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The Role of Agricultural Growth in South Asian Countries and the Affordability of Food: An Inter-country Analysis

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1. INTRODUCTION

Agriculture is the mainstay of the most developing countries, which supplies food and employment to the majority of the population. Because of the dominance of the agricultural sector, a sufficient supply of domestic food is indispensable to support stable socio-economic and political systems in these countries. To attain a sustained growth of agricultural productivity, sufficient investment in the agricultural sector is crucial, particularly in the initial stages of economic development. This increases agricultural production and as a result, there is a shift in (human) resources from the agricultural sector to the industrial and services sectors. According to Duranton (1998), in order to transform from agricultural sector to industrial sector a significant increase in the agricultural sector productivity is necessary. On the demand-side, the growth in agricultural production increases agricultural income which leads to increase in the demand for industrial products; whereas on the supply-side, the increase in the agricultural productivity shifts human resources from the agricultural to the industrial sector [Jorgenson (1967)].

Economists have further explained these interdependences and linkages between agricultural and industrial sectors. According to Kaldor's (1978) two-sector model, agricultural and industrial sectors supply inputs to each other and provide market for their outputs but differ in a number of ways. The agricultural sector has disguised unemployment and produces consumer goods for competitive markets, while industrial sector produces investment goods which are sold in imperfectly competitive markets at mark-up prices. The agricultural sector has diminishing returns to labour and capital, while the industrial sector relies on labour and capital

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and has increasing returns to scale. So, the surplus agricultural labour force can be redirected to the industrial sector without increasing wages.

Like many developing countries, South Asian Countries (SACs) have protected their agricultural sectors to stabilise domestic food supplies. This is also necessary as agriculture accounts for nearly 30 percent of the GDP, engages bulk of the population and for most people, agricultural products make up a large part of consumption, and have a weight of 57 percent in the consumer price index. Any policy change that affects agriculture thus eventually affects everyone in the society.

The provisions of Uruguay Round of the GATT agreement on agriculture reduce the ability of developing countries to continue their protectionist policies for domestically produced agricultural goods. The GATT agreement provisions on agriculture focus on aspects related to input subsidies, trade barriers including tariffs and non-tariff barriers, market access, and export subsidies. The application of the agreement will make agriculture in the developing countries less competitive as compared to developed countries mainly because of limited capital investment to improve agricultural productivity.

Under the structural reform policies in the developing countries, the agricultural sector is getting less attention as compared to the industrial and services sectors. Figures 1a and 1b indicate that the rate of gross capital formation is declining or stagnant as compared to the industrial and services sectors, both in Pakistan and India respectively.

Fig. 1a. Sectoral Gross Capital Formation in Pakistan.

—— Agri. Sector Gross Capital Formation —— Industrial Sector Gross Capital Formation
- - - - - - Services Sector Gross Capital Formation

Source: Economic Survey of India and *Economic Survey of Pakistan* (various issues).

Fig. 1b. Sectoral Gross Capital Formation in India.

Due to poor gross capital formation in the agricultural sector, the developing countries will have comparative disadvantages over developed countries. These countries will divert a large amount of their resources to the industrial and services sector, because, these sectors have higher marginal productivities than the agricultural sector [Koo and Duncan (1997)]. This selective emphasis on the industrial and services sector in the developing countries will lead to a lower level of investment in agriculture and it may slowdown productivity. This may threaten the food supply in the region. If the population growth exceeds the growth of food production, resources must be shifted from the industrial sector to buy food from world markets, which will restrict the investment at a certain level to support economic growth [Koo and Duncan (1997)]. Moreover, it may be unlikely for the developing countries with less per capita incomes to buy food from international markets. Furthermore, if the world could not meet the required demand for food and the developing countries could not develop their own domestic capabilities to expand their agricultural productivity, there can be absolute shortages of food supply.

The main focus of the study is to highlight the role of the agricultural sector in the economic development, the impact of agricultural gross capital formation on the agricultural productivity, and its ability to supply food in the region. The objective of this paper is to analyse the relationship of agricultural, industrial, and services sectors GDP, gross capital formation and cultivable land with agricultural productivity. A quantitative analysis of the agricultural sector is conducted in the context of the implementation of structural reform policies. This study improves, complete the work of other studies as it consider all sectors of the economy such as agriculture, industry and services sectors, while other studies often include only agriculture and industry.

The paper is organised as follows. The first section of the paper is comprised of introduction, statement of the problem and objectives of study. The second section is devoted to describe the significance of agricultural sector in the South Asian economies. The third section deals with econometric model specification and estimation. In the fourth section the impact of economic variables on agricultural production is discussed. Conclusions and policy implications are presented in the last section.

As sufficient data are not available for all countries in the region, annual time series data from two countries, namely, Pakistan and India from 1960 to 1998 are used for empirical analysis. The data sources are; *Economic Survey of Pakistan*, *Agricultural Statistics of Pakistan* (various issues) and *50 Years of Pakistan in Statistics* (1998), *Indian Economic Survey* (various issues), *Indian Statistical Yearbook* (1998), and FAO Stat (1999).

2. THE ROLE OF AGRICULTURAL GROWTH IN SOUTH ASIAN ECONOMIES

This section describes the significance of the agricultural sector in the South Asian economies; India, Pakistan, Bangladesh and Sri Lanka. Despite increasing emphasis on industrial development, the agricultural sector makes up for a third of GDP in the region. The share of agricultural products in GDP during 1977 accounted for India 38.2 percent, Pakistan 32.3 percent, Sri Lanka 30.7 percent, and Bangladesh 37.5 percent and with their average 34.7 percent. It is declined to 27.5 percent, 26.4 percent, 21.1 percent, 22.4 percent, and 24.35 percent for India, Pakistan, Sri Lanka, Bangladesh and SAC respectively in 1998. Moreover the growth of the agricultural sector remained slow compared to industrial and services sectors. See Table 1. Under this situation we cannot overlook the importance of agriculture in the process of economic development.

3. SPECIFICATION OF VECTOR ERROR CORRECTION MODEL

Using the Johansen's vector error-correction model (VECM), this research paper examines the dynamic relation between macroeconomic variables such as agricultural productivity index, agricultural sector GDP, industrial sector GDP, services sector GDP, agricultural gross capital formation and cultivable land. Although Engle and Granger's (1987) two-step error-correction model may also be used in the multivariate context, the VECM yields more efficient estimators of cointegrating vectors. This is because VECM is a full information maximum likelihood

Table 1

Economic Characteristics of South Asian Countries (SACs)

India	**Units**	**1977**	**1987**	**1997**	**1998**
Population	Million	647	800	966	982
Per Capita Culturable Land	ha/Person	0.252	0.204	0.167	0.164
GDP	US$ Billions	102.7	247.8	397.1	420.8
Per Capita GDP	US$/Person	158.73	309.75	411.07	428.50
Share of GDP in (i) Agriculture	%	38.2	31.4	29.3	27.5
(ii) Industry		23.0	26.2	26.1	26.1
(iii) Services		38.9	42.3	44.7	46.4
Growth Rate of (i) Agriculture	%	2.6	3.7	9.4	–1.0
(ii) Industry		5.2	6.6	6.0	5.9
(iii) Services		5.5	7.2	8.0	8.2
Pakistan	**Units**	**1977**	**1987**	**1997**	**1998**
Population	Million	78	108	144	148
Per Capita Culturable Land	ha/Person	0.254	0.187	0.146	0.142
GDP	US$ Billions	15.1	33.4	63.0	63.4
Per Capita GDP	US$/Person	193.6	309.2	437.5	428.3
Share of GDP in (i) Agriculture	%	32.3	26.2	26.4	26.4
(ii) Industry		22.9	24.0	24.5	24.7
(iii) Services		44.8	49.7	49.1	48.9
Growth Rate of (i) Agriculture	%	4.8	4.5	0.1	3.8
(ii) Industry		7.1	5.4	6.0	6.8
(iii) Services		7.5	4.8	3.6	3.2
Sri Lanka	**Units**	**1977**	**1987**	**1997**	**1998**
Population	Million	14	16.4	18.29	18.4
Per Capita Culturable Land	ha/Person	0.60	0.053	0.047	0.047
GDP	US$ Billions	4.1	6.7	15.1	15.7
Per Capita GDP	US$/Person	292.8	408.5	825.6	853.3
Share of GDP in (i) Agriculture	%	30.7	27.0	21.9	21.1
(ii) Industry		28.7	27.4	26.9	27.5
(iii) Services		40.6	45.6	51.2	51.4
Growth Rate of (i) Agriculture	%	3.5	2.0	3.0	2.5
(ii) Industry		5.0	7.1	7.8	5.8
(iii) Services		6.4	5.4	6.6	4.9
Bangladesh	**Units**	**1977**	**1987**	**1997**	**1998**
Population	Million	61.5	69.8	71.9	71.9
Per Capita Culturable Land	ha/Person	0.144	0.128	0.110	0.111
GDP	US$ Billions	9.5	23.8	41.0	42.3
Per Capita GDP	US$/Person	154.5	340.9	570.2	588.3
Share of GDP in (i) Agriculture	%	37.5	31.3	23.1	22.4
(ii) Industry		25.0	22.2	27.1	28.2
(iii) Services		37.5	46.5	49.8	49.4
Growth Rate of (i) Agriculture	%	3.6	2.6	6.1	3.0
(ii) Industry		4.3	6.9	5.6	8.3
(iii) Services		6.4	4.7	4.8	4.2
South Asian Countries	**Units**	**1977**	**1987**	**1997**	**1998**
Population	Million	800.5	994.2	1200.9	1220.3
Per Capita Culturable Land	ha/Person	0.240	0.200	0.16	0.156
GDP	US$ Billions	131.4	311.7	516.2	542.2
Per Capita GDP	US$/Person	164.14	313.5	430.0	444.3
Share of GDP in (i) Agriculture	%	34.7	29.0	25.18	24.35
(ii) Industry		24.9	25.0	26.15	26.62
(iii) Services		40.5	46.0	48.7	49.02
Growth Rate of (i) Agriculture	%	3.6	3.2	4.65	2.07
(ii) Industry		5.4	6.5	5.00	6.70
(iii) Services		6.45	5.5	5.75	5.12

Source: Various issues of *Economic Survey of India*, *Economic Survey of Pakistan*, *Central Bank of Sri Lanka, Annual Reports*, *Economic Survey of Bangladesh*, *World Tables*.

Note: The data exclude Nepal, the Maldives, and Bhutan.

estimation model, which allows for testing for cointegration in a whole system of equations in one step and without requiring specific variables to be normalised. This allows us to avoid carrying over the error from the first step into the second, as would be the case if Engle and Granger's method is used. It also has the advantage of not requiring a priori assumption of endogeneity or exogeneity of the variables. The VECM can be written as;

$$\Delta Y_i = \alpha + \sum_{j=1}^{k-1} \beta_j \Delta Y_{t-j} + \Pi Y_{t-j} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (1)$$

Where, $\sum_{j=1}^{k-1} \beta_j \Delta Y_{t-j}$ and Π_{t-j}

are the vectors of autoregessive component in the first differences and error-correction components, receptively. Δ denotes first differences in levels in Equation (1). Y_t is a $p \times 1$ vector of variables and is integrated of order one. α is a $p \times 1$ vector of constants. k is a lag structure, while ε_t is a $p\times1$ vector of white noise error terms. β_j is a $p \times p$ matrix that represents short-term adjustments among variables across p equations at the jth lag. Π the product of $r\times p$ vector of matrix of cointegrating vectors and $p\times r$ matrix of speed of adjustment parameter representing speed of error correction mechanism ($\Pi = \gamma_j \beta'$, where β' is a $r \times p$ matrix of cointegrating vectors and γ_j is the speed of adjustment parameter).

In estimating the VECM, we first check for stationarity and unit roots by performing the augmented Dicky-Fuller (ADF) tests on the variables in their level and first differences. Only variables integrated of the same order may be cointegrated, and the unit root tests help us to determine which variables are integrated of order one normally I(1).

The choice of lag length may be decided by using the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC), where *AIC = T ln(residual sum of squares) + 2n* and *SBC = T ln(residual sum of squares) + nln(T)*. In minimising the AIC and SBC, we minimise the natural logarithm of the residual sum of squares adjusted for sample size, *T*, and the number of parameters included, *n*.

Once the lag length is determined the model is estimated by regressing ΔY_t against the lagged difference of ΔY_t and Y_{t-1} and then the rank of $\Pi = \gamma\beta'$ is determined. The eigenvectors β' are estimated from canonical correlation of the set of residual from regression equations. The order of cointegration " *r* " is determined by estimating eigen-values. Furthermore, we test for " *r* " using the $Q_r = \lambda_{trace}$ statistics, which is given as;

$$Q_r = \lambda_{trace} = -T \sum_{i=r+1}^{p} log(1-\lambda_i) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (2)$$

Where $r = 0,1, \ldots k-1$ and λ is the *i*th largest eigenvalue. Q_r is trace statistics. The choice of the number of maximum cointegrating relationships is based on the λ_{trace}

test. Π has a full rank if all variables in Y_t are stationary and have no unit root, and so there would be no error correction.

Having determined the order of cointegration, we select and analyse the relevant cointegrating vector and speed of adjustment coefficients. Suppose our model does not have full rank and there are multiple cointegrating vectors, we will choose the first eigenvector based on the largest eigenvalue, which is probably the most useful.

Test on the parameter of cointegrating vector may be performed using the Likelihood Ratio (LR). This is crucial because we would like to test whether macroeconomic variables are significant in the cointegrating relationship. The null hypothesis in such a situation would be a linear restriction represented by;

$$H_0 : \beta = H\phi,$$

where β′ is a $(p + 1) \times r$ cointegrating matrix, H is a $(p + 1) \times s$ matrix with $(p + 1 - s)$ restrictions and ϕ is a $s \times r$ matrix for a case without a linear trend. The likelihood ratio is given by;

$$LR = T \sum_{i=1}^{r} \ln[(1 - \hat{\lambda}_{H,i}) / (1 - \hat{\lambda}_i)] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Here 'LR' follows χ^2 distribution with $r(p + 1 - s)$ degrees of freedom. The $\hat{\lambda}_{H,i}$ is eigenvalue based on restricted eigenvectors; the $\hat{\lambda}_i$ are those based on unrestricted eigenvectors.

The macroeconomic variables selected for this study are presented in Table 2. All variables are converted into natural logarithms, and their first differences are taken.

Table 2

Definition of Variables and Time-series Transformations

Variables in Level	Definition of Variables*
LAP_t	Natural Logarithm of agricultural productivity index
LAY_t	Natural Logarithm of agricultural GDP
LIY_t	Natural Logarithm of industrial sector GDP
LSY_t	Natural Logarithm of service sector GDP
$LAGC_t$	Natural Logarithm of agricultural gross capital formation
LCL_t	Natural Logarithm of cultivable land
Variables in First Differences	
$\Delta LAP_t = LAP_t - LAP_{t-1}$	Change in agricultural productivity index
$\Delta LAY_t = LAY_t - LAY_{t-1}$	Change in agricultural GDP
$\Delta LIY_t = LIY_t - LIY_{t-1}$	Change in industrial sector GDP
$\Delta LSY_t = LSY_t - LSY_{t-1}$	Change in service sector GDP
$\Delta LAGC_t = LAGC_t - LAGC_{t-1}$	Change in agricultural gross capital formation
$\Delta LCL_t = LCL_t - LCL_{t-1}$	Change in cultivable land

*For detailed definition of variables, see Appendix II.

4. UNIT ROOT TEST AND COINTEGRATION

As cointegration requires the variables to be integrated of the same order, in estimating VECM, we first check for stationarity and unit root by performing the augmented Dicky-Fuller (ADF) tests on the variables in levels and first differences.

Only variables integrated of the same order may be cointegrated and the unit root will help to determine which variables are integrated of order one or I(1). As unit root tests are well known in the economic literature, therefore a detailed description is omitted. Test results for a variety of lags are presented in Table 3.

Table 3 indicates that other than LCL_t, all six time series are integrated of one I(1), implying that time series have unit root and nonstationary. All the variables in the first difference are stationary at 5 percent significance level. As such, the final vector of variables to be examined is given by;

$$Y_t = (LAP_t, LAY_t, LIY_t, LSY_t, LAGC_t, LCL_t)$$

5. MODEL ESTIMATION

In building the VECM that capture the impact of economic forces on the agricultural productivity, we reduced lags of $k = 1$ to $k = 4$. Because of the small sample size, it is not possible to increase the lag structure. The model with lowest AIC and SBC value is estimated.

Table 3

Results of Unit Root Tests

	Pakistan				India			
Variables in Level	1 Lag	2 Lag	3 Lag	4 Lag	1 Lag	2 Lag	3 Lag	4 Lag
LAP_t	0.233	0.332	0.434	0.780	0.605	0.941	0.859	0.957
LAY_t	–0.744	–0.627	–0.495	–0.455	–0.128	0.458	0.784	0.760
LIY_t	–2.180	–1.651	–1.641	–1.309	–.792	–0.634	–0.213	0.307
LSY_t	–1.330	–1.403	–1.504	–1.649	3.590	2.849	2.919	3.171
$LAGC_t$	0.032	–0.057	0.189	0.1477	–0.877	–0.853	–.611	–0.306
LCL_t	–3.632	–3.012	–2.957	–3.600	–5.028	–3.274	–2.577	–2.198
Variables in 1st Difference								
ΔLAP_t	–8.218	–4.670	–4.269	–3.945	–7.692	–4.880	–3.948	–4.066
ΔLAY_t	–7.618	–5.063	–3.960	–3.051	–8.739	–6.746	–4.493	–4.297
ΔLIY_t	–4.531	–4.564	–4.082	–3.273	–5.432	–4.527	–4.402	–4.490
ΔLSY_t	–4.596	–5.086	–3.488	–2.999	–4.037	–2.573	–1.837	–1.694
$\Delta LAGC_t$	–5.562	–4.771	–3.505	–2.571	–6.680	–5.782	–4.675	–4.251
ΔLCL_t	–5.577	–3.623	–2.898	–4.519	–4.839	–3.245	–2.624	–1.985

The results of cointegration test are shown in Table 4. This likelihood ratio (LR) test indicates that there are three cointegration equations for Pakistan and four cointegration equations for India at 5 percent significance level or $r = 3$ for Pakistan and $r = 4$ for India. Having determined the order of cointegration, the relevant cointegrating vectors and speed of adjustment coefficients can be selected by choosing eigenvector based on the largest eigenvalue. The first eigenvalue based on the largest eigenvalue is regarded as the most useful.

Table 4

Johansen Cointegration Trace Test for Data

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesised No. of CE(s)
Pakistan Data				
0.826189	170.8586	102.14	111.01	None **
0.757312	109.6161	76.07	84.45	At most 1 **
0.540324	60.05678	53.12	60.16	At most 2 *
0.419933	32.85358	34.91	41.07	At most 3
0.180025	13.79217	19.96	24.60	At most 4
0.177643	6.845328	9.24	12.97	At most 5
Indian Data				
0.789151	151.2800	102.14	111.01	None **
0.587553	96.79858	76.07	84.45	At most 1 **
0.568226	65.80087	53.12	60.16	At most 2 **
0.436283	36.40599	34.91	41.07	At most 3 *
0.280907	16.34389	19.96	24.60	At most 4
0.128207	4.802131	9.24	12.97	At most 5

*(**) denotes rejection of the hypothesis at 5 percent (1 percent) significance level respectively.
L.R. test indicates 3 cointegrating equation(s) for Pakistan and 4 cointegrating equation(s) for India at 5 percent significance level.

Normalising with respect to the coefficient for LAP_p for Pakistan, the cointegrating vector based on the selection criteria is given by:

$$\beta'_p = (1.00\ \ -1.459,\ \ 0.419,\ \ -0.409, -0.051, 0.981,\ \ 2.111)$$

This yields the following cointegrating relationship;

$$LAP_p = 1.459LAY_p - 0.419LIY_p + 0.409LSY_p + 0.051LAGC_p$$
$$-0.981LCL_p - 2.1112$$

Similarly for India by normalising with respect to the coefficient for Indian LAP_i, the cointegrating vector based on the selection criteria is given by:

$$\beta'_i = (1.000,\ 1.761,\ 4.359,\ -6.028,\ -0.331,\ -3.878,\ 39.313)$$

$$LAP_i = -1.761LAY_i - 4.359LIY_i + 6.028LSY_i + 0.331LAGC_i + 3.878LCL_i - 39.313$$

Since a logarithmic functional form is used here, the coefficients in β' can be regarded as long-run elasticities.

To test the significance of the coefficients in the long-run relationship, Likelihood test is used. As this study attempts to determine whether variables Agricultural sector GDP, Industrial sector GDP, Service sector GDP, agricultural gross capital formation and cultivable land have any impact on the agricultural productivity, the model would be valid only if LAP_t contributes significantly to the cointegration relationship. Each of the individual variable is also tested for significance. The results show that LAP_t contributes to the cointegrating relationship for both Pakistan and India. Individually for Pakistan variables such as LAY_p, LSY_p and $LAGC_p$ have positive signs, while LIY_p, and LCL_p have negative signs in the model. For India, coefficients on the variables LSY_i, $LAGC_i$ and LCL_i possess positive sign, while, LAY_i, and LIY_i are negative.

The focus of VECM short-run analysis is on the ε_t terms. These terms are the residuals from the preceding cointegration equations. They provide an explanation of short-run deviations from the long-run equilibrium. The lag values of ε_t entail that the last period's disturbances will affect the current time period. If ε_{t-1} term is statistically insignificant, then there exist no short-run disturbances and the system under investigation is in a short-run equilibrium. If, on the other hand, this term is statistically significant, then short-run disturbances exist in the system under consideration. In such a case the sign of ε_{t-1} term gives an indication of direction of the impact among the test variables.

Appendix Table I gives the full set of adjustment coefficients in the VECM, which indicate the built-in adjustment mechanism to the long-run equilibrium for the same value of k.

For Pakistan, the short-run analysis for most of the variables other than ΔLIY_p and ΔLSY_p, are significant at 5 percent in the cointegration relationship as given below;

$$0.209\Delta LAP_p + 0.044\Delta LAY_p - 0.674\Delta LIY_p + 0.473\Delta LSY_p - 0.310\Delta LAGC_p + 0.207\Delta LCL_p$$

The short-run relationship of Indian agricultural productivity in the cointegrating variables can be given as follows;

$$1.570\Delta LAP_i + 2.896\Delta LAY_i + 1.106\Delta LIY_i + 0.332\Delta LSY_i + 4.830\Delta LAGC_i + 0.022\Delta LCL_i$$

For India, all the variables are statistically significant and have positive signs in the equation. Consequently, it is reasonable to conclude that all variables in the model have a positive impact on the agricultural productivity growth.

6. IMPACT OF ECONOMIC VARIABLES ON AGRICULTURAL PRODUCTIVITY

In case of Pakistan, the long-run empirical results indicate that agricultural sector GDP, services sector GDP and agricultural gross capital formation have contributed in the agricultural productivity during the period 1960–98. The order of elasticity coefficients on the variables contributing significantly toward agricultural productivity are:

$$LAY_P > LSY_p > LAGC_p$$

The elasticity coefficients on LAY_p, LSY_p and $LAGC_p$ indicate that any increase in the agricultural sector GDP, service sector GDP and agricultural gross capital formation will increase agricultural productivity. Following possible reasons may be given for these results. First, agricultural productivity in Pakistan is mostly based on agriculture-related activities. Second, most of the farmers are subsistence small holders and they are unable to have access to cheap credit and inputs. Consequently, they have to depend upon their own resources. Third, as in rural areas there is disguised unemployment, people are engaged in off-farm employment (including services sector) as it supports them to buy agricultural inputs.

The elasticity coefficients on the agricultural gross capital formation have positive sign and contributing significantly toward agricultural productivity. The coefficient on cultivable land has a negative impact on agricultural productivity. The reason for this insignificant contribution may be decreasing cultivable land due to land degradation such as water logging and salinity.

The contribution of LIY_p towards agricultural productivity is also negative, because the industrial sector growth is contingent upon the vital input supplies from agricultural sector due to backward and forward linkages. The raw materials needed by the industrial sector are mostly supplied in the form of agricultural inputs. Thus a demand creation mechanism for the output of agricultural sector is triggered due to higher levels of activity in the industrial sector. Thus, if there is any decline in the agricultural productivity, the industrial sector productivity will be effected. Ultimately, it may affect the agricultural productivity. The additional input demand for the industrial sector has to be matched with additional supplies (from the agricultural sector). Once the maximum achievable yield potential has been achieved, the extra supplies can not come through unless technological transformation takes place. The technological adoption decision at farmers' field can not be translated into practice unless the capital needs for the new technological packages are paid for. So, the GDP growth in the industrial sector spurs itself through financing capital formation in the agricultural sector.

In the short-run relationship variables LAY_p and LCL_p are significant. This depicts that in the short-run by using more inputs the productivity can be increased, but in the long-run, it is not possible as the cultivable land continue to decrease.

The empirical estimation of companion model using Indian data set during the reference period reveal almost identical results as that of Pakistan, other than insignificant agricultural sector GDP. The services sector GDP, and agricultural gross capital formation and cultivable land has considerable contribution toward agricultural productivity. The orders of the elasticity coefficients contributing toward agricultural productivity are given below;

$$LSY_i > LCL_i > LAGC_i$$

The identical coefficients on the agricultural gross capital formation in both countries show that any decline in the agricultural gross capital formation may decrease the agricultural productivity.

Now, if the agricultural productivity declines, it may have adverse affect on the industrial sector performance. Eventually, it will have negative impact agricultural productivity, as large portion of the industrial sector has been dependent upon agriculture for raw materials.

All variables in the short-run are significant and have positive sign, which indicates their positive contributions to the agricultural productivity.

A comparison of variables affecting agricultural productivity in Pakistan and India shows predictably similar impacts of services sector GDP, agricultural gross capital formation. These variables make a significant contribution toward higher agricultural productivity in both countries. Nevertheless, the elasticity coefficients on the service sector GDP in case of India is greater than Pakistan. This reflects that the agricultural production in India is more dependent on service sector as compared to Pakistan. This may be due to small size of holdings, large population, people in the rural areas are engaged in off-farm employment, and expanding services sector.

7. CONCLUSIONS AND POLICY IMPLICATIONS

This study examines the relationship between agricultural productivity, agricultural gross capital formation, and cultivable land, agricultural sector GDP, industrial sector GDP and services sector GDP in Pakistan and India during the period 1960–1998.

An overview of the factors affecting agricultural productivity in Pakistan and India reveals that agricultural gross capital formation and services sector GDP have a significant impact on agricultural productivity in the two sister economies.

These results verify the findings of Adelman (1983), Hwa (1983) and Yoa (1996) that agricultural growth and rural development are major contributing factors in economic development of any developing countries and it helps the industrial sector to grow faster. This may shift surplus labour from agricultural sector to other sectors by creating employment. On the other hand, policy-makers in these countries are continuing to pursue industrial-led growth policies with the hopes of stimulating economic development, the priority to spur agriculture is weakening.

So, any factor impeding the capital formation in the agricultural sector may have determinantal consequences on much needed productivity growth.

In order to comply with the implementation of economic and structural adjustment policies and to counterbalance the declining agricultural productivity, it is necessary to make concrete capital investment in the agriculture and agro-based industrial sectors in the region. It will secure food supply in these countries, particularly prepare to cope with increasing population and food demand.

Furthermore, we need to consider the macroeconomic directions of policy changes in the agricultural sector and their significance in the general equilibrium for growth, distribution and welfare.

APPENDICES

Appendix I Table 1

Results of Error Correction Model Estimation

Error Correction	ΔLAP_t	ΔLAY_t	ΔLIY_t	ΔLSY_t	$\Delta LAGC_t$	ΔLCL_t
Pakistan						
CointEq1	0.0038	1.1508	–0.1201	0.2451	–0.6194	0.0038
	(0.010)	(2.979)	(–0.391)	(0.808)	(–0.221	(0.010)
CointEq2	–0.4642	–1.6253	0.1003	–0.8229	0.4495	–0.4642
	(–0.943)	(–3.214)	(0.249)	(–2.073)	(0.122)	(–0.943)
CointEq3	0.2069	0.0443	–0.6739	0.4734	–0.3101	0.2069
	(0.631)	(0.131)	(–2.514)	(1.788)	(–0.126)	(0.631)
R-squared	0.5807	0.6822	0.7565	0.5978	0.4170	0.4646
Akaike AIC	–4.0790	–4.0243	–4.4827	–4.5080	–0.0606	–4.8522
Schwarz SC	–3.3680	–3.3133	–3.7717	–3.7970	0.6504	–4.1412
India						
CointEq1	–0.5197	–0.0739	1.0975	0.1306	–0.4726	–0.0518
	(–0.856)	(–0.102)	(1.768)	(0.564)	(–0.295)	(–1.069)
CointEq2	–0.3451	–1.7696	–1.1589	–0.2279	0.2851	0.0448
	(–0.572)	(–2.466)	(–1.879)	(–0.992)	(0.179)	(0.932)
CointEq3	–1.0434	–1.8062	–1.0282	–0.2500	–4.5175	–0.0181
	(–2.212)	(–3.218)	(–2.131)	(–1.391)	(–3.631)	(–0.480)
CointEq4	1.5701	2.8960	1.1063	0.3320	4.8304	0.0215
	(2.722)	(4.219)	(1.875)	(1.511)	(3.174)	(0.468)
R-squared	0.5732	0.7657	0.6221	0.7642	0.6165	0.4858
Akaike AIC	–3.4568	–3.1090	–3.4120	–5.3871	–1.5170	–8.5123
Schwarz SC	–2.7013	–2.3535	–2.6565	–4.6316	–0.7616	–7.7568

Appendix II

DEFINITIONS AND NOTES

Agricultural Sector or Primary Sector

The agricultural sector is comprised of primary production areas including agriculture, hunting, fishing, forestry and mining and quarrying. The figures are the aggregates of these groups. I have preferred to treat all these together in order to be consistent with data sources from different countries.

Agricultural Productivity

The FAO indices of agricultural production show the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 1980-81. They are based on the sum of price-weighted quantities of different agricultural commodities produced after deductions of quantities used as seed and feed weighted in a similar manner. The resulting aggregate represents, therefore, disposable production for any use except as seed and feed. All the indices are calculated by the Laspeyres formula. Production quantities of each commodity are weighted by 1980-81 average international commodity prices and summed for each year. To obtain the index, the aggregate for a given year is divided by the average aggregate for the base period 1980-81.

Industrial Sector or Secondary Sector

The industrial sector consists of manufacturing, electricity, gas and water supply, and construction. The industrial sector refers to the aggregate of all these components of the economy.

Services Sector or Tertiary Sector

The data involved in this major group are from services sectors including wholesale and retail, transport, storage and communications, finance, insurance, real estate, ownership of dwellings, community, social and personal services, and public administration, defence and other services.

Cultivable Land

Land which is available for cultivation, including land sown more than once.

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Comments

The main objective of the paper is to assess the role of agriculture sector in the economic development, the impact of agricultural gross capital formation and cultivable land on the agricultural productivity and its ability to supply food in the region.

My comment on the paper would be three faceted that are the relevance of the title with the subject of the paper, the specification of the model and the lastly the results of the study. The title of the paper is much wider and catchy. However, the author could not justify the title as well as the objective of the paper. I do not see anything about the growth analysis and also regarding the affordability of food in South Asian Countries in this paper.

There has been considerable effort in the past to investigate the growth in agriculture sector and the factors contributing towards growth. These studies used either average production function or a frontier production function. Other studies applied duality theory using either frontier or non-frontier techniques. This paper is based on Vector Error Correction Model (VECM). There is need to justify the use of VECM technique. What are the advantages of this switchover?

In introduction the author says that the rate of gross capital formation in agriculture is declining. Though, not referred to in the text, this statement is based on Figure 1. The graphs have to be tagged with country name. Moreover, the graphs do not show any declining trend in gross capital formation in agriculture sector in both the countries. It would have been better if the actual data, may be 5-years average, had been reported.

At the end of introduction, there is a statement that “A quantitative analysis of the agriculture sector is conducted under the implementation of structural reforms policies”. This statement needs more explanation. The next sentence says that this study goes step further to including other sectors in the analysis, which the other studies have failed to accommodate. Such studies need to be mentioned.

The study uses 1960 to 1998 data for the analysis. This duration includes a few years of pre-green revolution period. As we all know that the agricultural productivity rapidly increased with the introduction of green revolution technology. Could this differential in agricultural production response be accommodated in your model?

Table 2 of the paper defines the variables used in the study. This table does not clarify that how do you construct the agricultural productivity variable. Is this an aggregate output per unit of land or any other index?

The paper specifies a model that the agricultural productivity is affected by the agricultural GDP, services sector GDP, industrial sector GDP, gross capital formation in agriculture, and the cultivable land. This relationship does not make any sense to me: firstly, we do not know that how the agricultural productivity is defined and secondly, even if we knew the construction of the productivity, the GDP of agriculture sector is actually the total output of the country. Its beyond my comprehension that what the author is going conclude from the results of this model.

The results of the paper show that increase in agricultural sector GDP increases agricultural productivity. What does this mean? If I perceive correctly, the elasticity coefficients show that one percent increase in agricultural GDP increases agricultural productivity by 1.5 percent in Pakistan, and reduces agricultural productivity by about 1.8 percent in India. While looking at the cultivated land variable in case of India, this shows one percent increase in land under cultivation increases productivity by 3.9 percent, and this relationship is negative for Pakistan. The author has given no proper reasoning neither for the specification of the models nor for the outcome of these models.

The author reports that the inverse relationship between agricultural productivity and cultivable land in Pakistan is due to the declining trend in cultivable land mainly because of land degradation. It would be better if the author cites the reason as the 'deterioration of land quality due to water logging and salinity' not the reduction in land under cultivation. The author again emphasises in the results section that cultivable land is continuously declining in Pakistan and refers Figure 1 in Appendix III. The figure does not show this trend. However, the figure relating to India indicates declining trend starting from late 80s.

The text says that Indian data provide identical results as that of Pakistan. This is not true. In Indian case elasticities are very high and carry even different sign in certain cases. The order of the magnitude of elasticity coefficients contributing positively towards agricultural productivity is shown as $LCL_i > LSY_i > LAGC_p$, while, the results indicate as follows: $LCY_i > LCL_i > LAGC_p$.

The elasticity coefficient of services sector in case of India is about 15 times higher than the coefficients in case of Pakistan. On the other hand, the coefficient of industrial sector GDP in India is more than 10 times higher than the coefficients in Pakistan's case. The reasons for these differentials need to be reported.

At the end I would expect that the author would seriously consider to substantially revising the paper before submitting it for publication in Papers and Proceedings of *The Pakistan Development Review*.

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