm exports are integrated of order one. The results of the Auto Regressive Distributed Lag bounds testing approach to co-integration show that there is a positive and stable long-run equilibrium relationship between India's agricultural exports and GDP of agriculture. We find a unidirectional causal link running from farm exports to gross domestic product of agriculture. It indicates that in India, agricultural products export Granger causes the growth in GDP of agriculture, which supports the export-led growth hypothesis. It is suggested that in order to accelerate the agricultural growth rate in India, there is a need to implement the policies encouraging the agricultural exports.

Key words: co-integration, export-led growth hypothesis, Granger causality

Agriculture in India helps to ameliorate the conditions of those who belong to the lowest rungs of the social and economic strata. It softens the harsh edge of extreme poverty and plays an important role in improving the health and nutrition of the India's rural masses. By providing income and upholding the human right to food, farming establishes a resilient rural sector as a basis for a relatively egalitarian distribution of income and production (Ramphul 2012). As a matter of fact, the sustained and accelerated development of agriculture in India is the key to the acceleration in tempo of its economic growth, equity and a significant dent in poverty and hunger. Janvry and Sadoulet (2010) report that there is an overwhelming body of evidence which shows that in India, a one percentage growth in agriculture is at least two to three times more effective in eliminating poverty than the same growth originating from the non-agriculture sectors. Hence, the growth in the agricultural sector remains a 'necessary condition' for the inclusive growth as envisioned in the approach paper for the India's 12th Five-Year Plan (2012–2017), with an appropriate title: "Faster, Sustainable and More Inclusive Growth". As such, the agricultural sector and its future growth potential hold a critical value for the Indian economy.

In the era of trade liberalization, globalization and the World Trade Organization regime, India's farm trade has undergone some noteworthy changes. The compound annual growth rate of the value of India's agricultural exports has increased from 2.4% during 1980–1994 to 9.7% during 1995–2009. India's share in the world total farm trade has gone up from 0.7% to 1.1% during the same period. The openness of Indian agriculture, measured as the ratio of the value of the total farm trade to the gross domestic product (GDP) of agriculture, has jumped up from 7.4% in 1994–1995 to 14.4% in 2009–2010. It indicates the increasing importance of the farm exports in the Indian agricultural economy. India is a net exporter of agricultural commodities with net exports earnings of US$ 6541.1 million in the triennium ending 2009–2010. Nonetheless, globalization can greatly enhance the role of agriculture as an engine of growth in low-income countries like India by making it possible for the agricultural sector to grow considerably faster than the domestic consumption. It also increases the potential for agriculture to increase food security through enlarged multipliers to the rural masses.

The overwhelming importance of agriculture in the Indian economy has led to an intensive investigation of the drivers of its growth. From the relevant literature, it has been observed that there are some studies, which examine the role of the farm inputs management, marketing, institutions, irrigation,

seeds, fertilizers, credit, investment, technology, productivity, climate change, cropping intensity, post harvest management, value addition, and extension services, etc., to call for the increasing agricultural growth rate (for details, see, e.g., GoI 2012a). However, there is a dearth of empirical studies to examine the casual linkage between farm exports and agricultural growth in India. The study is undertaken to fill up this important gap in the literature and to make a quantitative contribution in the field of the objective assessment of the farm export liberalization for agricultural growth in India.

A survey of literature on the export-led growth hypothesis indicates that there are four main explanations for the relationship between exports and gross domestic product. These theoretical underpinnings are: (1) following short-run Keynesian arguments, the export growth leads to the income growth via the foreign trade multiplier, (2) the foreign exchange from exports can be used to finance the imported manufactured and capital goods and technology, which contribute to growth (Chenery and Strout 1966), (3) competition leads to the scale economies, the technological advance and growth (Helpman and Krugman 1985), and (4) following endogenous growth theory, the export sector creates positive externalities, such as more efficient production methods, which lead to growth (Balassa 1978; Grossman and Helpman 1993). During the last four decades, in average, agricultural exports accounted for 20% of India's total merchandise exports. As agricultural exports are a substantial proportion of the total merchandise exports in India, it is perhaps reasonable to assume that agricultural exports cause the GDP of agriculture also.

The both trade and development literature typically focuses on the role of the total merchandise exports as an engine of economic growth, but agriculture's contribution to the total exports is often substantial in many developing countries, e.g., in 2010–2011, this proportion was: 91% for Djibouti, 89% for both Burundi and Liberia, 86% for Malawi, 83% for Timor-Leste, 80% for Gambia, 77% for Ethiopia, 76% for Paraguay, 75% for Comoros, and 70% for both Nicaragua and Afghanistan. As noted by Sanjuán-López and Dawson (2010), it is surprising that the empirical relationship between agricultural exports and economic growth has been somewhat neglected in the literature despite its role in the development process being long recognised. In fact, expanding agricultural exports is one of the most promising means of increasing the farmers' incomes. Moreover, where a developing country exports are a small proportion of the world total trade, as it is typical, the export demand for that country is elastic and the policies that seek to stimulate agricultural exports are not irrational even when the world conditions are unfavourable, particularly where few alternatives exist (Johnston and Mellor 1961). We contribute to this literature by examining the direction of the casual linkage between gross domestic product (GDP) of agriculture and farm exports in India, a leading farm producing developing country.

In addition, as it has been duly acknowledged by the Government of India (GoI) in the Economic Survey (2012b), since a faster agricultural growth is necessary to achieve the desired economic growth for the economy as a whole, it is imperative to find the way forward for enhancing the agricultural growth. However, the GoI often imposes a ban on exports of different agricultural products from India (for details, see Ramphul 2010). For example, during 2008–2011, the GoI has hastily banned the exports of wheat, rice, sugar and cotton, which are the major farm products in terms of value. The establishment of the causal link between farm exports (X) and GDP of agriculture (G) has important implications for India's agricultural development strategies. If farm exports cause agricultural growth ($X \rightarrow G$), then the outward looking strategy is appropriate for the country. But if the causative process runs in the opposite direction ($G \rightarrow X$), then the inward looking may be useful for the country. A bi-directional causality between the farm export and agricultural growth ($X \leftrightarrow G$) would imply that one reinforces the other. Even in the situation of the feedback type relationship, restrictions on the farm export may impede the agricultural growth.[1] It is, therefore, imperative to understand the dynamics of the causality between the India's farm exports and agricultural growth. Against this backdrop, the main objective of the study is to investigate the causal linkage between the farm exports and the GDP of agriculture in India.

MATERIAL AND METHODS

We seek a casual relationship between the GDP of agriculture and agricultural exports in India. In order to trace the direction of the causal link between agricultural exports and the gross domestic product of agriculture in India, we resort to the technique of the Granger causality. This technique allows for a rigorous exploration of the potential

[1]The author is grateful to an anonymous referee of the journal for bringing this point to his attention.

linkages between the variables in the long-run and short-run, respectively. As noted by Engle and Granger (1987), if there is a long-run equilibrium relationship among the variables (co-integration), then estimating a bivariate time-series model using only first differences of the series can result in a serious misspecification since the important level terms will have been omitted. In other words, if the concerned variables are co-integrated then the standard causality techniques lead to misleading conclusions because these tests will miss out some of the "forecastability" which becomes available through the error-correction term. In the presence of a co-integration vector between the farm export and the GDP of agriculture, there is a possibility of causality between the two at least in one direction (Granger 1988). Thus the Granger causality test via the error-correction modelling can be used to examine the nature of the relationship (for details, see Granger 1986; Engle and Granger 1987).

In the present study, the co-integration between agricultural exports and the agricultural gross domestic product has been investigated using the Auto Regressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). The procedure is adopted because it enjoys the following main advantages over the conventional type of co-integration techniques. First, this procedure does not require the pre-testing of the variables under study for unit-roots unlike other techniques, such as the Johansen and Juselius (1990) approach. It is applicable irrespective whether the regressors in the model are integrated of order zero, i.e., I(0) or fractionally co-integrated. The ARDL bounds testing procedure, however, crashes in the presence of I(2) series, integrated of order two. Secondly, this technique generally provides unbiased estimates of the long-run model and valid '*t*'-statistic even when some of the regressors are endogenous. In view of the above advantages, the ARDL-Error Correction Model (ECM) was used for estimating the co-integration between farm exports and agricultural growth and it is specified as:

$$\Delta \ln G_t = \beta_0 + \sum_{i=1}^{p} \delta_1 \Delta \ln G_{t-i} + \sum_{i=1}^{q} \delta_2 \Delta \ln X_{t-i} + \\ + \beta_1 \ln G_{t-1} + \beta_2 \ln X_{t-1} + \varepsilon_t \qquad (1)$$

where Δ is the first-difference operator; G and X are the GDP of agriculture and farm exports, respectively; ln represents the natural logarithm transformation; β_0 is an intercept; t represents time and ε is a white noise error term, assumed to satisfy all the basic assumptions of the classical linear regression model.

Bounds testing procedure

The first step in the ARDL bounds testing approach is to estimate Equation (1) by the ordinary least squares (OLS) method in order to test for the existence of a long-run relationship among the variables (co-integration) by conducting an *F*-test for the joint significance of the coefficients of the lagged levels of the variables, H_0: $\beta_1 = \beta_2 = 0$ against the alternative H_1: $\beta_1 \neq \beta_2 \neq 0$. We denote the test which normalizes on G by $F_G(G|X)$. Two sets of the critical value are generated by Pesaran et al. (2001). If the computed value of *F*-statistic is above the upper bound, the null hypothesis of no co-integration is rejected. If it is below the lower bound, the null hypothesis of no co-integration cannot be rejected. Nevertheless, if the calculated value of *F*-statistic lies between the bounds, the test is inconclusive. The appropriate critical values are computed by stochastic simulations using 20 000 replications.

In the second step, once the co-integration is established, the conditional ARDL long-run model for G_t can be estimated as (for details, see Pesaran et al. 2001):

$$\ln G_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \ln G_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta \ln X_{t-1} + \varepsilon_t \qquad (2)$$

where all the variables are previously defined. This involves the selection of the order of the ARDL (p, q) model using the Schwarz Information Criteria (SIC). To see the robustness of the empirical results, we use two further tests, namely the Trace test and the Maximum Eigen value test-devised by Johansen and Juselius (JJ) (1990). However, the ARDL bounds testing approach is based upon the assumption that the variables are not integrated of order two (I(2) and that is ensured applying the Dickey-Fuller generalized least squares (DF-GLS) (Elliott et al. 1996) unit-root test. The conclusions of the DF-GLS test are confirmed by the Augmented Dickey-Fuller (ADF) (Dickey and Fuller 1979) and Phillips-Perron (PP) (1988) unit-root tests. Once the co-integration has been established, the ARDL model is used to estimate the long-run parameters. The long-run stability of the parameters to be estimated is tested applying the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) tests. The Microfit-5 is used to perform the ARDL model and the diagnostic tests. The series of India's farm exports and the GDP

of agriculture are found to be co-integrated. So to investigate the direction of the causality, we use the Granger causality test via the Vector Error-Correction Modelling (VECM).

Granger causality test

We now briefly introduce the bivariate Granger causality test used to explore the causality between farm exports and the GDP of agriculture (see, e.g. Engle and Granger 1987). An appropriate formulation of the co-integrated error-correction Granger causality test for agricultural GDP (G) and farm exports (X) is:

$$\Delta \ln(G)_t = \alpha_1 + \sum_{i=1}^{n} b_i \Delta \ln(G)_{t-i} + \sum_{j=1}^{m} d_i \Delta \ln(X)_{t-j} + \\ + r_i (EC_1)_{t-1} + e_t \quad (3)$$

$$\Delta \ln(X)_t = \alpha_2 + \sum_{i=1}^{n} c_i \Delta \ln(X)_{t-i} + \sum_{j=1}^{m} g_i \Delta \ln(G)_{t-j} + l \\ + l_i (EC_2)_{t-1} + u_t \quad (4)$$

where Δ is the first-difference operator, u_t and e_t are white noise error terms where $E[e_t e_s] = 0$, $E[u_t u_s] = 0$, $E[e_t u_t] = 0$ for all $t \neq s$, n and m are the numbers of lag lengths chosen by the Akaiki Information Criterion (AIC), and $EC_{1t\text{-}1}$ and $EC_{2t\text{-}1}$ are the error-correction terms which represent the lag residuals from the co-integration equations. More specifically, in Equation 3, the farm export Granger causes the GDP of agriculture if r_i is significantly different from zero. In Equation 4, the GDP of agriculture Granger causes farm exports if l_i is significantly different from zero. Furthermore, if both r_i and l_i are not zero, then it means that there is a bi-directional causality between the farm export and the GDP of agriculture. In addition, the short-run dynamics between the farm export and GDP of agriculture are characterized by the coefficients d_i's and g_i's. If d_i's are not all zero, movements in farm export will cause the changes in the GDP of agriculture in the short-run. On the other hand, if g_i's are not all zero, movements in the GDP of agriculture will lead to the changes in the farm export during the same period. The ordinary least squares (OLS) method is applied for the estimation of the parameters, and the standard 't'-test is used for testing the significance of each term. The E-Views 7 is used to perform the VECM and diagnostic tests.

The data used in the study are annual. The sample period is 1970–1971 to 2009–2010 (post-Green Revolution period). Both data series are transferred into the natural logarithmic (ln) form to achieve stationarity in variance. The data on agricultural exports in US$ terms are collected from the official website of the Food and Agriculture Organization, http://faostat.fao.org, and on the GDP of agriculture, in the US$ terms, from the Economic Survey, the Ministry of Finance, Government of India, New Delhi.

The empirical approach followed in applying the recently developed advanced econometric methods will be of an immense value for the future research, particularly for guiding the future agricultural developmental policies in developing countries.

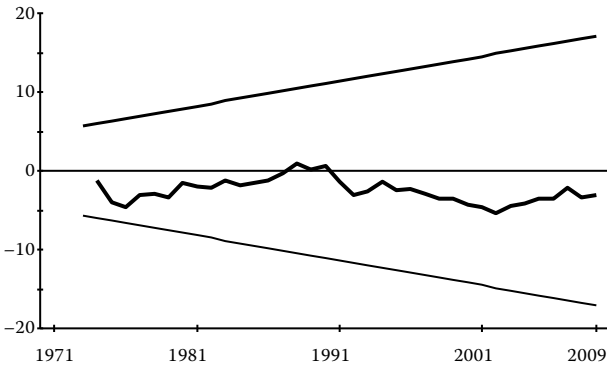
RESULTS AND DISCUSSION

In this section, we present and discuss our empirical results. Prior to the testing of co-integration, we

Table 1. Unit-root tests results for the India's GDP of agriculture and farm exports

Variable	Dickey-Fuller generalised least squares test statistic		Augmented Dickey-Fuller test statistic		Phillips-Perron test statistic	
	intercept	intercept and trend	intercept	intercept and trend	intercept	intercept and trend
ln$G$	1.42 (0)	–1.82 (0)	–0.38 (0)	–1.87 (0)	–0.38 (3)	–1.97 (2)
ln$X$	1.12 (0)	–1.79 (0)	–0.58 (0)	–1.87 (0)	–0.58 (0)	–2.05 (2)
Δln$G$	–5.86 (0)*	–5.87 (0)*	–5.82 (0)*	–5.74 (0)*	–5.82 (0)*	–5.74 (0)*
Δln$X$	–4.96 (0)*	–5.01 (0)**	–4.98 (0)*	–4.90 (0)*	–5.00 (2)*	–4.90 (2)*

Figures in parenthesis in Columns 2–5 are the optimal lag length chosen using the Schwarz Criterion, and in Columns 6–7, the optimal Newey West Bandwidth chosen using the Bartlett Kernel criterion. The critical values for the DF-GLS, ADF and PP tests with intercept and intercept and trend at 1% significance level are: –2.62, –3.61, –3.61 and –3.77, –4.21, –4.21, respectively. *indicates rejection of the null hypothesis of the unit-root at the 1% significance level



The straight lines represent critical bounds at 5% significance level

Figure 1. Plot of the cumulative sum of the recursive residual

The straight lines represent critical bounds at 5% significance level

Figure 2. Plot of the cumulative sum of squares of the recursive residual

first test the stationarity status of the series of India's GDP of agriculture and farm exports in the natural log form to determine their order of integration. Even though the ARDL framework does not require pre-testing of the variables to be done, the unit-root tests are performed to ensure that the variables are not integrated of order two $I(2)$ so as to avoid spurious results. Table 1 contains the results of the DF-GLS, ADF and PP unit-root tests for both variables, namely: InG and InX in level and first difference forms (Δ) with and without trend. It is evident from Table 1 that in level form of both the GDP of agriculture and the farm exports series, the calculated value of all three unit root tests, namely the DF-GLS, ADF and PP, are less than their critical values in all cases, suggesting that these variables are not level stationary. The null hypothesis of a unit-root cannot be rejected for both the GDP of agriculture and farm exports in the level form.

Since for the first difference form, the unit-root hypothesis can be rejected, it is concluded that the India's GDP of agriculture and farm exports are integrated of order one – I(1). There is no evidence of series of I(2) in which the ARDL approach to co-integration may be crashed. Next, we investigate a long-run equilibrium relationship between the farm exports and the GDP of agriculture, so that the appropriate form of the Granger causality test may be applied.

The null hypothesis of no co-integration ($r = 0$) is tested, and the results are presented in Table 2. The table shows that the computed F-statistic (F-statistic = 11.17) for the ARDL (1, 0) model is greater than the upper bound critical value of 4.33 at 5% significance level. Hence, the null hypothesis of no co-integration is rejected. This model passes all the usual diagnostic tests, including the CUSUM and CUSUMQ tests for structural stability – in the plots of results of these tests the cumulative sum of residuals and the cumulative sum of squares were within the critical lines, as seen in Figures 1 and 2. The estimated value of the Trace test statistic is 26.98 and the Maximum eigenvalue test statistic is 19.44, for null hypothesis of no co-integrating vector, which are greater than

Table 2. Results of the tests for co-integration between the India's GDP of agriculture and farm exports, and the long-run elasticity

	Co-integration tests $F_G(G\|X)$			Long-run elasticity $F_G(G\|X)$
ARDL (1, 0)	Johansen-Juselius (JJ) maximum likelihood			ARDL (1,0)
F-statistic	hypothesis	trace test statistic	maximum eigenvalue test statistic	
11.17	H_0: r = 0	26.98 (0.04)*	19.44 (0.05)*	0.76 (0.00)
	H_0: r ≤ 1	7.54 (0.29)	7.54 (0.29)	

The lower and upper bounds critical values at the 5% significance level for the F-test are: 3.2 and 4.3 respectively.
r stands for the number of co-integrating vectors
*indicates rejection of the null hypothesis of co-integration of rank r at the 5% significance level. The critical values for theses are the probability values for statistical significance of the parameters estimated.

the critical values of these tests (25.87 and 19.38) at 5% level of significance. These results confirm the conclusion followed from the ARDL bounds testing approach to co-integration.

Hence, we reject the null hypothesis of $r = 0$, in favour of the alternative $r = 1$. However, in case of the null hypothesis of $r \leq 1$, the estimated values of these tests are less than their critical values at 5% significance level. Consequently, we conclude that there is only one co-integrating vector between ln$G$ and ln$X$. This is an evidence of a long-run relationship between the India's GDP of agriculture and farm exports.

In Column 5 of Table 2, we have presented the results of the long-run elasticity between the India's GDP of agriculture and farm exports obtained from the ARDL bounds testing approach. The column shows that the long-run elasticity of the GDP of agriculture to farm exports is 0.76 and it is statistically significant at 1% level, a one per cent increase in agricultural exports increases the GDP of agriculture by 0.76 %. This result indicating that the Indian GDP of agriculture is highly elastic to its farm exports seems in line with the finding of Sanjuán-López and Dawson (2010), which supports the agricultural export-led growth hypothesis. But without evidence of the causality, nothing can be said whether the models attributed to the export-driven agricultural growth hypothesis or agricultural growth-led farm exports hypothesis is valid.

Table 3. Vector error correction Granger causality test results

Independent variable	Dependent variable	
	$\Delta\ln(G)_t$	$\Delta\ln(X)_t$
EC	–0.267 (–2.32)*	0.178 (0.96)
$\Delta\ln(G)_{t-1}$	0.082 (0.46)	0.213 (0.70)
$\Delta\ln(G)_{t-2}$	–0.070 (–0.40)	0.228 (0.24)
$\Delta\ln(X)_{t-1}$	0.007 (0.05)	0.170 (0.80)
$\Delta\ln(X)_{t-2}$	–0.187 (0.1.45)	0.005 (0.02)
Constant	0.076 (3.38)*	0.039 (1.09)
Diagnostic		
R^2	0.20	0.10
F-statistic	1.51	0.71
Akaiki IC	–1.75	–0.78
Normality χ^2	4.58 (0.33)	
Heteroscedasticity χ^2	20.2 (0.91)	

Figures in parenthesis are 't'-statistic. The optimal lag length is determined using the Akaiki Information Criterion (AIC)
*indicates rejection of the null hypothesis at the 1% significance level

We now turn to trace the direction of the causality between farm exports and the GDP of agriculture in India. Since the Indian GDP of agriculture and farm exports are co-integrated, the causal linkage between these variables is examined using the Granger causality test through the vector error correction approach. The results of the Granger causality test via the error correction model are given in Table 3. The estimates of the diagnostic tests presented in the last five rows of Table 3 indicate that our results are fit for the reliable interpretation. The estimate for the coefficient of the error correction term (EC_{t-1}), using a traditional t-test, is found to be statistically significant only in case of the farm export-led agriculture growth hypothesis (i.e., r_i in Equation 3). The results of the Granger causality test show that an unidirectional causality runs from farm exports to the GDP of agriculture, whereas the GDP of agriculture does not cause the growth in farm exports (i.e., the estimate for the coefficient l_i in Equation 4 is found to be statistically insignificant). In the short-run, however, there is no causality between the GDP of agriculture and farm exports in any direction. The policy implication is that the farm export is a powerful driver of the India's agricultural growth. In order to increase the agricultural growth, there is a need for implementing the measures aims at enhancing the farm exports.

CONCLUSIONS AND POLICY IMPLICATION

In the study, we have empirically investigated the nature of the causal relationship between the India's GDP of agriculture and agricultural exports using the Granger causality test via the Vector Error-Correction Model over the period 1970–1971 to 2009–2010. The time series properties of the data are examined applying three unit-root tests, namely the Dickey-Fuller generalized least squares, the Augmented Dickey-Fuller and the Phillips-Perron. The results of unit-root tests suggest that the series of the India's GDP of agriculture and farm exports are integrated of order one. Our results of the Auto Regressive Distributed Lag bounds testing approach to the co-integration and the Johansen-Juselius maximum likelihood tests show that there is a long-run positive

[2]Our attention was drawn to this by an anonymous referee of the journal.

association between the India's GDP of agriculture and farm exports. We find that in the long-run, the agricultural products export Granger-causes growth in the GDP of agriculture in India. At the same time, the increased GDP of agriculture does not drive farm exports. In other words, there is an evidence of a one-way Granger causality which runs from farm exports to agricultural growth. This insight lends a general support to the export-led growth hypothesis. The conclusion that agricultural exports can play a role similar to that of other drivers of growth, particularly in the low-income countries, lends support to Johnston and Mellor (1961) who argue that increasing agricultural exports leads to increasing economic growth, and that the export-led growth from agriculture may represent the optimal resource allocation for those countries which have a comparative advantage in agricultural production.

We have used the GDP of agriculture as a measure of income. Farm exports are a component of the agricultural GDP and the results which show that exports lead to the GDP growth may be a statistical artefact (see inter alia, Michaely 1977; Heller and Porter 1978; Sheehey 1990; Love 1994). A solution is to define income as the GDP of agriculture net of exports. The majority of empirical studies, however, including Levin and Raut (1997), Dawson (2005) and Sanjuán-López and Dawson (2010), use GDP as a measure of income rather than the GDP net of exports, as the former better reflects economic development. Thus, the estimated coefficients here represent the sum of spill-over effects from agricultural exports and the importance of these exports in the GDP of agriculture.[2]

Accordingly, there appears to be a potential for agricultural growth by adopting the outward-looking, export-promotion policies. The policy implication of these findings is that in order to accelerate the agricultural growth rate in India, there is a need to encourage the agricultural exports. In further research, it may be useful to extend the analysis to the other leading farm producing developing countries.

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