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Impact of financial development on agricultural productivity in South Asia

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Abstract: The paper examines the impact of financial development on agricultural productivity in South Asia using data for the period 1973–2015. The other variables included are physical capital, human capital, trade openness and income level. It is found that all variables have cross-section dependence and they are stationary at first differences. It is found that long-run cointegration holds among variables. The estimated results show that financial development has an inverted U-shaped effect on agricultural productivity, which implies that agricultural productivity first increases with the increase in financial development and then it declines when financial development further increases. Agricultural productivity increases with the increase in both physical and human capitals. Agricultural productivity also improves with trade openness and income level. The results of the robustness analysis show that terms of trade has a negative effect on agricultural productivity. Further, industrialisation has positive while carbon emission and rural labour force have negative effects on agricultural productivity in the region.

Keywords: agricultural productivity; cointegration; financial development; South Asia

Like in other developing countries of the world, agriculture is the mainstay of the South Asian countries. It provides food and employment to the fast-growing population and makes a significant contribution to the overall economic growth. Despite increasing emphasis on industrial development, agriculture significantly contributes to gross domestic product (GDP) in the region. It employs 55% of the rural labour force. It is an essential source of foreign exchange earnings and covers all the food needs of the area. This sector also provides raw material to industries. Since agriculture is the backbone of South Asia economies, it reflects the performance of these economies. In South Asia, agricultural productivity (the value added per worker) was typically less than 1 200 USD in 2015. The dismal performance of the agriculture sector and low productivity have increased poverty, malnourishment, underemployment and food shortages in South Asia. This requires an understanding of what determines agriculture growth and productivity.

The theory has identified several factors which affect agriculture growth and productivity, e.g. environment, skilled human capital, capital use, agricultural chemicals, gross domestic product, trade openness, agricultural terms of trade and industrialisation. One important factor is financial development. Financial development allows farmers to invest and adopt new inventions in the agriculture sector, which help to raise agricultural productivity. It provides finance to poor farmers to buy inputs like seeds, fertilisers and agrochemicals, which increase agricultural productivity. Thus, affordable and accessible financial services are necessary to improve the productivity of the agriculture sector.

Extensive research has been carried out to examine the impact of financial development on economic growth. However, only limited research is available concerning the effect of financial development on agriculture growth. In South Asia, few studies have been conducted which have investigated the impact of agriculture

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credit on the agriculture sector. These studies have been conducted for individual countries, i.e. Pakistan (Iqbal et al. 2003; Abedullah et al. 2009; Bashir et al. 2010; Ayaz and Hussain 2011; Akram et al. 2013; Shahbaz et al. 2013; Ahmad et al. 2015), and India (Sidhu et al. 2008; Narayan 2016). However, these studies have not examined the effect of financial development on the agriculture sector. Further, no study has been conducted for other South Asian countries and South Asia as a whole region. This study tries to fill this gap. The study examines the effect of financial development on agricultural productivity in South Asian region using panel data for the period 1973 to 2015.

MATERIALS AND METHODS

Generally, productivity analysis uses traditional Cobb-Douglas production function with two inputs with the assumption of constant returns to scale. However, more factors of production can be included in the production function (Echevarria 1998). The Cobb-Douglas production function can be written as:

$$Y_{it} = AK_{it}^{\alpha} L_{it}^{\beta} e^{\mu_{it}} \tag{1}$$

where Y is agricultural productivity, K represents capital and L stands for labour. The parameters α and ß are marginal impacts of capital and labour on agricultural productivity and they lie between 0 and 1, i.e. $0 < \alpha < 1$ and $0 < ß < 1$. i refers to number of countries, t is time period, and μ is stochastic error term.

The paper examines the impact of financial development on agricultural productivity by considering financial development as an important determinant of agricultural productivity. If we incorporate financial development (F) in the model, then the Equation (1) becomes:

$$Y_{it} = AK_{it}^{\alpha} L_{it}^{\beta} F_{it}^{\gamma} e^{\mu_{it}} \tag{2}$$

The parameter γ must lie between 0 and 1, i.e. $0 < \gamma < 1$ and it shows the marginal impact of financial development on agricultural productivity. After taking natural logarithm, the above equation becomes:

$$y_{it} = \beta_0 + \alpha k_{it} + \beta l_{it} + \gamma f_{it} + \mu_{it} \tag{3}$$

Besides financial development, some other economic factors also affect agricultural productivity which includes trade openness and income level. Now the above equation in its augmented form can be written as follows:

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 f_{it} + \beta_4 to_{it} + \beta_5 gdp_{it} + \mu_{it} \tag{4}$$

where:

y_{it} – agricultural value added per worker (agricultural productivity)
k_{it} – physical capital
l_{it} – labour (human capital)
f_{it} – financial development
to_{it} – trade openness
gdp_{it} – per capita GDP (income level)
μ_{it} – error term

Theoretical explanation of these independent variables is as follows:

Physical capital: Physical capital provides infrastructure for agriculture, which helps to increase the agricultural productivity. Therefore, the contribution of physical capital is viewed as one of the major engines of agricultural growth (Looney 1994; Janjua and Javed 1998).

Labour: Labour increases agriculture production (Iqbal et al. 2003; Chisasa and Makina 2015; Narayan 2016). However, overutilisation of labour has an adverse effect on agricultural productivity (Tijani 2006).

Financial development: Financial development is expected to increase agricultural productivity as the provision of easy credit to farmers boosts agricultural productivity. Financial development alleviates the financing constraints by rising national saving, bank credit and investment activities in agriculture sector and hence the agriculture output increases. Evidence suggests there is a positive association between financial development and agricultural productivity (Shahbaz et al. 2013).

Trade openness: Trade openness increases agriculture growth through specialisation, economies of scale, capacity utilisation and technology.

Income level: Income level positively affects agricultural productivity. The countries which have higher income level have experienced higher agricultural productivity as higher income level allows farmers to buy more agriculture inputs like improved seeds, fertilisers and pesticides.

RESULTS AND DISCUSSION

Data overview

For empirical analysis, data is collected for five South Asian countries, i.e. Bangladesh, India, Nepal, Pakistan and Sri Lanka for the period 1973 to 2015. Agricultural productivity is measured by agricultural

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value added per worker. Physical capital is measured by gross fixed capital formation (% of GDP). Labour represents human capital and is measured by the secondary school enrolment rate. Financial development is measured by domestic credit to the private sector (% of GDP). Trade openness is the sum of exports and imports (% of GDP). Income is GDP per capita. Data is collected from World Development Indicators (WDI) of the World Bank (World Bank 2018).

Figure 1 provides the scatter diagram between agricultural productivity and financial development. The figure shows that financial development has a non-linear effect on agricultural productivity, i.e. agricultural productivity first increases with the increase in financial development then it decreases when financial development further increases. It indicates an inverted U-shaped relationship between financial development and agricultural productivity in South Asia.

Estimated results

Cross-sectional dependence (CD) test

First, we have tested the cross-sectional dependence of the variables as it is present in panel data. Literature has highlighted a variety of tests for cross-section dependence, e.g. Breusch-Pagan (1980) Lagrange Multiplier (LM) test, Pesaran (2004) scaled LM test, Baltagi et al. (2012) bias-corrected scaled LM test and Pesaran (2004) CD test.

Consider the traditional panel data model:

$$y_{it} = \alpha_i + \beta'_{it} x_{it} + u_{it}$$

For $i = 1, \dots, N$ and $t = 1, \dots, T$ where ß is a $K \times 1$ vector of parameters, x_{it} *is* a $K \times 1$ vector regressors and α_i is time-invariant individual nuisance parameters. The null hypothesis of no cross-section dependence may be expressed as:

$$H_0 : \rho_{ij} = \mathrm{Corr}(\mu_{it}, \mu_{jt}) = 0 \text{ for } i \neq j$$

where ρ_{it} is correlation coefficient between the disturbances in cross-section units i and j. The results of various cross-sectional dependence tests are provided in Table 1. H_0 is rejected at 1% significance level, which shows the presence of cross-sectional dependence.

Panel unit root test

In the presence of cross-sectional dependence, we cannot apply first generation panel unit root tests to check the stationarity of the variables. Therefore, to check the stationarity, we apply the second generation panel unit root test of Pesaran (2007). Pesaran suggests the following cross-sectionally Augmented Dickey-Fuller (CADF) test to test the null hypothesis of panel unit root:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + \upsilon_{it}$$

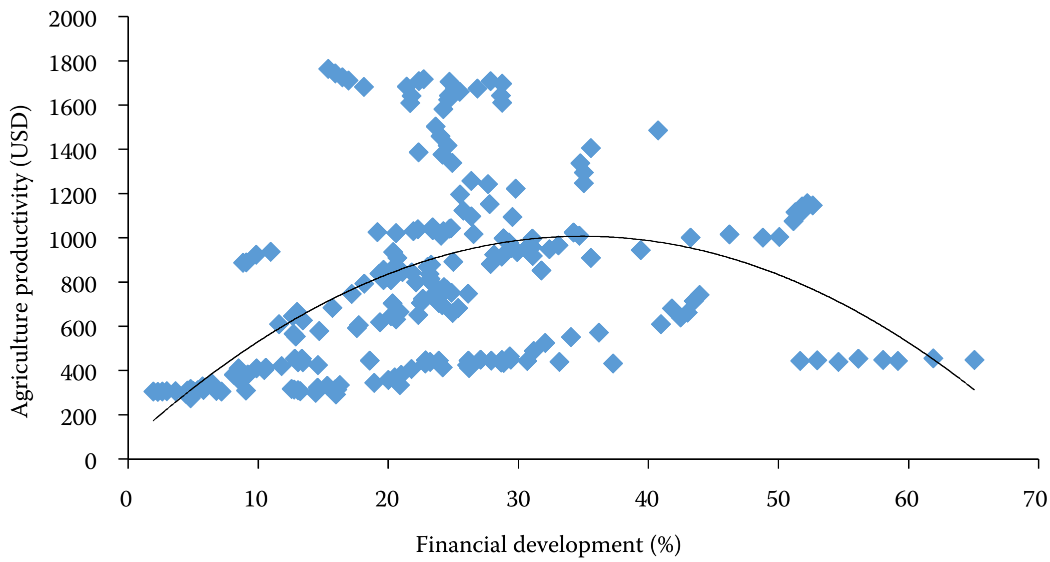

Figure 1. Scatter diagram between agricultural productivity and financial development

Source: developed by authors using data from World Development indicators (World Bank 2018)

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Table 1. Cross-section dependence (CD) test

Test	Statistics	*p*-value
Breusch-Pagan LM	92.4053***	0.0000
Pesaran scaled LM	17.3083***	0.0000
Pesaran CD	3.45376***	0.0006

***statistically significant at 1% significance level; LM – Lagrange Multiplier test

Source: calculated by authors

where $\overline{y}_{t-1} = (1/N)\sum_{i=1}^{N} y_{i,t-1}$, $\Delta\overline{y}_t = (1/N)\sum_{i=1}^{N} \Delta y_{i,t}$ and υ_{it} is the regression error, which is not assumed to be serially correlated. This test is based on the *t*-ratio of the ordinary least squares (OLS) estimate $\hat{\rho}_i$. Pesaran (2007) suggests the following cross-section IPS-test (CIPS):

$$\text{CIPS} = \frac{1}{N}\sum_{i=1}^{N} \text{CADF}_i$$

where CADF_i is the statistics of the i^{th} cross-section unit provided by the *t*-ratio of $\hat{\rho}_i$ in the above regression.

If the residuals are serially correlated, more lags of Δy_{it} and $\Delta\overline{y}_t$ need to be incorporated in the regression. For an $AR(p)$ process, the following CADF regression will be estimated:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0}^{p} d_{i,j}\Delta\overline{y}_{t-j} + \sum_{j=0}^{p} \beta_{i,j}\Delta y_{i,t-j} + \upsilon_{i,t}$$

Table 2 provides the panel unit root results of Pesaran (2007). The results reveal that all variables are not stationary at levels, but they are stationary at their first differences. This finding reveals the possibility of cointegration among variables.

Table 2. Pesaran panel unit root test results (Pesaran 2007)

	Level		First difference
y_{it}	–2.125	Δy_{it}	–4.743***
k_{it}	–1.883	Δk_{it}	–5.543***
l_{it}	–1.915	Δl_{it}	–4.811***
f_{it}	–1.945	Δf_{it}	–5.701***
to_{it}	–2.121	Δto_{it}	–6.049***
gdp_{it}	–1.851	Δgdp_{it}	–5.787***

***null hypothesis is rejected at 1% significance level; for level and first difference series, critical values for 1% are –2.410 and –2.360, respectively; y_{it} – agricultural value added per worker (agriculture productivity); k_{it} – physical capital; l_{it} – labour (human capital); f_{it} – financial development; to_{it} – trade openness; gdp_{it} – per capita GDP (income level)

Source: calculated by authors

Panel cointegration test

To find cointegration among variables, we apply Westerlund (2007) bootstrap panel cointegration test. The error correction test assumes the following data-generating process:

$$\Delta y_{i,t} = \delta_t^{'} d_t + \alpha_i\left(y_{i,t-1} - \beta_i^{'} x_{i,t-1}\right) + \\ + \sum_{j=1}^{p_i} \alpha_{i,j}\Delta y_{i,t-j} + \sum_{j=-q_i}^{p_i} \gamma_{i,j}\Delta x_{i,t-j} + \nu_{i,t}$$

where $y_{i,t}$ represents dependent variable and $x_{i,t}$ states for vector of independent variables. d_t contains the deterministic components. When $d_t = 0$ there is no deterministic term, when $d_t = 1$, Δy_{it} has a constant, and finally when $d_t = (1,t)'$, Δy_{it} has both constant and trend term.

The parameter α_i shows the speed of adjustment to the equilibrium $y_{i,t-1} - \beta_i^{'} x_{i,t-1}$ after a shock. In case $\alpha_i < 0$ it implies error correction in the model which indicates that cointegration exists between $y_{i,t}$ and $x_{i,t}$. In case $\alpha_i = 0$, it indicates the absence of cointegration. Thus, the null hypothesis is no cointegration, i.e. H_0: $\alpha = 0$ for all i. However, the alternative hypothesis depends on the assumption of the homogeneity of α_i. The first pair of tests, called group-means tests (G_τ and G_α) do not assume α_i's to be equal, thus alternative hypothesis is H_1^G: $\alpha_i < 0$ for at least one i. The second pair of tests, called panel tests (P_τ and P_α), require that α_i is equal for all i. In this case, the alternative hypothesis is H_1^P: $\alpha_i = \alpha < 0$ for all i.

Table 3 provides the Westerlund cointegration test results. The two test statistics (G_α and G_τ) among four tests rejects the null hypothesis. It indicates that long run cointegration exists among variables.

To verify our cointegration results we have also applied the Fisher/Johansen test as proposed by Maddala and Wu (1999). If the probability value (*p*-value) from an individual cointegration test for cross-section i is π_i then for the panel null hypothesis:

$$-2\sum_{i=1}^{N} \log(\pi_i) \rightarrow \chi^2_{2N}$$

The results of the Fisher/Johansen test are given in Table 4, where both trace and max-eigen tests indi-

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Table 3. Westerlund (2007) panel cointegration test

	Value of test	z-value	Robust p-value
Group mean test (G_a)	–9.359	1.523	0.000***
Group mean test (G_t)	–2.652	–0.014	0.000***
Panel test (P_a)	–5.564	1.543	0.700
Panel test (P_t)	–4.676	0.583	0.300

***statistically significant at 1% level

Source: calculated by authors

cate cointegration among variables as null hypothesis is rejected. Trace statistics indicate two cointegration vectors while max-eigen test indicates one cointegration vector at 1% significance level.

Estimation of the model

We have applied fully modified OLS (FMOLS) and dynamic OLS (DOLS) techniques to estimate the model. Estimated results are given in Table 5. The results reveal that physical capital has a statistically significant positive effect on agricultural productivity in both FMOLS and DOLS estimations. This implies that sustained capital formation plays a crucial role in boosting agricultural productivity in South Asian countries. The numerical value of the coefficient shows that when physical capital increases by 1%, agricultural productivity increases by 0.334% (0.229%) in FMOLS (DOLS) estimations. Like physical capital, human capital also has a statistically significant positive impact on agricultural productivity in South Asia. The marginal product of labour in the agriculture sector is 0.090 (0.097) in FMOLS (DOLS) estimations. The result endorses the theory that agricultural productivity increases with higher education.

The most important variable in the estimation is financial development. The coefficient of financial development is positive, which implies that financial development increases agricultural productivity in the region. The numerical value of the coefficient indicates that 1% increase in financial development increases agricultural productivity by 0.469% in DOLS estimation. To find the non-linear effect of financial development on agricultural productivity a squared term of financial development is included in the model. The coefficient of quadratic terms implies that if financial development further increases, agricultural productivity starts decreasing. One possible justification could be that if financial development further increases then the amount of financial development is used for some other purposes like industrialisation and not for agricultural production. Thus, there is an inverted U-shaped relationship between financial development and agricultural productivity in South Asia.

Trade openness has a positive effect on agricultural productivity. The coefficient of trade openness implies that 1% increase in trade openness increases agricultural productivity by 0.041% (0.044%) in FMOLS (DOLS). However, these results are statistically insignificant. Per capita income has a significant positive impact on agricultural productivity. The estimated value of coefficient implies that 1% increase in per capita income increases agricultural productivity by 0.452% (0.461%) in FMOLS (DOLS) estimations. High income means the high potential to sustain high-quality inputs in the agricultural sector which raises agricultural productivity. High values of R^2 and adjusted R^2 indicate that most of the variations in the model are due to independent variables. Economically speaking, in FMOLS (DOLS) model 87.6% (99.3%) variation in agricultural productivity is due to all independent variables.

Table 4. Fisher/Johansen panel cointegration test

Hypothesized	Fisher statistics* (from trace test)	p-value	Fisher statistics* (from max-eigen test)	p-value
None	80.91	0.000	47.61	0.000
At most 1	40.85	0.000	21.77	0.016
At most 2	23.52	0.009	12.04	0.282
At most 3	16.64	0.082	11.52	0.318
At most 4	11.69	0.306	11.79	0.299

*probabilities are computed using asymptotic Chi-square distribution

Source: calculated by authors

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Table 5. Fully modified OLS (FMOLS) and dynamic OLS (DOLS) estimations (period 1973–2015)

Variables	FMOLS	DOLS
Physical capital	0.334*** (10.266)	0.229** (2.322)
Human capital	0.090*** (3.165)	0.097 (1.289)
Financial development	0.023 (1.036)	0.469*** (3.209)
Square of financial development	–0.079*** (–2.898)	–0.102*** (–4.585)
Trade openness	0.041 (1.416)	0.044 (–1.178)
Income level	0.452*** (35.267)	0.461*** (8.003)
R^2	0.876	0.993
Adjusted R^2	0.870	0.986
Standard error of regression	0.193	0.060

***, ** significant at 1 and 5% significance level, respectively; values in parentheses are *t*-values

Source: calculated by authors

Robustness analysis

For robustness analysis, we have also included some other variables in our model, i.e. agricultural terms of trade, industrialisation, carbon emission and rural labour force. Table 6 provides the estimated results. All previous variables have not only maintained their signs, but their significance levels have also increased. Financial development has become statistically significant in both FMOLS and DOLS estimations. Moreover, trade openness has also become statistically significant. Agricultural terms of trade has a negative impact on agricultural productivity. In other words, when agriculture export price increases, relative to agriculture import price, agriculture production decreases. The intuition is that agriculture exports become expensive and agriculture imports become cheaper which discourages agriculture production. Economically speaking, 1% increase in agriculture terms of trade decreases agricultural productivity by 0.217% (0.003%) in FMOLS (DOLS).

Industrialisation increases agricultural productivity as the coefficient of industrialisation is positive and statistically significant in both FMOLS and DOLS estimations. The value of the coefficient implies that 1% increase in industrialisation increases agricultural productivity by 0.730% (0.245%) in FMOLS (DOLS) estimations. The intuition is that the industrial sector uses raw material from the agriculture sector. If there is any decline in the industrial sector, it adversely affects agricultural production in the region. Carbon emission has a significant negative effect on agricultural productivity, which indicates that when environmental quality deteriorates then agricultural productivity also decreases. The estimated value of the coefficient implies that 1% increase in carbon emission decreases agricultural productivity by 0.215% (0.099%) in FMOLS (DOLS) estimations. The coefficient of the rural labour force is negative and statistically significant, which implies that

Table 6. Fully modified OLS (FMOLS) and dynamic OLS (DOLS) estimations for robustness analysis (period 1973–2015)

Variables	FMOLS	DOLS
Physical capital	1.560*** (34.411)	0.271*** (5.354)
Human capital	0.389*** (12.551)	0.112* (1.703)
Financial development	0.081** (2.169)	0.518*** (3.203)
Square of financial development	–0.093*** (–3.175)	–0.104*** (–3.644)
Trade openness	1.451*** (37.810)	0.062*** (2.691)
Income level	0.451*** (32.956)	0.522*** (6.996)
Agricultural terms of trade	–0.217*** (–6.608)	–0.003 (–0.205)
Industrialisation	0.730*** (17.291)	0.245** (2.220)
Carbon emission	–0.215*** (–9.921)	–0.099*** (–3.048)
Rural labour force	–1.644*** (–4.739)	–1.211*** (–3.983)
R^2	0.530	0.998
Adjusted R^2	0.497	0.990
Standard error of regression	0.379	0.051

***, **,* significant at 1, 5 and 10% significance level, respectively; values in parentheses are *t*-values

Source: calculated by authors

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the rural labour force has adverse effects on agricultural productivity. The intuition is that when more labour force is working on a small area of land, then agricultural productivity decreases as land cannot produce beyond its capacity.

CONCLUSION

The study examines the effect of financial development on agricultural productivity in South Asia. The other variables included are physical capital, human capital, trade openness and income level. The estimated results show that financial development has an inverted U-shaped effect on agricultural productivity. It implies that agricultural productivity firstly increases with the increase in financial development and then it declines when financial development further increases. Agricultural productivity increases with the increase in both physical and human capitals. Agricultural productivity also improves with trade openness and income level. The results of the robustness analysis show that terms of trade has a negative effect on agricultural productivity. Further, industrialisation has positive while carbon emission and rural labour force have negative effects on agricultural productivity in the region.

The study has some important policy implications. To increase agricultural productivity, the governments in South Asia should promote strong and sound financial system. Governments should make more investments in both physical and human capitals so that more infrastructure and skilled labour force is available to increase agricultural productivity. Since trade liberalisation increases agricultural productivity, governments should further liberalise trade as it will increase the export of agriculture products which will enhance agriculture production. It will also bring foreign technology which will improve agricultural productivity.

Further, governments can increase agricultural productivity by increasing economic growth as it will increase per capita income and farmers will be able to adopt mechanised farming which will increase agricultural productivity. Industrialisation also increases agricultural productivity; therefore governments should take steps to boost the industrial sector to increase agricultural productivity in the region. Moreover, governments should adopt measures to reduce carbon emissions to increase agricultural productivity as it negatively affects agricultural productivity.

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