ISSN 2250-3153

Agricultural Export and Exchange Rates in India: The Granger Causality Approach

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***Abstract*-** This paper is an attempt to investigate the causal relationships among quantity of agricultural export and real exchange rate in India by using time series data for the period between 1980 and 2010. All the macroeconomic series used here are non-stationary, integrated at order one but not co-integrated. The long run relationships between exchange rates and agricultural export were explored by using co-integration analysis. A Granger-causality analysis has been carried out in order to assess whether there is any potential predictability power of one indicator for the other. The finding shows that there is no significant relationship between quantity of agricultural export and real exchange rate. In Other words, both the variables do not cause each other in either direction. The result also shows that the variables are not co-integrated, so there is no the long run relationship between agricultural export and exchange rates in India.

***Index Terms*-** Agricultural Exports, unit root test, Granger Causality, Exchange Rates, Johansen test

I. Introduction

Exchange rate is an important economic variable influencing the export, import, and prices of India's agricultural products worldwide. While stronger Indian rupees make India's Exports more expensive in other countries, it also reduces the cost of imported products, resulting in lower prices for India. A weaker Indian rupee has the opposite effects, leading to increased exports and higher producer prices, but lower imports and higher prices for consumers. Both currency depreciation and a currency appreciation are, in most cases, short term in nature. Their effects occur during the first several months after the exchange rate change. Exchange rate is the price of one country's currency expressed in another country's currency. In other words, the rate at which one currency can be exchanged for another. Exchange rate is used to convert foreign prices into domestic currency and vice versa. These prices determine which goods are traded and where they are shipped or sourced. Being able to convert one currency into another at the prevailing exchange rate is crucial to international business and decision making. The difference in relative prices determines the flow of agricultural products and the patterns of trade. Agriculture is described as the backbone of Indian economy mainly because of the three reasons. One, agriculture constitutes largest share of country's national income though the share has declined from 55 percent in early 1950s to about 17 percent in early 2012.Two, more than 2/3rd of workforce of the country was employed in agriculture sector till1971. Recent census data for the year 2012 indicate that agriculture workers (cultivators and agricultural labourers) account for 52 percent of workforce of India. Three, growth of other sectors and overall economy depends on performance of agriculture to a considerable extent. Agriculture has also played important role as foreign exchange earner. Agricultural exports accounted for 44 percent of India's total merchandise export during 1960-61. The share has declined over time but agriculture still contributes more than 17 percent of export earnings of India.

India's foreign trade has expanded rapidly following sweeping trade policy and exchange rate reforms during 1991-93. India's total trade has expanded more than eleven-fold from $46 billion in 1990-91 to about $465 billion in 2009-10. During this period, exports grew 13 percent annually and imports grew 14 percent annually in U.S. dollar terms, with exports reaching $179 billion in 2009-10 and imports reaching $287 billion. Despite this expansion, India's share of world trade remains small, rising from 0.5 percent in 1990 to about1.4 percent in 2010.

The growth of India's foreign trade since the reforms of 1991-93 has contributed to the strengthening of India's balance of payments and foreign exchange reserve positions. In 1990, prior to the reforms, India's foreign exchange reserves were $5.8 billion-the equivalent of just two and a half months of imports. In 2009-10, reserves reached more than $279 billion-equivalent to about one year of imports-providing Indian policymakers with significantly more flexibility in adjusting domestic and trade policies. Indian agriculture has increasingly been opened to global agriculture with the ratio of agricultural exports and imports as a percent of Agricultural GDP rising from 4.9 percent in 1990-91 to 12.7 percent in 18 State of Indian Agriculture 2010-11. (Figure 1) This is still low as compared to the share of India's total exports and imports as a percent of India's GDP at 55.7 percent India is a net exporter of agricultural commodities with agricultural exports constituting 11 percent of India's total exports. However, the share of agricultural exports in India's overall exports has been declining from 18.5 percent in 1990-91 to 10.5 percent in 2010-11.

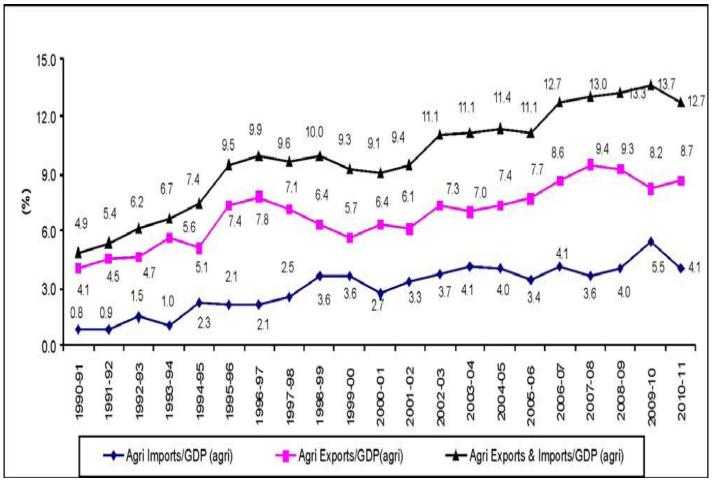

Figure 1: Trend in Trade of agricultural commodities in India

[1] Source: http://www.csostat.gov.mm

Figure 2 shows how just a quick view on the data can support a positive relation between the two variables. The analysis in this paper will show in formal terms what kind of relation can be hypothesized on these two variables.

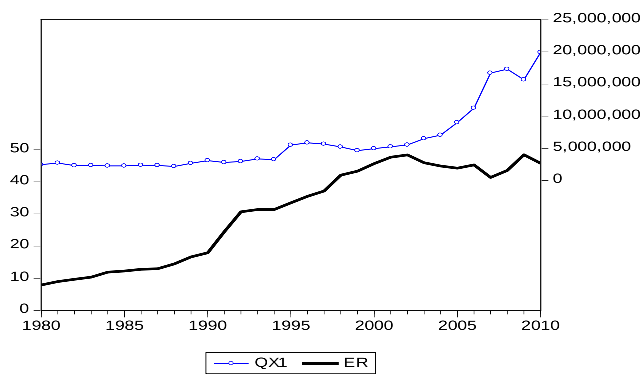

Figure 2: plots for exchange rate and export of agricultural product

Therefore, the main focus of the paper is to further analyze empirically the existence and direction of Granger causality and co-integration between agricultural export and exchange rate to help the policy makers for having a better insight into economic growth and to formulate effective economic policies.

Objectives of the study:

The objectives of this study are as follows:

1- To check whether there exists causality between exchange rate and agricultural export in India.
2- To determine the long run relationship between exchange rate and agricultural export in India.

II. LITERATURE SURVEY

Shombe [21] investigated causal relationships among agriculture, manufacturing and exports in Tanzania using the time series data for the period between 1970 and 2005. The empirical results found the evidence of Granger causality where agriculture causes both exports and manufacturing. Khalafalla and Webb [13] empirically tested the export-led growth hypothesis for Malaysian economy undergoing major structural changes. They investigated the relationship between the exports and economic growth in Malaysia using the quarterly data from 1965-1996. Bashir [1] studied the impacts of economic reforms and trade liberalization on agricultural export performance in Pakistan. The author suggested that the agricultural export performance is more sensitive to the domestic factors, which changes due to economic reforms. Oyejide [15] examines effects of trade and exchange rate policies on Nigeria's agricultural export using Ordinary Least Squares (OLS) over the period 1960-1982 and concludes that appreciation of real exchange rate adversely influences to non-oil export especially during the oil boom. Shirazi and Manap [20] re-investigate the exports-economic growth nexus, using the data from 1960 to 2003 period. The results strongly support a long-run relationship among the three variables i.e. imports, export and output. As far as the causality between the exports and output growth is concerned, exports causes' output growth, but converse is not true. Khan *et. al.* [14] investigated the direction of causation between exports growth and economic growth using the granger causality test and co-integration methods. They find stable long-run two way relationship between total exports and output while one way relationship between output and primary exports. They also find the bi-directional causality between total exports growth and economic growth.

There are few studies relating to only agricultural sector about the effect of exchange rate on agricultural trade. Huges and Penson [10] studies have shown a marked increase in volume of agricultural exports over the years. However, the volatility, frequency and instability of the exchange rate movements since the beginning of the floating exchange rate raise a concern about the impact of such movements on agricultural trade flows. Vellianitis-Fidas [23] tested the hypothesis that exchange rate changes have a significant effect on the demand for U.S. agricultural exports. Johnson, Grennes, and Thursby [10] compared the impact of exchange rate versus the impact of foreign commercial policy in the pricing of U.S. wheat. Chambers and Just [5] noted that while some research found that exchange rates play a role in agricultural exports, still others found that the exchange rate has relatively small impact on the agriculture sector of the economy. Paarlberg, et al. [17] 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 [19] compared the effects of changes in exchange rate (and other macroeconomic variables) in a simple competitive versus a noncompetitive market for wheat. Bradshaw and Orden [2] tested the Granger Causality of exchange rates on agricultural prices and exports.

In case of India, Chandra [3] found bi-directional causal relationship between growth of exports and GDP growth which is a short-run causal relation, as co integration between growth of exports and GDP growth was not found. Sharma and Panagiotidis [8] test the export-led growth hypothesis in the context of India, and the results strengthen the arguments against the export-led growth hypothesis for the case of India. Raju and Kurien [18] analyzed the relationship between exports and economic growth in India over the pre-liberalization period

1960-1992, and found strong support for unidirectional causality from exports to economic growth using Granger causality regressions based on stationary variables, with and without an error-correction term. Dash [6] analyzes the causal relationship between growth of exports and economic growth in India for the post-liberalization period 1992-2007, and the results indicate that there exists a long-run relationship between output and exports, and it is unidirectional, running from growth of exports to output growth.

III. METHODOLOGY

a. DATA BASE

The secondary data regarding exchange rate and India's agricultural export are utilized in this study. Annual time series data from 1980 to 2010 are analyzed through the Granger causality test. The data required was collected from FAO, World Bank website and balance sheets of financial reports of the Central Bank of India.

b. GRANGER CAUSALITY APPROACH

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. Granger (1969) proposed a time-series data based approach in order to determine causality. In the Granger-sense *x* is a cause of *y* if it is useful in forecasting *y*. In this framework "useful" means that *x* is able to increase the accuracy of the prediction of *y* with respect to a forecast, considering only past values of *y*.

Assuming to have information set Ω_t with the form $(x_t, \ldots, x_{t-j}, y_t, \ldots, y_{t-i})$, we say that x_t is Granger causal for y_t wrt. Ω_t if the variance of the optimal linear predictor of y_{t+h}, based on Ω_t, has smaller variance than the optimal linear predictor of y_{t+h}, based only on lagged values of y_t, for any h. Thus, *x* Granger-causes *y* if and only if $\sigma_1^2(y_t : y_{t-j}, x_{t-i}) < \sigma_2^2(y_t : y_{t-j})$ with *j* and *i* = 1,2,3,...,n and σ^2 representing the variance of the forecast error.

There are three different types of situation in which a Granger-causality test can be applied:

• In a simple Granger-causality test there are two variables and their lags.

• In a multivariate Granger-causality test more than two variables are included, because it is supposed that more than one variable can influence the results.

• Finally Granger-causality can also be tested in a VAR framework, in this case the multivariate model is extended in order to test for the simultaneity of all included variables.

The empirical results presented in this paper are calculated within a simple
Granger-causality test in order to test whether quantity of agricultural export "Granger cause" exchange rates and vice versa. The following two equations can be specified:

$$(Q_x)_t = \alpha + \sum_{i=1}^{m} \beta_i (Q_x)_{t-i} + \sum_{j=1}^{n} \tau_j (ER)_{t-j} + \mu_t \qquad (1)$$

$$(ER)_t = \theta + \sum_{i=1}^{p} \emptyset_i (ER)_{t-i} + \sum_{j=i}^{q} \psi_j (Q_x)_{t-j} + \eta_t \qquad (2)$$

Where Q_x and *ER* are quantities of agricultural export (in tone) and exchange rates (percentage) respectively. Based on the estimated OLS coefficients for the equations (1) and (2) four different hypotheses about the relationship between Q_x and ER can be formulated:

1. Unidirectional Granger-causality from *ER* to Q_x. In this case exchange rates increase the quantities of agricultural export but not vice versa. Thus $\sum_{j=1}^{n} \tau_j \neq 0$ and $\sum_{j=1}^{q} \psi_j = 0$.

2. Unidirectional Granger-causality from Q_x to *ER*. In this case quantities of agricultural export increase the prediction of the exchange rates but not vice versa. Thus $\sum_{j=1}^{n} \tau_j = 0$ and $\sum_{j=1}^{q} \psi_j \neq 0$.

3. Bidirectional (or feedback) causality. In this case $\sum_{j=1}^{n} \tau_j \neq 0$ and $\sum_{j=1}^{q} \psi_j \neq 0$, so in this case quantities of agricultural export increases the exchange rates and vice versa.

4. Independence between Q_x and *ER*. In this case there is no Granger causality in any direction, thus $\sum_{j=1}^{n} \tau_j = 0$ and $\sum_{j=1}^{q} \psi_j = 0$.

Hence by obtaining one of these results it seems possible to detect the causality relationship between quantity of agricultural export and the exchange rates of a country.

Granger test analysis

The steps involved in implementing the Granger causality test are as follows:

I. Regress current Q_x on all lagged Q_x terms and other variables, if any, but do not include the lagged *ER* variables in this regression. From this regression obtain the restricted residual sum of squares, RSS_R.

II. Now run the regression including the lagged *ER* terms. From this regression obtain the unrestricted residual sum of squares, RSS_{UR}.

III. The null hypothesis is $H_0 : \sum \alpha_i = 0$, that is, lagged *ER* terms do not belong in the regression.

IV. To test this hypothesis, apply the *F* test as follows:

$$F = \frac{[(SSR_R - SSR_{UR})/m]}{[SSR_{UR}/(n-k)]}$$

Which follows the *F* distribution whit m and *(n-k)* df. In this present case m is equal to number of lagged *ER* terms and *k* is the number of parameters estimated in the unrestricted regression

V. If the computed *F* value exceeds the critical *F* value at the chosen level of the significance, reject the null hypothesis, in which case the lagged *ER* terms belong in the regression. This is another way of saying that *ER* causes Q_x.

VI. Steps 1 to 5 can be repeated to test the model (1), that is, whether Q_x causes *ER*.

The first step in this analysis concerns the stationarity of the Q_x and *ER* series. Granger causality requires that the series have to be covariance stationary, so an Augmented Dickey-Fuller test has been calculated. Then, since the Granger-causality test is very sensitive to the number of lags included in the regression, both the Akaike (AIC) and Schwarz Information Criteria have been used in order to find an appropriate number of lags.

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c. UNIT ROOT TEST

Dickey-Fuller (DF) test [Dickey and Fuller (1979, 1981)] is most commonly used for testing unit root. The DF-test requires estimating the following by OLS:

$\Delta Yt = \sigma + \beta t + (\varphi - 1)\ Yt-1 + \mu t$ … … … … (2)

Equation (2) indicates that the series *Yt* has both stochastic and deterministic trends and can be used as a DF-equation for testing the unit root hypothesis i.e., Ho:

$(\varphi - 1) = 0$. The test statistic used to test the unit root hypothesis is the *Tt*-statistic. If the calculated *Tt*-value (*t*-value of the coefficient $\varphi - 1$) is greater than the critical *Tt*value, then *Yt* is non-stationary.

From (2) we can also test the joint hypothesis of unit root and no trend *i*., Ho: $(\varphi - 1) = \beta = 0$ against the alternative hypothesis of trend stationary i.e., H1: $(\varphi - 1) = \beta \neq 0$ by using the φ – statistic with critical values from Dickey and Fuller (1981, Table (Vt, p. 1063). If the calculated $(\varphi -1)$ value is less than the critical value, the null is rejected; *Yt* is stationary with a significant trend and is a trend stationary series. If the error term is not white-noise, there is autocorrelation in the residuals. To overcome this problem first, we can generalise the testing Equation of (3.2) or second, we can adjust the DF-statistics [Thomas (1997), p. 407]. It is common to follow the former that is the augmented Dickey-Fuller (ADF) test. For this lagged values of the dependent variable are included on the right hand side of the DFEquation of (2) which becomes:

$\Delta Yt = \sigma + \beta t + (\varphi - 1)\ Yt-1 + \Sigma = ki\ 1\ \theta 1\ \Delta Yt-1 + \mu t$ … … (3)

Langrange Multiplier (LM) test [Holden and Perman (1994), p. 62] is used to know the number of lagged values of the dependent variable. If there is more than one unit root, then first it is tested for a unit root in the levels of the series *Yt*. If the hypothesis of the presence of a unit root is not rejected, we test the first difference (i.e. ΔYt) for the presence of a second unit root and so on. This testing procedure from lower to higher orders of integration continues until the null of a unit root is rejected.

d. JOHANSEN TEST

Johansen's Full Information Maximum Likelihood (FIML) approach [Johansen (1988); Johansen and Juselius (1990)] was used to test for co-integration and it allows the estimation of all possible co-integrating relationship and develops a set of statistical tests about how many co-integrating vectors exist. The Johansen maximum likelihood approach for multivariate co-integration is based on the following vector autoregressive (VAR) model: $Zt = At\ Zt-1 + \ldots + Ak\ Zt-k + \mu t$ … … … … (1) Where *Zt* is an $(n \times 1)$ vector of *I* (1) variables, *At* is an $(n \times n)$ matrix of parameters, μt is $(n \times 1)$ vector of white-noise errors. Since *Zt* is assumed to be non-stationary, it is convenient to rewrite (1) in its first-difference or error correction form as: $\Delta Zt = \Gamma 1\ \Delta Zt-1 + \ldots + \Gamma k-1\ \Delta Zt-k+1 + \Pi\ Zt-k + \mu t$ … … (2)

Where $\Gamma i = -(I-A1-A2-\ldots-Ai)$, $(i=1, \ldots k-1)$, and $\Pi = -(I-A1-A2-\ldots.-Ak)$.

Equation (2) differs from the standard first-difference form of the VAR model only through the inclusion of term $\Pi\ Zt-k$. This term provides information about the long-run equilibrium relationship between the variables in *Zt*. If the rank of the Π matrix, *r*, is $0<r<n$, there are '*r*' linear combinations of the variables in *Zt* that are stationary. In this case, the Π matrix can be decomposed into two matrices α and β such that $\Pi = \alpha\beta$, where α is the error correction term and β contains '*r*' distinct cointegrating vectors i.e., the co-integrating relationships between the non-stationary variables. If there are variables which are *I*(0) and are insignificant in the long-run co-integrating space but affect the short-run model, (2) can be rewritten as: $\Delta Z\ t = \Gamma 1\ \Delta Z\ t-1 + \Psi\ Dt + \mu\ t$

Where *Dt* represent the *I*(0) variables, which are often included to take account of short-run shocks to the system such as policy interventions. Two likelihood ratio

(LR) tests are constructed for detecting the presence of a single co-integrating vector. The first is the trace test statistics: λ trace = $-2lnQ = -Ti\ \Sigma = +prln1(1-\lambda\ t)$

It tests the null hypothesis of at most *r* co-integrating vectors against the alternative that it is greater than *r*. The second is the maximal-eigenvalue test:

λ max = $-2ln(Q: r|r+1) = -Tin\ (l-\lambda\ r+1)$ Which tests the null hypothesis of *r* co-integrating vectors against the alternative that it is *r* + 1? The critical values for these tests have been derived by Monte Cario number of issues need to be addressed before using this methodology. First, the endogenous variables included in the VAR are all *I*(1). Second, the additional exogenous variable included in the VAR which explain the short-run behaviour need to be *I*(0). Third, the choice of lag length *k* (i.e., order) in the vector autoregressive (VAR) is important and the Akaike information criterions (AIC), Schwarz information criterion (SBC) are often used.

IV. RESULTS AND DISCUSSION

First, the Augmented Dickey-Fuller (ADF) test, the popular tests for unit roots, has been performed for variables. The results of the ADF test at level and first differences are reported in Table 1 and 2 respectively. Based on Table 1, the t-statistics for all series from ADF test are statistically insignificant to reject the null hypothesis of non-stationary at 0.05 significance level. This indicates that these series are non-stationary at their level form. Therefore, these variables are containing a unit root process or they share a common stochastic movement. When the ADF test is conducted at first difference of each variable, the null hypothesis of non-stationary is easily rejected at 0.05, 0.01 and 0.1 significance levels as shown in Table 2. This is consistent with some previous studies that have been demonstrated the most of the macroeconomics and financial series expected to contain unit root and thus are integrated of order one, I(1).

Table 1: ADF tests for unit roots of the variables

ADF test for Unit Root			
Variables	**ADF test statistic**		**Levels**
	t-statistic	**Prob.**	**t-statistic**
Q_x	2.090412	0.9998	-3.670170
			-2.963972

			-2.621007
ER	-1.207199	0.6580	-3.670170
			-2.963972
			-2.621007

Table 2: ADF tests for unit roots of the variables

ADF test for Unit Root			
Variables	**ADF test statistic**		**First Differences**
	t-statistic	Prob.	t-statistic
Q_x	-3.878413	0.0062	-3.670170*
			-2.963972**
			-2.621007***
ER	-3.984654	0.0048	-3.670170*
			-2.963972**
			-2.621007***
Note: 1.* denotes significant at 1% level 2.** denotes significant at 5% level 3.***denotes significant at 10% level			

Johansen test:
To test whether the variables are cointegrated or not, Johansen test of cointegration has been performed with appropriate assumptions on trends and lags.

Table 3: Cointegration between Qx and ER

Hupothosized No. of CE(s)	Trace Statistic	5% critical value	Max-Eigen statistic	5% critical value
None	5.041649	15.49471	5.041170	14.266460
At most 1	0.000479	3.841466	0.000479	3.841466

Table 4: Cointegration between ER and Qx

Hupothosized No. of CE(s)	Trace Statistic	5% critical value	Max-Eigen statistic	5% critical value
None	4.8451	15.495	4.8383	14.265
At most 1	0.00068	3.8415	0.00068	3.842

Both the tables show that we can't reject the hypothesis of 'no cointegrated equations' at 5% level of significance. So we can conclude that agricultural export is not cointegrated with exchange rate, in other words there is no long run relationship between agricultural export and exchange rate.

Granger Causality Tests:
There are two ways in which causality can express itself: through the F-test of joint significance of the lagged differenced terms, and through the error-correction term. The results are reported in Table 5. It can be seen that in this case of India F-statistics for Qx→ER and ER→Qx are insignificant at 95 percent level of confidence. Thus, the data suggest that there is no causality in either direction. If one looks at the error-correction terms, they appear insignificant in both equations for India (Table 5), implying that there is no long term causality runs from agricultural export to exchange rate.

Table 5: Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Prob.
D(ER) does not cause D(QX)	28	0.27810	0.7597
D(QX)does not cause D(ER)	28	0.32664	0.7246

V. CONCLUSION

This paper has examined the possibility of Granger causality between the quantity of agricultural exports and exchange rate in India during 1980-2010. The study findings suggest that quantity of agricultural exports and exchange rate are not co integrated, so there is no the long run relationship between agricultural export and exchange rates. The double steps procedure has evidenced that it can be reasonable to better investigate in the amount of exchange rate of predicting short and long term macroeconomic growth. On the other side it can be concluded that the exchange rate is not a good indicator for predicting future quantity of agricultural exports. Advanced econometric methodologies have been applied in order to investigate the short- and long-run causality relationship between quantity of agricultural exports and exchange rate. One of the merits the advocates of depreciation of local currency commonly put forward is its contribution to increase export earnings. In fact in the era of devaluation the authority in India, like in many third world countries, used to place export as one of the foremost reasons of devaluing local currency against US$. For India's agricultural export to be price elastic, policies that help increase the share of domestic goods in exportable commodities by the expansion of production base and that help diversification of the pattern of the export items should be prioritized. However, the impact of exchange rate depreciation might not be same for all sub-sectors of export. This is why the relation of exchange rate with various sub-sectors of export should be analyzed and considered separately. In addition, careful investigation of various incentive options is required to select an effective and pragmatic policy to support export. One policy may not fit all. Moreover, the bad impacts of depreciation on other sectors of economy should also be considered seriously before taking any policy that help depreciation. India's exchange rate policy, which is generally aimed at supporting agricultural exports, will need to be re-evaluated. Exchange rate policy should not aim at export promotion in isolation, instead it should balance both exports and imports growth. This will, in turn, help Indian firms to export more and, more importantly, facilitate firms to achieve a higher level of productivity and efficiency.

Appendix

AUGMENT DICKEY-FULLER UNIT ROOT TEST ON ER

Null Hypothesis: ER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.206952	0.6581
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

AUGMENT DICKEY-FULLER UNIT ROOT TEST ON D(ER)

Null Hypothesis: D(ER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.987303	0.0047
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

AUGMENT DICKEY-FULLER UNIT ROOT TEST ON QX

Null Hypothesis: QX1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.090412	0.9998
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

AUGMENT DICKEY-FULLER UNIT ROOT TEST ON D(QX)

Null Hypothesis: D(QX1) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.878413	0.0062
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

JOHANSEN COINTEGRATION TEST BETWEEN QX AND ER

Date: 12/31/12 Time: 22:59
Sample (adjusted): 1985 2010
Included observations: 26 after adjustments
Trend assumption: Linear deterministic trend
Series: QX1 ER
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.169798	4.845046	15.49471	0.8251
At most 1	0.000261	0.006794	3.841466	0.9337

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.169798	4.838252	14.26460	0.7621
At most 1	0.000261	0.006794	3.841466	0.9337

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

JOHANSEN COINTEGRATION TEST BETWEEN ER AND QX

Date: 12/31/12 Time: 23:02
Sample (adjusted): 1985 2010
Included observations: 26 after adjustments
Trend assumption: Linear deterministic trend
Series: ER QX1
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.169798	4.845046	15.49471	0.8251
At most 1	0.000261	0.006794	3.841466	0.9337

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.169798	4.838252	14.26460	0.7621
At most 1	0.000261	0.006794	3.841466	0.9337

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

GRANGER CAUSALITY TEST

Pairwise Granger Causality Tests
Date: 12/31/12 Time: 23:04
Sample: 1980 2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
ER does not Granger Cause QX1	29	0.59315	0.5605
QX1 does not Granger Cause ER		0.41081	0.6677

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