Research Article

The Effect of Public Spending on Agricultural Growth: Evidence from 1972 to 2014 in Pakistan

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Abstract | The purpose of this study is to analyse the impact of government spending on agricultural growth in Pakistan. The relationship among agriculture value added per worker and public spending on education, health, road length, the number of tube wells in the agriculture sector, improved seed distribution has been estimated through various econometric approaches in the study. Pakistan's agriculture growth has registered mixed trends from 1972 to 2014. Empirical evidence from developing countries suggests that public spending has a profoundly positive relationship with agricultural growth. Agriculture is the second largest sector of Pakistan's economy, accounting for more than one-fifth of Gross Domestic Product (GDP) and employing almost half of the country's workforce. The study utilized time series data for the period 1972 to 2014. The stationarity of time series data has checked through Augmented Dickey-Fuller (ADF) test. Johansen Co-integration test and Error Correction Model (ECM) have employed for the long run and short run empirical estimation. The Co-integration test results show the presence of a long run relationship among the variables. The coefficient of the ECM term (-.537563) in the ECM model is negative and statistically significant, which validates stable long-run equilibrium relationship among the variables, with speed of 53 per cent to restore disequilibrium in case of any shock. The regression results reveal that public spending on education, health and road length has a positive influence on agriculture value addition in Pakistan. The study recommends the allocation of greater resources to education, health and transport and communication sectors for agricultural growth.

Received | November 13, 2018; **Accepted** | February 14, 2019; **Published** | March 18, 2019
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Citation | Ahmed, T., K.S. Khan and M. Naeem. 2019. The effect of public spending on agricultural growth: Evidence from 1972 to 2014 in Pakistan. *Sarhad Journal of Agriculture,* 35(2): 349-357.
DOI | http://dx.doi.org/10.17582/journal.sja/2019/35.2.349.357
Keywords | Agricultural growth, Public Spending, ADF, Johansen cointegration test, ECM, Pakistan

Introduction

The Agriculture sector has a significant role in the sustainable economic development of a country (Fan et al., 2008). The significance of agricultural growth in the economic development of countries is reinforced by Rostow's Stages of Growth, which lays emphasis on agricultural growth as a pre-requisite for the take-off stage (Rostow, 1990). Agriculture is the major sector in many countries regarding its stake in national income and employment (Armas et al., 2012). Public spending plays a key role in increasing agricultural output growth and eradicating poverty especially in developing countries (Loto, 2011). Among different government investments, public education, health and infrastructure expenditures significantly contribute to macro-economic growth and development (Nadeem et al., 2011). Several country-level studies have investigated the association between government spending and agricultural growth (Benin et al., 2009; Fan et al., 2009; Loto, 2011). Empirical evidence suggests that Public expenditures can be used as an effective policy tool by governments to promote growth and equitable distribution of wealth in underdeveloped countries (Fan et al., 2009; Benin et al., 2009).

Fan et al. (2009) exposed that Public investments contributed to agricultural production, poverty eradication, and employment. They concluded that increased spending on education enhances farm productivity since well-educated farmers readily adopt modern technologies and farming practices (Admissive and Afar, 1997; Fan et al., 2009). Public spending on health has a strong impact on farmer health. Improvement in health not only enhances agricultural output growth but also increases farmers' income, since poor health negatively influences the income and productivity of farmers (Ulimwengu, 2009). Public spending on infrastructure is crucial for increasing farmer's access to input-output markets. Infrastructural investment also increases consumer demand and facilitates the integration of far-flung rural areas (Armas et al., 2012).

Considering the trends of public expenditure variables utilized by this study, the education expenditure in Pakistan regarding the proportion of GDP increased from 1.58% in 1972 to 2.4% in 2014. In contrast, India is spending 4.1 % of its GDP on Education, while Nepal spends 3.4 % and Bangladesh 2.4 % (Economic survey of Pakistan, 2013-14). Marginal allocations in education have hampered Pakistan's efforts to achieve universal goals in education as compared to neighboring countries. Similarly, expenditures on health as a percentage of GDP were 0.49% in 1972, which remained 0.30% in 2011. This stands in contrast to the World Health Organization (WHO) recommendations, which stipulate developing countries to spend 5 per cent of its GDP on health for ensuring the provision of adequate health facilities to its citizens. Concerning infrastructural development, road density is taken as a measure, which currently stands at 0.32 km per sq. Km, which is far less as compared to neighboring countries (Economic Survey of Pakistan, 2012-13).

With a GDP contribution of 22 per cent and employing almost half of the country's workforce, agriculture is the backbone of Pakistan's economy (Economic Survey of Pakistan, 2013-14). Agriculture provides the necessary inputs and raw materials to the industrial sector. In Pakistan, there are two major crop growing seasons. The first sowing season of Kharif crops starts in April-June and is harvested during October-December. The Kharif crops consist of rice, sugarcane, cotton, bajra, mask and jowar. The second sowing season of Rabi crops, start in October-December and ends in April-May. Wheat, lentil (masoor), gram, tobacco, rapeseed, mustard and barley are Rabi crops (Economic Survey of Pakistan, 2013-14).

Despite Pakistan's structural shifts towards the industrial sector, agriculture remains the second largest sector in Pakistan's economy (Economic Survey of Pakistan, 2013-14). The decade wise growth rate of agriculture value added per worker in Pakistan is presented in Table1.

Table 1: *Agriculture Value added Per Worker (% Growth rate) and share of Agriculture in GDP (1960-2014).*

Decade	Agriculture Value Added % Growth	Percentage Share of Agriculture to GDP
1960s	5.1	45.8
1970s	2.4	38.9
1980s	5.4	30.6
1990s	4.4	25.8
2000s	3.2	22.1
2010s	2.16	21.5

Source: *Pakistan Economic Survey (various issues); Federal Bureau of Statistics (2014).*

Since independence, Pakistan has progressed with the development of the agriculture sector. The agriculture sector registered a growth of 5.1 per cent during the 1960s (Table 1). In the early years, Pakistan's agriculture sector experienced high returns, but soon it started diminishing returns because less attention was paid to efficiency. In the 1970s, the growth rate of agriculture value added was observed as 2.4 per cent, which was much lower than the previous decade (Table 1). Many factors led to low agricultural production during the 70s; these included disincentive policies, bad weather condition and a high inflation rate (Ahmad and Amjad, 1984). During the decade of the 1980s, agriculture value added grew at 5.4 per cent (Table 1). This shows that as compared to previous decades there had been an increase in the growth rate of agriculture value added. Factors such as availability of key inputs and their proper utilization, favorable weather condition and policy changes for crop price stability led to high agricultural output growth in the decade of 1980s (Ali, 2005).

In the 1990s, the growth rate of agriculture value added was observed as 4.4 per cent which was slightly less to compare with that of 1980s (Table 1). The devastating floods in the early nineties affected the production of important cotton crops severely. The decline in research spending at Federal and Provincial also led to low output growth in the 1990s.

During the 2000s, the output growth rate in agriculture remained at 3.2 per cent (Table 1). It is evident that agriculture sector gained growth momentum in the first half of the 2000s. However, production of major crops was adversely affected by natural calamities, and therefore the growth rate of agriculture value added declined to 3.21 per cent. During 2011-14, the agriculture sector performed poorly as its growth declined to 2.16 per cent. Lack of mechanization and structural problems remained main hindrances to agricultural growth. Concerning Pakistan's GDP share Agricultural contribution declined from 47.7% in 1960's to 21.5% in 2010.

Analysts attribute weak growth of agriculture sector to a number of factors including minimal rate of technological innovation, limited adaptation to modern farming, inadequate supply of agricultural inputs, water logging and salinity, shortage of agricultural finance, instability in market prices, lack of adequate water reservoir, problem of land reforms and low public outlay on agricultural R and D, infrastructure, education and health (Economic Survey of Pakistan, 2013-14).

Evidence from different developing countries on the impact of public spending on agricultural growth indicates a positive relationship. For instance, Fan et al. (2004); Udoh (2011); Weir (1999) and Yasmeen et al. (2011) analyzed the influence of various government spending variables on agricultural growth. Fan et al. (2000) concluded that the Indian government should focus more on additional investments in agriculture research and rural roads for the eradication of rural poverty. According to them, these types of investments are more crucial for agricultural growth and rural poverty eradication as compared to other government investments. They also indicated that public education expenditures have a third significant impact on agricultural output growth and rural poverty eradication. Whereas, other government investments like health, irrigation, rural and community development and conservation of water and soil had shown little influence on agricultural growth and poverty per additional rupee spent. Fan et al. (2009) revealed that public spending on agricultural R & D, education, health and roads contributed significantly to agriculture growth and reduced regional disparities and poverty. They also indicated that public spending on education provides the highest returns to poverty eradication and has an extremely significant influence on agricultural growth and rural economy. Empirical evidence from Ghana on the impact of government expenditure on agricultural output revealed that public expenditure on agriculture, health education and rural roads played a vital role in increasing agricultural productivity growth (Benin et al., 2009). Ashok and Balasubramanian (2006) also pointed out that investments in rural roads, markets, irrigation, and education improve TFP growth of agriculture in Tamil Nadu, India. Positive effects of farmer's education on farming productivity are well documented.

Yasmeen et al. (2011) established that literate farmers were found more capable and productive than uneducated farmers. While Weir (1999) focused on how education affects farmer productivity in rural Ethiopia. The empirical analysis revealed that education enhances farmer's productivity significantly, particularly concerning efficiency gains.

Regarding Pakistan however, there are only a few studies on the relationship between government spending and Total Factor Productivity Growth. For instance, Nadeem et al. (2011) found that rural education, rural health, rural roads and agriculture have a statistically significant effect on total factor productivity (TFP). Similarly, Nadeem and Mushtaq (2012) revealed the occurrence of a long-run correlation between TFP and agricultural research and extension expenditure. Their results further revealed that there occurs a bidirectional relationship between government agricultural research and extension expenditure and agricultural productivity.

Another study carried out by Ali (2005) studied the empirical relationship between public investment in agricultural R and E and Total Factor Productivity (TFP), revealed that public investments in agricultural R and E positively impacted TFP growth in agriculture. Moreover, Kiani (2008) found that an increase in the number of tractors and road regarding kilometers contributed significantly to agricultural productivity growth in NWFP by 1.5 per cent average annual growth of annual crop production.

In the context of Pakistan, the effect of government expenditure on economic growth has been explored in depth. However, limited studies have been carried out in relation to how public spending influences agricultural growth in Pakistan (Nadeem et al., 2011, 2012; Kiani, 2008). It is in this context that this study explores how public spending on health, education, infrastructure (in terms of road length), improved seed distribution and the number of tube wells (representing agricultural technology) affects agricultural value added per worker in Pakistan.

Materials and Methods

The study has used annual time series data from 1972 to 2014. Data on variables under consideration were taken from Pakistan Bureau of Statistics, Economic Survey of Pakistan and State Bank of Pakistan. The study analyzed the impact of public spending on Agriculture Value Added Per Worker in Pakistan. Agriculture value added as dependent variable while public spending on education, health, transport and communication (proxied by road length), number of tube wells and improved seed distribution revealed as an independent variable.

To show the influence of public spending on Agriculture value added per worker in Pakistan, the multiple regression model is used as presented below. The following previous studies of Nadeem et al. (2012); Kiani (2008); Ali (2005) have focused the same econometric model as presented below on the relationship of Agriculture value added per worker and public spending.

$$LAGV = bo + b1\ LPSE + b2\ LPSH + b3\ LRL + b4\ L\ NTB + b5\ L\ ISD + Ut$$

LAG = Agriculture Value Added Per Worker (constant, 2005) ($. Million)

LPSE = Public Spending on Education (Percentage of GDP)

LPSH = Public Spending on Health (Percentage of GDP)

LRL = Road Length (Kilometer)

LNTB = Number of Tube Wells (Thousands)

LISD = Improved Seed Distribution (Thousand tones)

Also, bo represents the intercepts; bi is the coefficients while Ui shows the remainder term, which reveals the impact of all those variables which are not incorporated in the model.

Public spending on education is an important explanatory variable, which significantly affects agricultural and economic growth. Economists like Adam Smith, Lucas, Rome, and Solow's have developed many economic growth theories and models in which they have prescribed education as an important factor of growth. Public spending on health plays a significant role in overall agricultural production. Road length is incorporated as an important variable in the model since it is considered very crucial for agricultural growth globally. The number of tube wells plays a very effective role in the agriculture sector, so the study incorporates the number of tube wells in the model to determine the influence of tube wells on agriculture value added. In the existing literature, very few studies incorporated the number of tube wells as an independent variable to find out the effect on agricultural output growth Kiani (2008); Raza and Siddiqui (2014). Finally, improved seed distribution is incorporated in the model as an independent variable to investigate the effect of improved seed distribution on agriculture value added per worker.

The study has employed annual time series data. Therefore, it is prerequisite to check the stationarity of data before empirical estimation. The regression analysis produces spurious results when non-stationary data are employed in regression (Granger and Newbold, 1974). There are several unit root tests such as Phillips-Perron test, KPSS, Ng-Perron and Schmidt-Phillips test, which are used for checking the stationarity of time series data. Augmented Dickey-Fuller test has been utilized by the nature of annual time series data utilized in the study. Dickey and Fuller (1981) introduced Augmented Dickey-Fuller test, which is widely used for testing unit root in time series data.

The stationarity of time series data is tested through ADF test relying on the following form of regression equation:

$$\Delta Zt = \alpha o + \alpha_1 t + \alpha 2xt\text{-}I + \sum_{i=1}^{k} b3\Delta Zt\text{-}I + ui$$

Where;
Z is the variable; which is tested for stationarity; αo shows the intercept; Δ is the first difference operator; t is time trend; ui is the error term in time period t while the maximum lag length is k and its optimal lag length is identified. It is clarified that the error

term has zero mean; it is homoscedastic and having no serial correlation.

The ADF test is conducted under the null hypothesis α=o (series are stationary) against the alternative α <0 (series are non-stationary)

Using the test statistic:

$$F\tau = \alpha / SE(\alpha)$$

Where;
SE (α) represents the standard error of α; The computed value of test statistic Fτ will be matched with the critical value for the Dickey-Fuller test. If the computed value of test statistic Fτ is found to be less than the critical value of Dickey-Fuller test, then the null hypothesis is rejected, which indicates that the time series data sample has no unit root problem.

Cointegration test is applied to measure the long run association among the variables. The Cointegration approach was first introduced by Engle and Granger to investigates the long run relationship among the variables. This methodology was further modified by Stock and Watson (1988) and Pesaran et al. (2001). This study has adopted Johansen (1998) and Johansen and Juselius (1990) Cointegration test to estimate the long run association among the variables.

After testing the unit root problem, the Johansen Cointegration test measures the long run association among the variables. The necessary condition for Johansen Co-integration test is that all variables should turn out to be stationary at the same level. The general form of Co integration equation is as follow.

$$Yt = \alpha o + \alpha_1 Yt\text{-}_1 + \ldots\ldots\ldots + \alpha k\text{-}_1 Yt\text{-}k + Vt$$

Where;
Yt is an n×1 column vector of variables that are integrated of order 1(1); αi are n×n parameters and Vt represent the independently and normally distributed error term.

If the variables are non-stationary in the regression model and no Cointegration exists between variables, then the OLS technique will give false regression results (Chan and Lee, 1997). The cointegration technique in such a case will give a solution to the prevailing problem. According to Philips (1986), Bentzen and Engsted (1993), the OLS technique produces consistent and reliable results if the variables utilized are co-integrated in the equation.

When the long-run relationship is established among variables, then the Error Correction Mechanism (ECM) is applicable to investigate the short run relationship and to calculate how rapidly the equilibrium can be restored. ECM will not be valid if there exists no long-run relationship among variables. The general form of ECM is as follows.

$$\Delta Z = \alpha o + \alpha 1\ \Delta Yt_i + \alpha_2 Ut\text{-}1 + Vt$$

Where;
Δ is the first order difference operator; Yti represents the explanatory variables; Ut-1 is the one period lagged value of the error term and Vt is the usual random term in time period t.

Results and Discussion

Augmented Dickey-Fuller (ADF)
The results of the ADF test are outlined in Table 2. The t-statistic value of ADF test for all the variables (LAGVAD, LPSE, LPH, LLRD, LNTB, LISD) is statistically insignificant at 5% level. Therefore, all the variables are non-stationary at level. Table 2 further reveals that the ADF statistics for all variables are statistically significant at 5 % level of significance. Therefore, all the variables for the model are stationary at first difference or order 1(1).

Table 2: *ADF Test for unit Root.*

Variables	Level		First difference		Conclusion
	Statistic value	Critical value at 5%	Statistic value	Critical value at 5%	
LAGVAD	-0.526002	-2.936942	-7.864221*	-2.938987	1(1)
LPSE	-2.742125	-2.936942	-5.829643*	-2.938987	1(1)
LPSH	-2.407811	-2.936942	-6.368550*	-2.941145	1(1)
LRD	1.241869	-2.938987	-4.614484*	-2.938987	1(1)
LISD	-1.372592	-2.936942	-7.046794*	-2.938987	1(1)
LNTB	-1.751015	-2.936942	-5.479405	-2.938987	1(1)

Now, it is determined the existence of the long run association between agriculture value added per worker and explanatory variables; LPSE, PLH, LRD, LISD and LNTB.

Investigation of long-run relationship
In the co-integration technique, the values of Trace statistics and Maximum Eigen are used to explore the number of cointegration vectors. The results of

the Johansen cointegration test are given in Table 3. The value of trace statistics (148.5067) is greater than the critical value of 95.75366 at 5 per cent level of significance. The value of Maximum Eigen (57.93196) is greater than the critical value of 40.07757. Hence null hypothesis of no co-integration (R=0) is rejected, and alternative hypothesis occurrence of co-integration is accepted. The trace statistics indicate four co-integrating vectors and the maximum Eigen also indicate two co-integrating vectors at a 5 per cent significance level. Hence the results indicate the presence of a long-run association between agriculture value added per worker and PSE, PSH, RL, NTB and ISD.

Table 3: *Results of Johansen Co integration Test for Agricultural Growth Model.*

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	148.5067*	95.75366	57.93196*	40.07757
R ≤ 1	R ≥ 2	90.57471*	69.81889	38.64521*	33.87687
R ≤ 2	R ≥ 3	51.92950*	47.85613	21.44287	27.58434
R ≤ 3	R ≥ 4	30.48663*	29.79707	16.61294	21.13162
R ≤ 4	R ≥ 5	13.87369	15.49471	11.45523	14.26460
R ≤ 5	R ≥ 6	2.418456	3.841466	2.418456	3.841466

Regression result on the impact of public spending on agricultural value added

The results presented in Table 4 indicate that public expenditure on education has significant and positive effects on agriculture value added. The obtained result gets support from the results of Nadeem et al. (2011); Fan (2008); Reimers and Klasen (2013), who argued that public spending on education contributes significantly to agricultural output growth. Public spending on health has positively while insignificantly influences agriculture value added. This result is matched with the findings of Fan and Zang (2008); Fan et al. (2000), who revealed that government spending on health plays no role in increasing agricultural output growth. In Pakistan, the insignificant impact of health expenditures is attributed to some factors including weak governance, poor quality of Health care services and staff, rampant corruption, poor planning and lack of monitoring in rural areas. The third variable influencing agriculture value added is road length proxied by public spending on transport and communication has positive and highly significant influence on agriculture value added. This result is validating with Kiani (2008); Tunde and Adeniyi (2012); Nadeem et al. (2011); Armas et al. (2012); Ali (2005) and Benin et al. (2009), who found that infrastructure investments play an important role in boosting agricultural output growth.

Table 4: *Regression results on the effect of public spending on Agriculture value added.*

Dependent variable LAGVAD			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	-1.739274	-5.260798	0.0000
LPSE	0.144319	2.067233	0.0462
LPH	0.061122	1.652464	0.1074
LLRD	0.360290	4.732038	0.0000
LISD	0.094190	3.080329	0.0040
LNTB	0.295325	4.394913	0.0001

R-squared = 0.895325; Adjusted R-squared =0.888217; F-statistic = 671.9616; Prob(F-statistic) = 0.000000; Durbin-Watson = 1.651482

Improved seed distribution (ISD) also exerted a positive influence on agriculture value added. This result indicates that improved seed distribution is contributing significantly to the agriculture sector output. Finally, the results of the study reveal the number of tube wells in the agriculture sector positively and significantly influences agriculture value added per worker. The given result is in support of past studies undertaken by Kiani (2008); Raza and Siddiqui (2014); Ludena (2010), who indicated that tube wells have a strong influence on agricultural growth.

The value of adjusted R-squared is 0.895325 hence the fit is good. It shows that public spending on education, health, Length of roads, improved seed distribution and the number of tube wells explained approximately 89% systematic variations in agriculture value added throughout 42 years in Pakistan agriculture value added. Whereas, the remaining 11% variation is explained by other variables outside the model. The value of F-statistic indicates that the model is statistically significant at 5 % level of significance. The value of Durban-Watson statistic is 1.65 which is nearer to 2, reveals that there is no first-order serial correlation.

Error correction model estimates

The results of the error correction model are presented in Table 5. In the short run, all explanatory variables have positive effects except the number of tube wells has a negative effect on agriculture value added. The coefficients of all explanatory variables are statistically insignificant at 5 per cent level of significance, which shows that all variables have no strong association in the short run analysis. The coefficient of error correction term (-0.537563) is negative and significant, which validates the presence of Cointegration. The coefficient of ECM is -.53, meaning that the system adjusts to its previous disequilibrium at a speed of about 53 percent in one year.

Table 5: *ECM Estimates.*

Dependent variable D(AGVAD)			
Variable	**Coefficient**	**T-statistics**	**Prob.**
Constant	0.026359	3.236575	0.0028
D(LPSE)	0.002962	0.061962	.9510
D(LPSH)	0.013225	.591651	.5581
D(LRD)	.220158	1.303791	.2013
D(LISD)	.030589	1.584303	.1227
D(NTB)	-0.056414	-.600988	.5520
ECT01(-1)	-.537563	-4.502010	0.0001

R-squared = .406977; Adjusted R-squared = .299155; F-statistics = 3.774520;Prob(F-statistics)=.005698;Durbin-Watson=1.628776.

Graphic representation of CUSUM tests

The cumulative sum and the cumulative sum of squares are used to check the stability of multiple regression coefficients. A graphical depiction of CUSUM and CUSUMsq are presented in Figure 1 and Figure 2. The plots of both the CUSUM and CUSUMsq are lies within the acceptance bound, which shows no proof of mis-specification and structural instability for the estimation period of the model

This study aims to estimate the influence of government expenditure on agriculture value added per worker in Pakistan from 1972 to 2014. Agriculture value added per worker as dependent variable while public spending on education, health, road length, number of tube wells and improved seed distribution have included as an independent variable. The stationarity of data has been checked through the Augmented Dickey-Fuller test. Johansen co-integration test and Error Correction Model have been utilized for the long run and short run empirical estimation. The results indicated a long-run relationship between public spending and agriculture value added per worker, while public spending has short run insignificant influence on agriculture value added. The regression results revealed that public spending on education, road length, number of tube wells and improved seed distribution have a positive and significant influence on agriculture value added. Whereas, public spending on health was found insignificantly related to agriculture value added per worker.

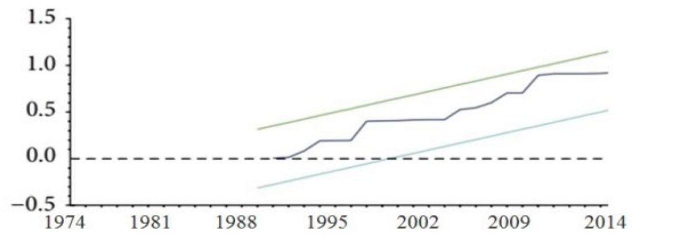

Figure 1: *Plot of cumulative sum of squares of recuresive residules of CUSUM.*

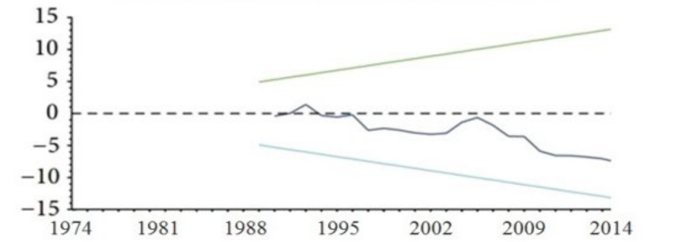

Figure 2: *Plot of cumulative sum of squares of recuresive residules of CUSUMsq.*

Conclusions and Recommendations

For sustained agricultural growth in Pakistan, this study suggests that the government needs to divert and allocate more resources towards the development of education since rural primary education increases the technical efficiency of the farming community. Moreover, educated farmers easily adopt modern agricultural techniques, which in turn enhance agricultural output and lessen rural poverty. The government needs to focus more on the health sector, particularly in rural areas where the majority of the inhabitants continue to remain deprived of basic health facilities. Availability of proper health facilities in rural areas will contribute towards improved health status of farmers, thereby increasing agricultural productivity growth. Lastly, for enhancing agricultural efficiency and reducing rural poverty, the government needs to increase spending on transport and communication.

Author's Contribution

Tanweer Ahmed was the main investigator of the study, who conceptualised the research and designed it with the help of Muhammad Naeem and Kashif

Saeed. Tanweer Ahmed collected and analyzed the secondary time series data. All the authors wrote the manuscript.

References

Admassie, A. and A. Afar. 1997. The impact of education on allocative and technical efficiency of farmers: the case of Ethiopian smallholders, paper presented at the seventh annual conference on the Ethiopian economy in Nazret (Addis Ababa: Addis Ababa Univ. Dep. Econ. Mimeographed).

Ahmed, V. and R. Amjad. 1984. The management of Pakistan's economy, 1947-82. Oxf. Univ. Press, Karachi.

Ali, S. 2005. Total factor productivity growth and agricultural research and extension: An analysis of Pakistan's agriculture, 1960 to 1996. Pak. Dev. Rev. 44: 4. 729-746.

Armas, E.B., C.G. Osorio, B. Moreno-Dodson and D.E. Abriningrum. 2012. Agriculture public spending and growth in Indonesia. Policy Res. Working Pap. 5977.

Ashok, K. and R. Balasubramanian. 2006. Role of infrastructure in productivity and diversification of agriculture. Islamabad: S. Asia Netw. Econ. Res. Inst., Pak. Inst. Dev. Econ.

Benin, S., T. Mogues, G. Cudjoe and J. Randriamamonjy. 2009. Public expenditures and agricultural productivity growth in Ghana. Int. Food Policy Res. Inst. Contrib. Pap. IAAE.

Bentzen, J., T. Engsted. 1993. Short and long run elasticities in energy demand: A cointegration approach. Energy Econ. 15: 9-16.

Chan, J. and K.S. Lee. 1997. Modelling and forecasting the demand for Coal in the China. Energy Econ. 32: 301-317.

Dickey, D.A. and A.W. Fuller. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrics, 49(4): 1057-1072.

Economic Survey of Pakistan. 2013-14. Ministry of finance, GoP. Islamabad.

Economic Survey of Pakistan. 2012-13. Ministry of Finance, Government of Pakistan. Islamabad.

Economic Survey of Pakistan. 2010-11. Ministry of finance, GoP. Islamabad.

Fan, S., J. Brzeska and G. Shields. 2008. Investment priorities for economic growth and poverty reduction. 2020 Focus brief on the world's poor and hungry people.

Fan, S., S. Jitsuchon and N. Methakunnavut. 2004. The importance of public investment for reducing rural poverty in middle-income countries: The case of Thailand. Int. Food Policy Res. Inst. Discuss. Pap. 7.

Fan, S., J. Brzeska and G. Shields. 2008. Investment priorities for economic growth and poverty reduction. 2020 Focus Brief on the World's Poor and Hungry People.

Fan, S., T. Mogues and S. Benin. 2009. Setting priorities for public spending for agricultural and rural development in Africa. Int. Food Policy Res. Inst. Policy Brief.

Fan, S., X. Zhang and N. Rao. 2004. Public expenditure, growth, and poverty reduction in rural Uganda. Int. Food Policy Res. Inst. DSGD Discuss. Pap. 4.

Fan, S., P. Hazell and S. Throat. 2000. Government spending, growth and poverty in rural India. Am. J. Agric. Econ.. 82(4): 1038-1051. https://doi.org/10.1111/0002-9092.00101

Granger, C., P. Newbold. 1974. Spurious regressions in econometrics. J. Econ. 2(2): 111- 120. https://doi.org/10.1016/0304-4076(74)90034-7

Johansen, S. 1988. Statistical analysis of co-integrating vectors. J. Econ. Dyn. Control. 12(2-3): 231-254. https://doi.org/10.1016/0165-1889(88)90041-3

Johansen, S. and K. Juselius. 1990. Maximum likelihood estimation and inference on cointegration with application to the demand for money. Oxf. Bull. Econ. Stat. 52(2): 169-210.

Kiani, A. 2008. An analysis of productivity growth and rate of returns to research in agriculture sector of north west frontier province. Sarhad J. Agric. Vol. 24 No. 3.

Loto, M.A. 2011. Impact of Government sectoral expenditure on economic growth. J. Econ. Int. Finance. 3(11): 646-652.

Ludena, C. 2010. Agricultural productivity growth, efficiency change and technical progress in Latin America and the Caribbean. IDB Working Paper Series No. IDB-WP-186 (15).

Nadeem, M. and K. Mushtaq. 2012. Role of agricultural research and extension in enhancing agricultural productivity in Punjab, Pakistan. Pak. J. Life Soc. Sci.. 10(1): 67-73.

Nadeem, N., K. Mushtaq and I. M. Javeed. 2011. Impact of social and physical infrastructure on agricultural productivity in Punjab, Pakistan, A production function approach. Pak. J. Life Soc. Sci. 9(2): 153-158.

Pesaran, M.H., Y. Shin and R.J. Smith. 2001. Bounds testing approaches to the analysis of levels relationships. J. Appl. Econ. 16(3): 289-326. https://doi.org/10.1002/jae.616

Phillips, P.C.B. 1986. Understanding spurious regressions in econometrics. J. Econ. 33(3): 311-340. https://doi.org/10.1016/0304-4076(86)90001-1

Raza, J. and W. Siddiqui. 2014**.** Determinants of agricultural output in Pakistan: A johansen co-integration approach. Acad. Res. Int. Vol. 5 No. 4.

Reimers, M. and S. Klasen. 2013. Revisiting the role of education for agricultural productivity. Am. J. Agric. Econ. 95(1): 131-152. https://doi.org/10.1093/ajae/aas118

Rostow, W.W. 1990. The stages of economic growth: A non-communist manifesto. Cambridge: Cambridge Univ. Press.

Stock, J.H. and M.W. Watson. 1988. Testing for common trends. J. Am. Stat. Assoc. 83(404): 1097-1107. https://doi.org/10.1080/01621459.1988.10478707

Tunde, A.M. and E.E. Adeniyi. 2012. Impact of road transport on agricultural development: A Nigerian example. Ethiop. J. Environ. Stud. Manage. Vol. 5 No. 3.

Udoh. 2011. An examination of public expenditure, private investment and agricultural sector growth in Nigeria: Bounds testing approach. Int. J. Bus. Soc. Sci. Vol. 2 No. 13.

Ulimwengu, J. 2009. Farmer's health and agricultural productivity in rural Ethiopia. Afr. J. Agric. Resour. Econ. 3(2): 83-100.

Weir, S. 1999. The effect of education on farmer productivity in rural Ethiopia. WPS99-7.

Yasmeen, K., E. Abbasian and T. Hussain. 2011. Impact of educated farmer on agricultural product. J. Pub. Adm. Governance. Vol. 1 No. 2.