Agriculture on the Road to Industrialisation and Sustainable Economic growth: An Empirical Investigation for Pakistan

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Abstract: The present empirical study investigates the dynamic link between the agricultural and industrial output of Pakistan economy using the Autoregressive Distributed Lag (ARDL) bounds testing approach. Empirical results suggest that agricultural output effect on the industrial output in the long run and short run but the industrial output effect the agricultural output only in the long run. The agricultural output effect on the industrial output more than the industrial output effect on the agricultural output. The error correction terms (ECT) indicates that when shock in industrial output more quickly (61% per year) adjusted agricultural output than the shock in agricultural output and adjustment in the industrial output (13% per year).

Keywords: Agriculture output, Industrial output, ARDL

INTRODUCTION

In developing countries the interaction between agriculture and industry has been extensively explored on the theoretical and empirical grounds. But in the case of Pakistan this issue has not been discussed at length. Lewis model (1954) provides pioneer theoretical literature of interaction between agricultural and industry. Industrial sector engine of growth, growth enhances by employing the surplus labor of agricultural sector in the new industries. Sah and Stiglitz (1984), Rattso (1988) and Taylor (1991) concluded agricultural and industrial sectoral association depends on the macro closure of the model. Nachane *et al* (1989) explicated the different links between the agriculture and industry. Henneberry *et al* (1999) concluded industry tends to benefit more from agricultural growth. Chaudhuri *et al* (2004) found bidirectional causality between the agricultural output and industrial output. Craigwell *et al* (2008) stated industrial output has associated with lower agricultural GDP in the long run but in the short run changes in industrial output promoted agricultural output.

Agricultural and industrial sectors played an important role in the economy of Pakistan. Agricultural sector helps the other sectors of the economy in the growth process and contributes 21.5 percent (2008) to the GDP and employing 42 percent of the labor force. More than two-thirds population lives in the rural areas and their living continues to rotate around agriculture and connected activities. Therefore the development of agriculture will be a major vehicle for alleviating not only rural poverty but also the urban poverty. The importance of agricultural sector in the economy of Pakistan may be defined in five ways. Firstly, the sector provides food to the consumers and fiber to the domestic industry. Secondly, it is a major source of foreign exchange earnings. Thirdly, it provides a market for industrial production. Fourthly, an increase in agricultural output can increase government saving by increase in indirect tax collection and lastly, increase in agricultural terms of trade may boost households saving and investment in rural areas.

This sector has strong backward linkages (by buying agricultural inputs including fertilisers, pesticides, farm machinery, etc) and forward linkages (by providing raw materials to food and fiber processing industries in the industrial sector). Industrial sector contributes 25.1% to the GDP and employing 28% labor force of the country. Currently Pakistan's economy is facing four major problems such as, rising inflation, decline in growth, fiscal deficit and widening of trade and current account deficits. In order to overcome these challenges and being an agricultural country, Pakistan's government must work to boost its production of agriculture and industrial sectors. The aim of this research is to model the dynamic relationship between agricultural output and industrial output by using the recent advance Cointegration technique ARDL (Pesaran *et al*, 2001). Rest of paper is organising as follow. Section B presents data and econometric methodology. Section C represents empirical results and final section (D) represents the conclusion and policy recommendation.

Model, Data and Estimation Methods

The present study is composed simple regression model, in order to explain interaction between agricultural and industrial output in Pakistan. The estimation model as follows,

$$Ln(IO) = \xi_0 + \xi_1 Ln(AO) + \psi_t -----(1)$$

Alternative re-writes as,

$$Ln(AO) = \xi_2 + \xi_3 Ln(IO) + \psi_t -----(2)$$

Where, AO and IO are agricultural output and industrial output respectively. The terms ξs represent parameters, ψ is the error terms and Ln, symbols of natural logarithm. The time series data of agricultural output (AO) and industrial output (IO) contain annual observations for the period 1971- 2007. Data of both variables is taken from various issue of Pakistan Economic Survey. Both data series were transformed in natural logarithm form for econometric analysis and both series are used in an index form, based on the 2000=100.

Table 1: Descriptive Statistic & Correlation Matrix

Descriptive Statistic		
	Ln(AO)	Ln(IO)
Mean	4.21	4.11
Median	4.27	4.20
Maximum	4.76	5.38
Minimum	3.65	3.06
Correlation Matrix		
	Ln(AO)	Ln(IO)
Ln(AO)	1.00	-
Ln(IO)	0.98	1.00

This study uses the Phillips and Perron (1988) unit root test in order to determine the time series properties. Phillips and Perron (PP) test propose an alternative (nonparametric) method of controlling for serial correlation when testing unit root of time series data. The PP method estimates the non-augmented Dickey Fuller equation (3). The test detects the presence of a unit root in a series, say Xt by estimating as

$$\Delta X_t = \alpha + \rho X_{t-1} + \varepsilon_t -----(3)$$

The PP test estimate the modified t-value associated with the estimated coefficient of ρ so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test is based on the following statistic

$$\tilde{t}_\rho = t_\rho \left(\frac{\gamma_0}{f_0}\right)^{\frac{1}{2}} - \frac{T(f_0 - \gamma_0)(se(\tilde{\rho}))}{2 f_0^{\frac{1}{2}} s} -----(4)$$

Where $\tilde{\rho}$ is the estimate, and t_ρ the t-ratio of ρ, $se(\tilde{\rho})$ is coefficient standard error, and s is the standard error of the test regression. In addition, γ_0 is a consistent estimate of the error variance (in eq.1) which calculated as,

$$\gamma_0 = \frac{(T-k)s^2}{T} -----(5)$$

Where k is the number of regressors and T tabulated value. The remaining term, f_0, is an estimator of the residual spectrum at frequency zero. The series is stationary if ρ is negative and significant.

ARDL Co-integration

To search for possible long run relationship between the both variables, Ln(AO) and Ln(IO) this empirical work employ the autoregressive distributed lag (ARDL), bound test approach to Cointegration (Pesaran *et al*, 2001). This involves estimating the following unrestricted error correction model (UECM)

$$\Delta Ln(AO)_t = \lambda_0 + \sum_{i=0}^{n} \lambda_i \Delta Ln(AO)_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta Ln(IO)_{t-i} + \alpha_1 Ln(AO)_{t-1}$$
$$+ \alpha_2 Ln(IO)_{t-1} + v_{1t} -----(6)$$

$$\Delta Ln(IO)_t = \gamma_0 + \sum_{i=0}^{n} \gamma_i \Delta Ln(IO)_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta Ln(AO)_{t-i} + \beta_1 Ln(IO)_{t-1}$$
$$+ \beta_2 Ln(AO)_{t-1} + v_{2t} -----(7)$$

Where Δ is the first difference operator, Ln AO is the natural logarithm of agricultural output and Ln IO is natural logarithm of industrial output. The F-test is used to determine whether a long run relationship exists between the variables through testing the significance of the lagged levels of the variables. The Pesaran *et al*. approach compute two sets of critical values for a given significance level. One set assumes that all variables are I(0) and the other set assumes they are all I(1). If the computed F-statistic exceeds the upper critical bounds value, then the H_0 (null hypothesis) is rejected. If the F-statistic falls into the bounds, then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no Cointegration. When long run relationship exists, the F-test indicates variable should be normalised. The null hypothesis of equation (6) is $\langle H_0 = \alpha_1 = \alpha_2 = 0 \rangle$. This is denoted as $F_{LnAO}\langle LnAO \mid LnIO \rangle$. In equation (7), the null hypothesis is $\langle H_0 = \beta_1 = \beta_2 = 0 \rangle$ this is represented by $F_{LnIO}\langle LnIO \mid LnAO \rangle$.

RESULTS AND DISCUSSIONS

All time series data show some trend. When working with the time series data, the first issue is weather the series are stationary or not. A stochastic process is said to be stationary if its mean and variance are constant over time and the covariance between the two time periods and not the actual time at which the covariance is computed. To test the stationarity of the variables Phillips-Perrons unit root test apply for both variables. The critical absolute value of the test statistics of the PP test is higher than the critical absolute value, the null hypothesis is rejected. It means that there is no unit root in the series and the variables are stationary. Conversely, if the absolute value of the test statistic is less than the absolute value, the null hypothesis is not rejected. The results about the order of integration of the series, given by the Phillips and Perron (PP) unit root test is presented in Table 2.The results indicate that the natural logarithm of Agricultural output and the natural logarithm of Industrial output are not stationary in their levels. On other hand, after taking first difference of the variables the null hypothesis of no unit root is rejected in both series. So, respectively, leading to conclude that [Ln AO & Ln IO] are integrated of order one. The Cointegration hypothesis between the variables is examined through the Bound test for Cointegration (Table-2).

The bound test results of the existence of long run relationship are presented in Table-2 where eq-6&7 are estimated and then the F-Statistics is computed. Before proceeding to calculating the F-test, an important step is to establish the optimal lag length to be in Co-integration analysis. Using the Schwarz Information Criterion finds that 2 lags are the optimal for this empirical work. The F-Statistic lies above the 10% upper bound when the agricultural output (AO) dependent variable and F-Statistic lies above the 5% upper bound when the industrial output dependent variable [Using the asymptotic critical value bounds computed by Pesaran *et al* (2001)]. Thus the null hypothesis of no long run relationship is rejected in both cases.

Table-2 Unit Root and Bound Test Results

Phillips-Perron unit root test		
Variable	I(0)	I(1)
Ln(AO)	-0.43	-8.10***
Ln(IO)	-1.72	-4.11***
***: indicate the 1% level of significance.		
Bounds Test Result of long run relationship		
Dependent Variable	Computed F-Statistic	
LnAO	3.55*	
LnIO	5.17**	
** 5% level of significance * 10% level of significance		

Table-3 shows the long and short run coefficient when agricultural output dependent variable. In the part (a) the long run results indicate that the industrial output positively impact on the agricultural output in the sample period. An increase in the industrial output by one percent will have a significant long run impact on the agricultural output by 0.52 percent. In the part (b), in the short run the industrial out (at two years lag) negatively affect the agricultural output. The coefficient of error correction terms is statistically significant at 0.00 percent with the expected negative sign. The error correction term represents the speed of adjustment of the change in the agricultural output to its long run equilibrium following a shock in the short run. Moreover the significance of the error correction term confirms the existence of a long run relationship between the regressors and the dependent variable. The error correction term suggests that 61 percent of the adjustment back to long run equilibrium is corrected after one year. The large magnitude of the coefficient of the error correction term suggested that previously shocked, convergence to equilibrium very fast. The diagnostic test also passes the overall validity of the model.

Table-3 Long run & Short run coefficient

(a) Long Run Coefficients using the ARDL Approach ARDL (1,0,2,0,1) selected based on Akaike Information Criterion		
Dependent Variable : Ln(AO)		
Variable	Coefficient	T-Statistics [Inst-values]
Ln(IO)	0.52	13.45[0.00]
Constant	2.17	13.48[0.00]
R-Squared = 0.99	R-Bar-Squared = 0.97	
DW-statistic = 2.08	F-Statistics = 735.36[0.00]	
(b) Error Correction Representation for the Selected ARDL Model ARDL selected based on Akaike Information Criterion		
Dependent Variable : ΔLn(AO)		
ΔLn(IO)	0.33	1.59[0.12]
ΔLn(IO(-1))	-0.27	-1.24[0.22]
ΔLn(IO(-2))	-0.49	-2.44[0.02]
ecmt-1	-0.61	-4.14[0.00]
Constant	1.29	4.20[0.00]
R-Squared = 0.40	R-Bar-Squared = 0.29	

DW-Statistic = 2.24	F-Statistics = 4.61[0.005]	
(c) Sensitivity Analysis		
Test Statistics	LM Version	F Version
I: Serial Correlation	2.02[.154]	1.71[0.20]
II: Functional Form	2.96[.085]	2.57[0.12]
III :Normality	1.14[.563]	-
IV: Heteroscedasticity	0.003[.954]	0.003[0.95]

I: Lagrange multiplier test of residual serial correlation.
II: Ramsey's RESET test using the square of the fitted values.
III: Based on a test of skewness and kurtosis of residuals.
IV: Based on the regression of squared residuals on squared fitted values.

Table 4 shows the long and short run coefficient when dependent variable industrial output. In the part (a) the long run results indicate that the agricultural output positively impact on the industrial output in the sample period. An increase in the agricultural output by one percent will have a significant long run impact on the industrial output by 1.98 percent. In the part (b) in the short run the agricultural output positively affect the industrial output. The coefficient of error correction terms is statistically significant at 6 percent with the expected negative sign. The error correction terms represents the speed of adjustment of the change in the industrial output to its long run equilibrium following a shock. The error correction terms suggests that 13 percent of the adjustment back to long run equilibrium is corrected after one year. The diagnostic tests also pass the overall validity of the model.

Table-4 Long & short run coefficient.

(a) Long Run Coefficients using the ARDL Approach ARDL (1,0,2,0,1) selected based on Akaike Information Criterion		
Dependent Variable : Ln(IO)		
Variable	Coefficient	T-Statistics [Inst-values]
Ln(AO)	1.98	10.73[0.00]
Constant	-4.21	-5.70[0.00]
R-Squared = 0.99	R-Bar-Squared = 0.97	
DW-statistic = 2.14	F-Statistics = 1919.0[0.00]	
(b) Error Correction Representation for the Selected ARDL Model ARDL selected based on Akaike Information Criterion		
Dependent Variable : ΔLn(IO)		
ΔLn(IO)	0.48	2.98[0.00]
ΔLn(IO(-1))	0.30	1.71[0.09]
ΔLn(AO)	0.26	2.03[0.05]
ecmt-1	0.13	1.90[0.06]
Constant	0.57	2.01[0.05]
R-Squared = 0.36	R-Bar-Squared = 0.28	
DW-Statistic = 2.24	F-Statistics = 4.22[.008]	
(c) Sensitivity Analysis		
Test Statistics	LM Version	F Version
I:Serial Correlation	0.72[0.39]	0.60[0.44]
II:Functional Form	2.19[0.13]	1.92[0.17]
II :Normality	6.87[0.11]	-
IV: Heteroscedasticity	0.73[0.39]	0.70[0.40]

CONCLUSION AND POLICY IMPLICATIONS

The goal of this paper was to model the relationship between the agricultural output and industrial output. ARDL bounds testing approach by Pesaran, *et al* (2001) was employed in order to establish the long run relationship. Empirical evidence indicates the bidirectional relationship between agricultural output and industrial output. The agricultural output affects industrial output in the long run and short run. But industrial output affects the agricultural output in the long run only. The elasticity of industrial output with respect to agricultural output is 1.98 & the elasticity of agricultural output with respect to industrial output is 0.52.The coefficient of adjustment (when agricultural output dependent variable) is 0.61 and (when industrial output dependent variable) the ECT is 0.13. The ECT shows the speed of adjustment.

With the help of above results the following policy implication can be derived. Normally the general view is, that countries relying on agricultural income cannot maintain over all sustainable economic growth because of cyclical fluctuations in agricultural output. But this empirical work proves that this cyclical fluctuation in agriculture also affects the industrial sector which takes time moving towards equilibrium. So for industrial growth and over all economic growth, there is need of a long term policy for agricultural sector.

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