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8 April 2016

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Abstract

Public investment and agricultural sector productivity nexus has been examined in the current paper using the ordinary least squares (OLS), vector error correction model (ECM), and Johansen test in a trivariate model, for the period 1961-2013, using annual time series data, for Ghana. The results indicate that public investment have significant negative effect on agricultural sector productivity (using the OLS test), whereas, investment by enterprises, government and households (measured by gross fixed capital formation) have significant positive effect on agricultural sector productivity. The findings of the Johansen test results indicate stable long run relationship among public investment, gross fixed capital formation, and agricultural sector productivity. The agricultural sector has not benefited from public investment over the period under discussion. The findings of the study seems to suggest that, policy makers in the agricultural sector should not rely on public investment to improve agricultural sector productivity. The findings suggest that investment by enterprises, government and households could be relied on as a policy tool to influence agricultural sector productivity. Other investment variables such as foreign direct investment should be included in future research to examine whether the current findings could be collaborated. Nonlinear models should be examined in future studies to determine if the results will be replicated.

Keywords: Public Investment, Gross Fixed Capital Formation, Agricultural Value Added
Jel Classification: O16, Q14

1.1 Introduction

The debate on the link between public investment and agricultural sector productivity is not new yet theoretical and empirical examination of the link has not yielded consistent findings, as such the issue continues to attract attention among researchers as a results of the very important role the sector plays in an economy (Nadeem, Mushtaq & Dawson, 2013; Benin, Mogues, Cudjoe, & Randriamamonjy, 2009; Diao et al., 2007; Anderson, de Renzio, & Levy 2006). Improvement in Agricultural leads to provision of food, income and poverty reduction (Evenson, 2001). Agriculture sector is argued to be supported with public resources due to factors such as market failure which produces inefficiencies (Anderson et al., 2006). The theoretical arguments in support of public investment in the agricultural sector are reported in the works of researchers such as Gockowski and Sonwa (2011); Lewis, Barham, and Zimmerer (2008); Anderson et al. (2006); Kakwani and Son (2006).

The empirical research works have produced inconsistent results and are reported in the works of researchers such as Pratt and Fan (2010); Benin et al. (2009); Kiani (2008); Diao et al. (2007); Ashok and Balasubramanian (2006); Huffman and Evenson, (2006); Fan et al. (2004); Ali (2005); Ashipala and Haimbodi (2003); Fan and Rao (2003); Fan (2000); and Fan et al. (2000).

The performance of the agricultural sector over the years has not been impressive in relation to the other sectors of the Ghanaian economy (service sector and industrial sector). The sector has recorded low contributions to gross domestic product (GDP) (Growth rate of 0.8% in 2011; Growth rate of 5.3% in 2010; Growth rate of 7.2%; in 2009; Growth rate of 7.4% in 2008), and even negative contribution (Growth rate of -1.7%; in 2007) in recent times. The current paper contributes to the body of knowledge in literature in the area of agricultural productivity by empirically examining the effect of public investment on the agricultural sector. The research specifically tests the long run and short run stable link between public investment and agricultural productivity. The paper provides answers to questions such as what is the effect of public investment and gross capital investment on agricultural sector productivity in the long run and short run? The paper is based on the following assumptions: (H1): There is stable long run link between public investment and agricultural sector; (H2) the agricultural sector has not benefited from public investment. The paper is based on time series econometric modelling using secondary data from World Bank data base. The findings might suffer from errors in variables which might not be known by the researcher. The rest of the paper looks at the methodology, empirical results, discussions, conclusions, and recommendations.

2. Research Methodology

2.1 Design

The research design for the current paper is econometric time series modelling of the nexus between public investment and agricultural sector productivity for the period 1961-2013.

2.2 Data

Public investment data and agricultural sector data used are secondary time series data obtained from World Bank data base. The sample size is 52. Various articles reviewed were selected from internationally recognised Journals on the internet. The data used in the estimation are public investment (the money that a government spends on public services, such as agriculture, education, and health) and agricultural sector productivity, and gross fixed capital formation (improvements in land, plant, machinery, and equipment purchases; and the construction of roads, railways).

Table 1 Data Description, Proxies and Sources

Data Description	Proxy/Measure	Source
Agricultural Sector Productivity (ASP)	Agricultural Value Added	World Bank World Development Indicator (WDI)
Public Investment (PV)		World Bank World Development Indicator (WDI)
Investment by enterprises, government and households	Gross Fixed Capital Formation (GCF)	World Bank WDI

2.3 Conceptual Framework

The link between public investment and agricultural sector is modelled for Ghana to determine whether the agricultural sector has benefited from public investment over the period under discussion.

2.4 Econometric Model

The link between public investment and agricultural sector is modelled in the current research paper in a trivariate model as shown in equation (1). The dependent variable in the model is agricultural sector productivity (proxied by agricultural value added, AVA) whereas the independent variables are public investment (PV) with gross fixed capital formation (investment by enterprises, government and households) as the control variable (GCF).

$$\ln ASP_t = \ln PV_t + \ln GCF_t + e_t \text{...}(1)$$

2.5 Estimation Methods

The estimation methods for the current study are: (1) The Ordinary Least Square method (OLS) which is used to examine the linear link among the variables in a log-linear form; (2) The Johansen Method, which is used to investigate the long run relationship among the variables; (3) The VECM, which is used to examine the nature of short run link among the variables in the model; (4) The Granger-Predictability test, used to examine the nature of causality among the variables under investigation. There are two forms of Johansen method, the trace test, and the eigenvalue test, with equivalent results. The null hypothesis for the trace test is that the number of cointegration vectors is $r=r^*<k$, against the alternative hypothesis that $r=k$. Testing proceeds sequentially for $r^*=1, 2, 3, \ldots, T$. The first non-rejection of the null assumption is taken as an estimate of r. The null assumption for the "maximum eigenvalue" test is the same as that for the “trace” test but the alternative assumption is $r=r^*+1$ and, again, testing roceeds sequentially for $r^*=1, 2, 3, \ldots T$, with the first non-rejection used as an estimator for r.

The Granger-Predictability test aims at testing whether there is neutral causality, unidirectional causality or bidirectional causality among the variables (AVA, PV, and GCF). For the purposes of the study Engel Granger (EG) causality test is used. Granger (1986) indicate that when variables are integrated of order one I(1) and are cointegrated there is at least one form of causality such as unidirectional causality. The hypothesis underlying Granger-Predictability test is that, the variables in the model should have significant long run relationship.

2.6 Diagnostic Methods for the Estimated Model

Various diagnostic tests are used to assess the model. These are: R-Square (R^2), Joint significance test, J-B Normality test, Breusch-Godfred LM test, ARCH LM test, White Heteroskedasticity test, and Ramsey RESET. The reset test for specification is based on the assumption of adequate specification; heteroskedasticity test is based on the null assumption of heteroskedasticity not present; test for normality of residual is based on null assumption that the errors are normally distributed; LM test for autocorrelation up to order 1 is based on the null assumption that there is no autocorrelation; test for ARCH of order 1 is based on the null assumption that no ARCH effect is present. The stability of the model is tested using the Cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ). In the use of the two plots, CUSUM and CUSUMSQ, if the statistics stay within the critical bonds of 5% level of significance, the null hypothesis of all coefficients in the given regression are stable and cannot be rejected. CUSUM test for parameter stability is based on the null assumption that there is no change in parameters estimated.

3 Empirical Results

3.1 Descriptive Statistics

Table 2 reports the descriptive statistics for the variables in the model estimated. ASP varies between 23.1514 and 65.0449. PV falls as low as 3.5315 and rise as high as 30.9269. GCF falls as low as 3.3776 and rise as high as 31.7848. The minimum and maximum values measure the degree of variations in the data. The mean is use to measure the central tendency of the variables in the estimated model. The mean value of ASP is greater than that of GCF whereas that of GCF is greater than that of PV. The values of the standard deviation (which is use to measure the dispersion of the data from their means) does not indicate more spread of the data from their means since the values are not larger in relation to the mean values. The volatility of the data are measured by the coefficient of variation (C.V). The values of the C.V show that PV is more volatile followed by GCF, and ASP. The values of the coefficient of skewness for the measure of the nature of skewness indicate that ASP is negatively skewed, whereas PV, and GCF are positively. The coefficient values of kurtosis (measure of the nature of peakness) of the data indicate the more flat-topped distribution since they are less than zero (0).

Table 2 Summary Statistics, using the observations 1970 - 2011

Variable	**Mean**	**Median**	**Minimum**	**Maximum**
ASP	45.0939	45.0484	23.1514	65.0449
PV	15.7439	13.1562	3.5315	30.9269
GCF	16.3278	15.8790	3.3776	31.7848
Variable	**Standard. Dev.**	**C.V**	**Skewness**	**Ex. Kurtosis**
ASP	9.7691	0.2166	-0.2189	-0.2619
PV	7.8139	0.4963	0.1945	-1.2493
GCF	7.4619	0.4570	0.0759	-1.0241

Source: Author's Computation March, 2016

3.2 Results on Unit Root Test

3.2.1 Time Series Plot

The time series plot results are reported in figure 1 to figure 6. The figures indicate that the variables (PV, GCF, and AVA) are non-stationary in levels (figure 1 to figure 3), however, the variables attained stationarity after they were first differenced (figure 4 to figure 6). The stationarity features are further scientifically examined using the ADF test, and the KPSS tests. The results of the test are shown in Tables 1 to Table 4.

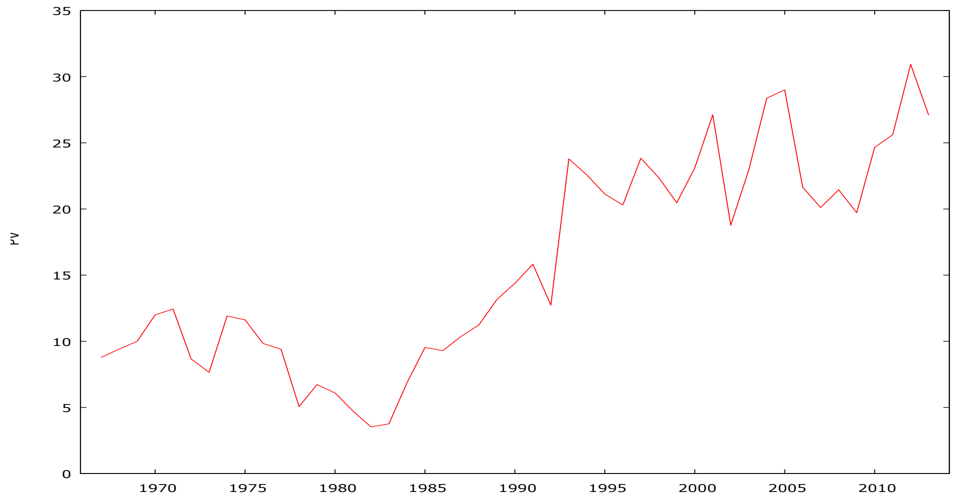

Figure 1. Time Series Plot of PV (levels)

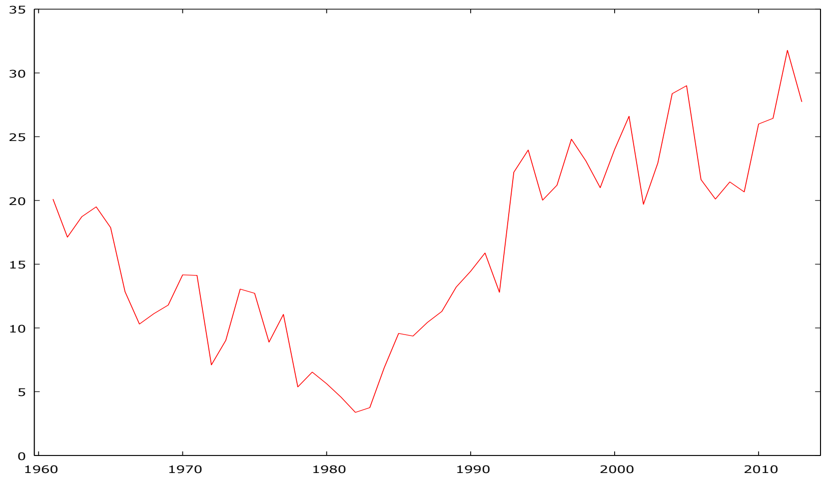

Figure 2. Time Series Plot of GCF (levels)

Figure 3. Time Series Plot of AVA (levels)

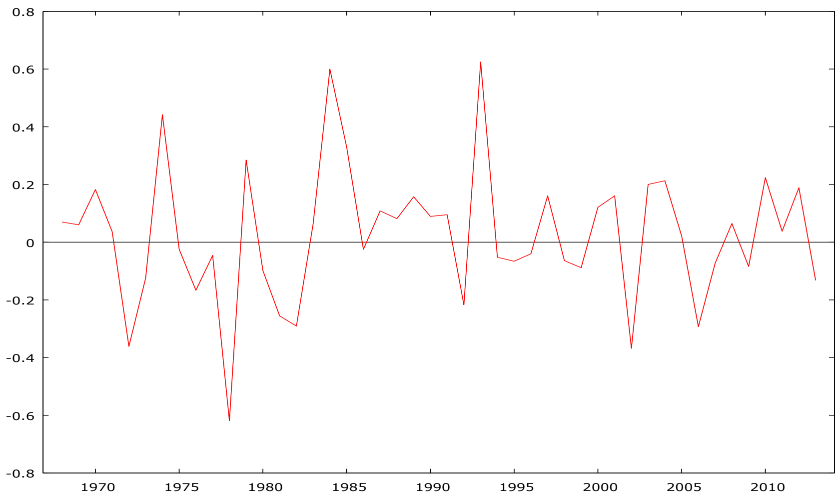

Figure 4. Time Series Plot of PV (in 1st difference)

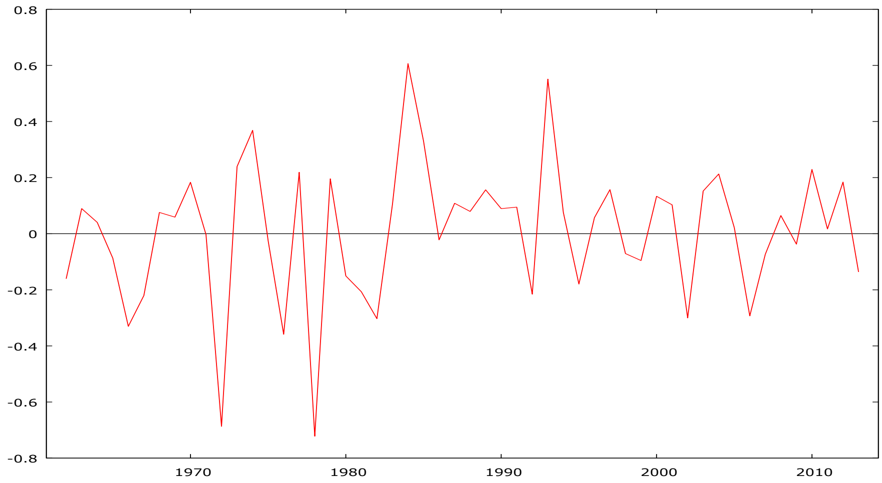

Figure 5. Time Series Plot of GCF (1st difference)

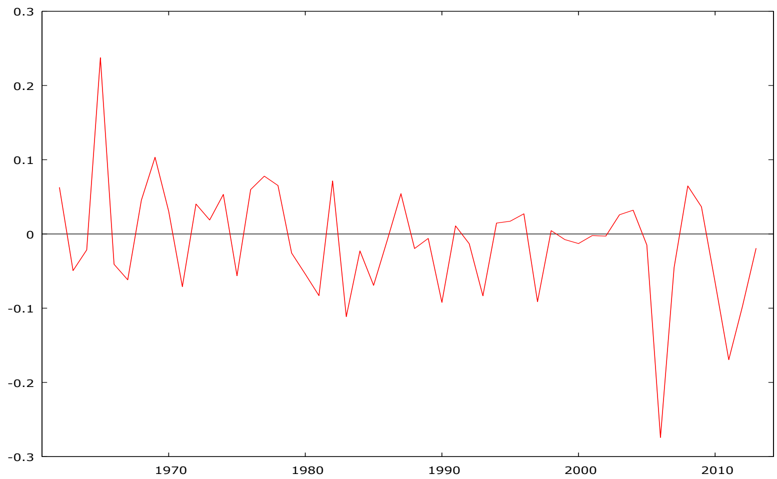

Figure 6. Time Series Plot of AVA (1st difference)

3.2 Results of Unit Root Tests

The two main unit root tests used in the current study are the Augmented Dickey-Fuller test (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS).

3.2.1 The ADF Test

First, the Augmented Dickey-Fuller test was used to test for unit root. The results of the ADF test for unit root in levels and in first difference (logarithm of the first difference) show that the series are non-stationary in in levels but attained stationarity on first differenced. The null hypothesis of unit root was accepted for all the series (in levels), however, the null hypothesis of unit root was rejected. Table 3 reports the results of the tests.

Table 3 ADF stationarity test results with a constant and trend

Variables	t-observed	ADF P-Value	t-critical	Results	Lag length
PV-level	-0.3589	0.3190	-2.5186	Unit Root	9
PV-1st diff.	-1.5767	3.287e-008	-6.6004	Not Unit Root	9
GCF-level	-0.1906	0.474	-2.2269	Unit Root	9
GCF-1st diff	-1.5463	2.183e-010	-7.3557	Not Unit Root	9
AVA-level	-0.1809	0.2719	-2.6185	Unit Root	9
AVA-1st diff	-1.7547	7.043e-007	-6.0882	Not Unit Root	9

Source: Author's Computation March, 2016

3.2.1 The KPSS Test

The KPSS test for examining the unit root features (based on the null assumption that the series variables under investigation are stationary against the alternative hypothesis that the series are not stationary) was used in addition to the ADF test. The results (in levels and in first difference as well as in their logarithm form) are reported in Table 4. All the variables attained stationarity on first differenced but not in levels.

Table 4 ADF stationarity test results with a constant and trend

Variables	t-observed	Results	Lag length
PV_{-level}	0.1567	Unit Root	3
$PV_{-1st\ diff.}$	0.0781	Not Unit Root	3
GCF_{-level}	0.2639	Unit Root	3
$GCF_{-1st\ diff}$	0.0935	Not Unit Root	3
AVA_{-level}	0.2839	Unit Root	3
$AVA_{-1st\ diff}$	0.0787	Not Unit Root	3
Critical values: 10% 0.121; 5% 0.149; 1% 0.213			

Source: Author's Computation March, 2016

3.3 Regression Results

3.3.1 Ordinary Least Square (OLS)

The OLS regression was performed as the initial step to investigate the link among the variables in the model. The results as reported in Table 5 shows. The results indicate significant negative link between public investment (PV) and agricultural sector productivity (ASP) and a significant positive link between gross fixed capital formation (GCF) and agricultural sector productivity (ASP). The results indicate that 1% increase in public investment and gross fixed capital formation, leads to about 95.72% decrease in agricultural sector productivity and about 65.33% increase in gross fixed capital formation respectively.

The values of the R^2 and the adjusted R^2 show that the estimated model do not behave as expected. The value (R^2) show that public investment, and investment by enterprises, government and households explains only about 48.78% changes in agricultural sector productivity. The estimated model did not pass autocorrelation assumption (p=6.47657e-009), specification assumption (p=0.0138), and parameter stability assumption. The model however, passed the normality assumption (p=0.1216), and heteroskedasticity (p=0.7026).

Table 5. OLS Regression Results

Number of observations 1971-2013 (N = 43): Dependent variable: lnAVA				
	Coefficient	Std. error	T-ratio	P-value
Constant	4.5327	0.1347	33.6560	0.000***
$lnPV_{-4}$	-0.9572	0.3760	-2.5457	0.0149**
$LnGCF_{-4}$	0.6533	0.3729	1.7519	0.0875*
Mean dependent var	3.7752		S.D. dependent var	0.2560
Sum squared resid	1.4100		S.E. of regression	0.1878
R-squared	0.4878		Adjusted R-squared	0.4622
F(2, 40)	19.0457		P-value(F)	1.55e-06
Log-likelihood	12.4640		Akaike criterion	-18.9281
Schwarz criterion	-13.6445		Hannan-Quinn	-16.9796
rho	0.8316		Durbin-Watson	0.4590

(Source: Author's computation, March, 2016)

Note *** and ** denotes significance at 1% and 5% levels

3.3.2 Johansen Test Results

The results on the examination of the long run relationship among public investment, gross fixed capital formation (investment by enterprises, government and households)), and agricultural productivity are reported in Table 6. The results indicate significant long run association among public investment, gross fixed capital formation, and agricultural productivity.

The short run link among public investment, gross fixed capital formation (investment by enterprises, government, and households)), and agricultural productivity was investigated using the error correction (ECM) model at lag 7. The results indicate that there is no disequilibrium in the short run since the error correction term (ECM_{-1}=0.7183; p=0.0006) is significant. The value does not have the expected a priori theoretical sign of negative. The value is not correctly signed. The positively signed valued of the error correction term means that the nexus among investments and agricultural productivity has the tendency to explode over time.

Table 6 Johansen Cointegration Test Results and the Vector Error Correction Results

Number of equations = 3 Lag order = 1 Estimation period: 1968 - 2013 (T = 46)					
Rank	Eigen-value	Trace Test	P-value	L-Max Test	P-value
r=0	0.5041	39.6080	0.0023***	32.2670	0.0005***
r=1	0.1327	7.3414	0.5450	6.5514	0.5513
	0.0170	0.7899	0.3741	0.7899	0.3741
Variable	Coefficient	Std. Error	T-Ratio	P-value	
EC_{-1}	0.7183	0.1771	4.0550	0.0006 ***	
Mean dependent var	-0.0208	S.D. dependent var	0.0703		
Sum squared resid	0.0663	S.E. of regression	0.0576		
R-squared	0.6558	Adjusted R-squared	0.3288		
rho	-0.0861	Durbin-Watson	2.1656		

Note *** denotes significance at 1% level

4 Discussions

In spite of the fact that the findings have been inconclusive in the empirical literature, the findings of the current paper are not in lined with previous studies such as Benin et al. (2009); Diao et al. (2007); Ashok and Balasubramanian (2006); Huffman and Evenson (2006); Kiani (2008); Ali (2005); Fan and Rao (2003); Fan et al. (2000); Binswanger and Rosenzweig (1993); and Leinbach (1983) that produced significant positive effect of public investment on agricultural productivity.

The findings do not support the theories that government should spend by way of subsidies to the agricultural sector to attain growth in the agricultural sector. The findings of stable long run link between public investment and agricultural sector productivity is consistent with that of Lee and Hsu (2009) for Taiwan, and Shyjan (2007) for India.

However, the findings of the paper are consistent with that of earlier researchers such as Ashipala and Haimbodi (2003) and Devarajan et al. (1996) whose studies indicated lowering effect of public investment on agricultural productivity. The findings of the study on the positive effect of investment (gross fixed capital formation) is in support of the findings of researchers such as Huang and Ma (2010) for China.

5 Conclusions and Policy Implications

The effect of public investment on agricultural sector productivity have been examined in the current paper using the ordinary least squares (OLS), vector error correction model (ECM), and Johansen test in a trivariate model, for the period 1961-2013, using annual time series data for Ghana. The results indicate that public investment have significant negative effect on agricultural sector productivity (using the OLS test), whereas, investment by enterprises, government and households (measured by gross fixed capital formation) have significant positive effect on agricultural sector productivity.

The findings (Johansen test) in addition show stable long run relationship among public investment, gross fixed capital formation, and agricultural sector productivity. The agricultural sector has not benefited from public investment over the period under review. The theories in support of government provision of subsidies to the agricultural sector is not supported.

Policy makers in the agricultural sector should reconsider their reliance on public investment as a policy tool in achieving growth in the agricultural sector. The findings suggest that investment by enterprises, government and households could be relied on as a policy tool to influence agricultural sector productivity.

Other investment variables such as foreign direct investment should be included in future research to examine whether the current findings could be collaborated. Nonlinear models should be examined in future studies to assess if the results will be replicated. Issues of structural breaks were not examined in the current study and as such future studies are worth doing. Causality issues are worth examining in future studies since the current research did not account for that.

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