GROWTH AND RAW MATERIAL IMPORTS NEXUS: AN EMPIRICAL STUDY OF PAKISTAN’S AGRICULTURAL SECTOR

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ABSTRACT

A study was conducted at Applied Economics Research Centre, University of Karachi, Karachi, Pakistan during 2009. The objective was to test the import led agricultural growth hypothesis in case of Pakistan. Agriculture is a vital sector of Pakistan’s economy. It contributes significantly to its GDP and provides employment to bulk of labour force. The country also imports agricultural raw material to bridge the gap of demand and supply of this raw material. The data used in this study relate to the year 1971-2007. For statistical evidence this study employs the most reliable cointegration techniques like JJ cointegration, Gregory Hansen’s cointegration test, VAR-L, VAR-D and ECM. The results of JJ cointegration and Gregory Hansen's test of cointegration confirmed long run association between agricultural growth and agricultural raw material imports, and bidirectional causality was found by using VAR-L, VAR-D and ECM.

KEYWORDS: Agricultural growth; raw material; import; Pakistan.

INTRODUCTION

Agriculture is a vital sector of the Pakistan’s economy. If the growth of this sector is disturbed, it can badly affect the industrial sector due to forward and backward linkages between these two sectors. Thus it is essential to maintain the agricultural growth for sustaining industrial as well as overall growth. Pakistan also imports raw material for agriculture sector like

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1Agriculture sector has forward linkages with the industrial sector by providing raw materials to food and fibre processing industries and backward linkages by buying agricultural inputs including fertilizers, pesticides and farm machinery from industrial sector.
machinery, fertilizers and insecticides to maintain stable growth of agriculture sector.

In 1999-00, worth of imports of agricultural machinery, fertilizer and insecticides was 49.8, 197.6 and 90.7 million $, respectively (Table 1). In 2000-01 import of agricultural machinery declined by 52.21 percent, fertilizer imports by 13.71 percent and insecticides import declined by 32.52 percent. The highest growth of agricultural machinery, fertilizer and insecticides imports i.e. 159.19, 85.67 and 112.41 percent was witnessed during the year 2003-04, 2005-06 and 2003-04, respectively.

Table 1. Raw material imports of agricultural sector.

<table>
<thead>
<tr>
<th>Year</th>
<th>Agricultural machinery</th>
<th>Fertilizer</th>
<th>Insecticides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million ($)</td>
<td>Growth (%)</td>
<td>Million ($)</td>
</tr>
<tr>
<td>1999-00</td>
<td>49.8</td>
<td>-</td>
<td>197.6</td>
</tr>
<tr>
<td>2000-01</td>
<td>23.8</td>
<td>-52.21</td>
<td>170.5</td>
</tr>
<tr>
<td>2001-02</td>
<td>16.1</td>
<td>-32.35</td>
<td>176.2</td>
</tr>
<tr>
<td>2002-03</td>
<td>36.8</td>
<td>128.57</td>
<td>239.8</td>
</tr>
<tr>
<td>2003-04</td>
<td>95.383</td>
<td>159.19</td>
<td>284.7</td>
</tr>
<tr>
<td>2004-05</td>
<td>128.273</td>
<td>34.48</td>
<td>342.326</td>
</tr>
<tr>
<td>2005-06</td>
<td>132.061</td>
<td>2.95</td>
<td>635.956</td>
</tr>
<tr>
<td>2006-07</td>
<td>188.969</td>
<td>43.09</td>
<td>408.805</td>
</tr>
<tr>
<td>2007-08</td>
<td>152.59</td>
<td>-19.25</td>
<td>718.532</td>
</tr>
<tr>
<td>2008-09</td>
<td>106.518</td>
<td>-30.19</td>
<td>448.969</td>
</tr>
</tbody>
</table>

Source: State Bank of Pakistan.

Numerous studies investigated the hypothesis like export-led growth, import-led growth and relationship between the trade and economic growth on the aggregate level (1, 3, 4, 5, 7, 9, 12, 15, 19, 20, 21, 22, 24, 27, 28, 30, 31). But on the sector level, empirical literature provided few studies on association between agricultural imports and agricultural sector growth, agricultural exports and agricultural growth. Kellogg et al. (16) examined the association between agricultural imports and agricultural production in developing countries. They stated that per capita agricultural imports positively correlated to per capita income in developing countries.

Mylene and John (25) empirically investigated the association among agricultural output growth, agricultural imports and development assistance in the sample of 56 developing economies. They found a long run relationship between aid and agricultural imports and also the aid had a positive impact on agricultural growth. They observed that aid helps market expansion and strengthens trade ties of industrialized countries. Henneberry
and Curry (8) evaluated agricultural import demand of 12 out of 15 largest agricultural import markets by using the data from 1974-1990. They found that domestic production positively related to agricultural import volume in the high growth countries. They found agricultural exports lead the overall economic growth of the country. Yamaguchi and Sanker (33) investigated the impact of structural adjustment program on food imports and agricultural exports in case of Sri Lanka. They found agricultural exports positively related to agriculture sector GDP and food imports negatively impacted on the domestic food sector. On the other hand, devaluation of currency reduces real food imports and increases agricultural exports. Memon et al. (23) found bi-directional Granger-causality between total exports and agricultural GDP in case of Pakistan by using the data of 1971-2007. Kohansal (18) concludes that trade liberalization increases the agricultural imports because cost of agricultural production is high in case of Iran. Hye et al. (12) empirically proved that agricultural raw material imports lead the agricultural exports in case of Pakistan.

The objective of the present study is to explore the link between agricultural sector growth and agricultural raw material imports by using the data of 1971-2007.

**METHODOLOGY**

This study was conducted at Applied Economics Research Centre, University of Karachi, Karachi, Pakistan during the year 2009. It employs the following model to capture the causal link between agricultural growth and agricultural raw material imports.

\[
\begin{align*}
\ln AG &= \psi_0 + \psi_1 \ln Am + D_t \ldots \ldots (1) \\
\ln AM &= \zeta_0 + \zeta_1 \ln AG + \mu_t \ldots \ldots (2)
\end{align*}
\]

Here \( \ln AG \) and \( \ln AM \) are agricultural growth and agricultural raw material imports, respectively and \( \ln \) represents the symbol of natural logarithms which means that both variables are used in natural log form for econometric estimation. \( \psi \)'s and \( \zeta \)'s are the parameters, and \( \nu_t \) & \( \mu_t \) are the error terms. The data of both variables from 1971-2007 were taken from World Bank, world development indicators. The agricultural growth is proxied by agricultural sector GDP. The both agricultural sector DGP and agricultural raw material imports are measured in local currency. In empirical research it
is vital to determine the order of integration of variables. For this purpose, present standard unit root tests like Augmented Dickey Fuller (ADF) and Phillips-Perron test (PP) were employed in this study. ADF unit root test is based on the following regression model.

\[ \Delta Y_t = a_0 + a_1 T + a_2 Y_{t-1} + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \varepsilon_t \quad \cdots \cdots (3) \]

Here \( \varepsilon_t \) is pure white noise error term, \( Y_t \) is a time series, \( T \) is a linear time trend, \( \Delta \) is the first difference operator, \( a_0 \) is a constant and \( k \) is the optimum number of lags on the dependent variable. The null hypothesis is \( H_0: \alpha_2 = 0 \) meaning economic series are non-stationary\(^2\). The second Phillips-Perron (1988) test\(^3\) test is employed by this study. In PP test, the property of unit root is noticed by estimating the \( Y_t \) as follows,

\[ \Delta Y_t = a + \rho Y_{t-1} + \varepsilon_t \quad \cdots \cdots (4) \]

The series is stationary if \( \rho \) is negative and significant. When the order of integration is confirmed then next step is to apply Johansen and Juselius (13, 14) maximum likelihood approach to cointegration\(^4\). Johansen’s method tests the restrictions imposed by co-integration on the unrestricted VAR involving the series. Consider a VAR of order \( p \).

\[ Y_t = A_1 y_{t-1} + \ldots + A_p Y_{t-p} + Bx_t + \varepsilon_t \quad \cdots \cdots (5) \]

Here \( Y_t \) is a \( k \)-vector of non-stationary I (1) variables, \( x_t \) is a \( d \)-vector of deterministic variables, and \( \varepsilon_t \) is a vector of innovations. we can write the VAR as

\[ \Delta y_t = \Pi y_{t-1} \sum_{i=1}^{p-1} A_i \Delta y_{t-i} + 1 + Bx_t + \varepsilon_t \quad \cdots \cdots (6) \]

Where \( \Pi = \sum A_i - I, i = 1, \ldots, p \)

\(^2\) That is \( Y_t \) is a random walk and it has a unit root. If the t-statistic associated with estimated coefficient, where \( \alpha_2 \), is less than the critical value for the test, null hypothesis of non-stationary cannot be rejected at 1 or 5 10% level of significance.

\(^3\) This unit root test is used because it is robust to a wide variety of serial correlation.

\(^4\) The maximum likelihood procedure is based on the well-established likelihood ratio principle.

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Granger’s representation theorem asserts that if the coefficient matrix $\Pi$ has reduced rank $r < k$, then there exist $k \times r$ matrices $\alpha$ and $\beta$ each with rank $r$ such that $\Pi = \alpha$ and $y_t$ is stationary is the number of co-integrating relations (the co-integrating rank) and each column of $\beta$ is the co-integrating vector. The elements of $\alpha$ are known as the adjustment parameters in the vector error correction model$^6$.

**Gregory Hansen’s test of cointegration**

Gregory and Hansen (6) have developed residual based tests of cointegration which allows the existence of one time changes in the cointegration parameters. They also pointed out the presence of a structural break reduce the power of residuals basis cointegration test. Cointegration models with allowing shift in the intercept can be written as follows:

\[
\begin{align*}
\text{LnAG}_t &= \varphi_1 + \varphi_1 D_t + \sigma_1 \text{LnAM}_t + \varepsilon_{1t} \quad \ldots \quad (7) \\
\text{LnAM}_t &= \varphi_2 + \varphi_2 D_t + \sigma_2 \text{LnAG}_t + \varepsilon_{2t} \quad \ldots \quad (8)
\end{align*}
\]

Here $D_t$ is a dummy variable equal to 0.0 if $t \leq \theta$ and 1.0 if $t > \theta$. The unknown parameter $\theta$ indicates the time of change. $\varphi_1$ and $\varphi_2$ expresses the change in the intercept coefficient at the time of shift. When recognizing the $\theta$, next step is that to estimate equation and finding the coefficients for statistical inference.

**Causality test**

$^6$Johansen’s method is to estimate the $\Pi$-matrix in a n unrestricted from and then test whether reject the restrictions implied by the reduced rank of $\Pi$. Johansen’s method uses two test statistics for the number of co integrating vectors: the trace test and maximum eigenvalue ($\lambda_{max}$) test. This is used the $|\hat{\lambda}_{max}|$ statistic tests in order determination of cointegrating vectos.

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This study also uses two steps method of Hsiao (10) to determine the direction of causality between LnAG and LnAM. Three bivariate models like vector autoregressive model in levels (VAR-L), vector autoregressive model in first differences (VAR-D) and error-correction model (ECM) are specified to causal inference. These bivariate models write in equation form as given on next page.

**Vector autoregressive model in levels (VAR-L)**

\[
\begin{align*}
\text{Ln}(AG)_t &= \gamma_1 + \sum_{j=1}^{K} \beta_{1j} \text{Ln}(AG)_{t-j} + \sum_{j=0}^{K} \phi_j \text{Ln}(AM)_{t-j} + V_{1t} \quad \ldots \quad (9) \\
\text{Ln}(AM)_t &= \gamma_1 + \sum_{j=1}^{K} \alpha_{1j} \text{Ln}(AM)_{t-j} + \sum_{j=0}^{K} \delta_j \text{Ln}(AM)_{t-j} + \mu_{1t} \quad \ldots \quad (10)
\end{align*}
\]

**Vector autoregressive model in first difference (VAR-D)**

\[
\begin{align*}
\Delta \text{Ln}(AG)_t &= \gamma_2 + \sum_{j=1}^{K} \beta_{2j} \Delta \text{Ln}(AG)_{t-j} + \sum_{j=1}^{K} \phi_{2j} \Delta \text{Ln}(AM)_{t-j} + V_{2t} \quad \ldots \quad (11) \\
\Delta \text{Ln}(AM)_t &= \gamma_3 + \sum_{j=1}^{K} \alpha_{3j} \Delta \text{Ln}(AM)_{t-j} + \sum_{j=0}^{K} \delta_j \Delta \text{Ln}(AG)_{t-j} + \mu_{1t} \quad \ldots \quad (12)
\end{align*}
\]

**Error correction Model (ECM)**

\[
\begin{align*}
\Delta \text{Ln}(AG)_t &= \gamma_3 + \sum_{j=1}^{K} \beta_{3j} \Delta \text{Ln}(AG)_{t-j} + \sum_{j=1}^{K} \theta_{3j} \Delta \text{Ln}(AM)_{t-j} + \psi_1 \text{ecm}_{t-1} V_{3t} \quad \ldots \quad (13) \\
\Delta \text{Ln}(AM)_t &= \gamma_3 + \sum_{j=1}^{K} \alpha_{3j} \Delta \text{Ln}(AM)_{t-j} + \sum_{j=0}^{K} \delta_{3j} \Delta \text{Ln}(AG)_{t-j} + \psi_2 \text{ecm}_{t-1} + \mu_{3t} \quad \ldots \quad (14)
\end{align*}
\]

**FPE formula for selection the optimal lag structure**

---


7First, bivariate model of vector autoregressive in levels (VAR-L) in Equation 1-2 suppose that LnAG and LnAM are integrated of order of zero.

8Second, bivariate model of vector autoregressive in first difference (VAR-D) in Equation 3-4 suppose that LnAG and LnAM are integrated of order of one.

9The third error correction models (ECM) in Equations 5-6 assumes that both variables are integrated of order of one and from model-3 (ECM) by including ECM terms in the VAR-D model measures the divergences from the long-run equilibrium association between LnAG and LnAM.
Growth and raw material imports nexus

\[ FPE(k) = \frac{(T + k + 1)}{T - k - 1} \frac{\text{SSE}(k)}{T} \quad \ldots (15) \]

\[ FPE(k^*, n) = \frac{(T + k^* + n + 1)}{T - k^* - n - 1} \frac{\text{SSE}(k^*, n)}{T} \quad \ldots (16) \]

Here \( \text{LnAG} \) and \( \text{LnAM} \) represent the logarithm of agricultural sector GDP and raw material imports of agricultural sectors. \( V_t \) and \( \mu_t \) represent the error term and FPE stands for final prediction error, \( T \) is the number of observations, SSE is the sum of squared residuals, and \( k \) & \( n \) are, respectively, the orders of lags for controlled and manipulated variables; \( k^* \) is the optimal order of lags of controlled variable.

**EMPIRICAL RESULTS**

The decision of unit root was taken in the way that the null hypothesis ‘unit root’ is rejected, if the absolute test statistics of ADF and PP test was higher than the critical value. On the other hand if the absolute value of the test statistic was less than the critical value the null hypothesis was accepted. The results of both unit root tests (Table 1) indicate that both \( \text{LnAG} \) and \( \text{LnAM} \) are unit root (non-stationary) in their level form and stationary at their first difference.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF C</th>
<th>ADF C &amp; T</th>
<th>PP C</th>
<th>PP C &amp; T</th>
</tr>
</thead>
<tbody>
<tr>
<td>( AG )</td>
<td>-1.79</td>
<td>-2.69</td>
<td>-1.87</td>
<td>-2.05</td>
</tr>
<tr>
<td>( \Delta AG )</td>
<td>-4.31*</td>
<td>-4.69*</td>
<td>-5.08*</td>
<td>-5.61</td>
</tr>
<tr>
<td>( AM )</td>
<td>-1.49</td>
<td>-2.56</td>
<td>-2.65</td>
<td>-1.98</td>
</tr>
<tr>
<td>( \Delta AM )</td>
<td>-5.82*</td>
<td>-4.57*</td>
<td>-9.24*</td>
<td>-7.61*</td>
</tr>
</tbody>
</table>

*Significant at 0.01 level.

The results of unit-root tests confirmed that both \( \text{LnAG} \) and \( \text{LnAM} \) are integrated order one. Next we apply the procedure of Johansen and Juselius test (13) to conclude long run robustness among the variables. The results of JJ cointegration approach (Table 2) start with the null hypothesis of no co-integration \( (r = 0) \) among the variables the Trace statistic is 29.39, it rejects the null hypothesis \( r = 0 \) at zero percent level of significance in favour of specific alternative that there is one co-integrating vector \( r \geq 1 \). As is evident
in Table 2, the null hypothesis of \( r \leq 1 \) at 8 percent level of significance. Thus this study concludes that there are two cointegration vectors.

Table 2. Johansen maximum likelihood test for co-integration.

<table>
<thead>
<tr>
<th>Trace statistic test</th>
<th>Null hypothesis</th>
<th>Alternative hypothesis</th>
<th>Trace statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r = 0 )</td>
<td>( r \geq 1 )</td>
<td></td>
<td>29.39</td>
<td>0.00</td>
</tr>
<tr>
<td>( r \leq 1 )</td>
<td>( r \geq 2 )</td>
<td></td>
<td>7.82</td>
<td>0.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max-Eigen statistic test</th>
<th>Null hypothesis</th>
<th>Alternative hypothesis</th>
<th>Max-Eigen statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0 )</td>
<td>( R = 1 )</td>
<td></td>
<td>21.56223</td>
<td>0.00</td>
</tr>
<tr>
<td>( R \leq 1 )</td>
<td>( R = 2 )</td>
<td></td>
<td>7.82828</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Turning to the Max - Eigen Statistic, the null hypothesizes of no co-integration (\( r = 0 \) and \( r \leq 1 \)) is rejected at zero and 8 percent level of significance, respectively. Thus on the basis of both tests (Trace Statistic and Max-Eigen Statistic) this study concluded that long run relationship exists and there are two cointegration vectors.

Results of Gregory Hansen’s test of cointegration

The cointegration relationship between agricultural growth and agricultural raw material exports after allowing break in 1995 was estimated by using the Phillips-Hansen FMOLS techniques (Table 3). The results indicated that coefficient of dummy variable is statistically significant in both cases, supporting the significance of structural break. The break in 1995 was due to the implementation of trade liberalization policies in Pakistan. On the other hand the cointegrating slope coefficient is significant in both cases, either agricultural growth is dependent variable or agricultural raw material dependent variable.

Table 3. Gregory Hansen’s test of cointegration and long run coefficient.

<table>
<thead>
<tr>
<th>Part- A</th>
<th>Endogenous break date = 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model – A ( LnAG_t = \phi_1 + \gamma D_t + \sigma_1Am_t + \epsilon_{1t} )</td>
<td></td>
</tr>
<tr>
<td>( ADF = -5.41^* )</td>
<td></td>
</tr>
<tr>
<td>( AG_t = 5.9 + 0.97D_t + 1.05 AM_t )</td>
<td></td>
</tr>
<tr>
<td>(0.00)(^*) (0.00) (0.02)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part-B</th>
<th>Model – B ( LnAM_t = \phi_2 + \gamma_2 D_t + \sigma_2 AG_t + \epsilon_{2t} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ADF = -4.79^** )</td>
<td></td>
</tr>
<tr>
<td>( AM_t = -3.5 - 0.49Dt + 0.76AG )</td>
<td></td>
</tr>
<tr>
<td>(0.00) (0.01) (0.00)</td>
<td></td>
</tr>
</tbody>
</table>

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ADF test values show the Gregory Hansen’s tests of cointegration with an endogenous break in the intercept. Critical value for the ADF test are as follows: (1%)* -5.13, *(5%) -4.61 and ***(10%) -4.34. a: denotes the prob values.

When agricultural growth is dependent variable then agricultural raw material imports positively expedite agricultural growth and also dummy variable coefficient is positive and statistically significant indicating trade liberalization policies leads agricultural growth. In model-b when agricultural raw material imports are dependent variable then agricultural growth positively cause agricultural imports. However, the important finding is that dummy variable coefficient is negative and statistically significant which shows trade liberalization reduces agricultural imports in Pakistan.

Results of causality tests

The data (Table 4) of causality tests based on three models (VAR-L, VAR-D and ECM). demonstrate bidirectional causality between agricultural growth and imports of agricultural raw material.

<table>
<thead>
<tr>
<th>Table 4. Result of causality test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable</strong></td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>Vector autoregressive model in levels (VAR-L)</strong></td>
</tr>
<tr>
<td>AG</td>
</tr>
<tr>
<td>AG</td>
</tr>
<tr>
<td>AM</td>
</tr>
<tr>
<td>AM</td>
</tr>
<tr>
<td><strong>Vector autoregressive model in first differences (VAR-D)</strong></td>
</tr>
<tr>
<td>∆AG</td>
</tr>
<tr>
<td>∆AG</td>
</tr>
<tr>
<td>∆AM</td>
</tr>
<tr>
<td>∆AM</td>
</tr>
<tr>
<td><strong>Error correction model (ECM)</strong></td>
</tr>
<tr>
<td>∆AG</td>
</tr>
<tr>
<td>∆AG</td>
</tr>
<tr>
<td>∆AM</td>
</tr>
<tr>
<td>∆AM</td>
</tr>
</tbody>
</table>

The null hypothesis that LnAM does not Granger-cause LnAG is rejected by all three specified models FPE (2, 2) 0.003455 < FRE (2) 0.003540 in VAR-L, FPE (2, 2) 0.003536 < FRE (2) 0.003682 in VAR-D and FPE (2, 2)
0.003437 < FRE (2) 0.003682 in ECM. The null hypothesis that LnAG does not Granger-cause LnAM is rejected by all three specified models because FPE (2, 2) 0.051791 < FPE (2) 0.057641 in VAR-L, FPE (2, 2) 0.003536 < FPE (2) 0.055489 in VAR-D and FPE (2, 2) 0.051335 < FPE (2) 0.055489 in ECM.

CONCLUSION

The empirical literature on trade and growth nexus has only focussed on aggregate level relationship. This study investigates the sectoral level association of agricultural growth and agricultural raw material imports in case of Pakistan by using the time series data 1971-2007. For econometric evidence this study employs the JJ cointegration approach, Gregory Hansen’s test of cointegration. To determine the direction of causality three specified VAR model (VAR-L, VAR-D and ECM) are implemented. Results of JJ cointegration and Gregory Hansen’s test of cointegration demonstrate that long run relationship exists among agricultural growth and agricultural raw material imports. The causality tests results of VAR-L, VAR-D and ECM indicate that there is bidirectional causality between agricultural growth and agricultural raw material imports. But the important finding of this study is that trade liberalization has positive impact on agricultural growth but impede agricultural raw material imports.

REFERENCES