SCIENTIFIC INFORMATION

Impacts of literacy rate and human development indices on agricultural production in South Africa

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Abstract: Agriculture is an important sector in South Africa, and the impact that education and human development would have made in this sector via non-white small scale farming was limited through biased policies of the apartheid era. Due to apartheid laws, South Africa found itself with high levels of unskilled labour force. This study seeks to find the impacts of literacy rate and human development indices on agricultural production using Auto Regressive Distributed Lag (ARDL) Bounds Test approach to co-integration. A long run relationship among the variables, agricultural production (agriculture GDP), literacy rate and human development indices were found. Literacy rate has a positively significant effect on agricultural production in the long run while Human Development Index has a positive and significant impact in the short run. This indicates that the apartheid regime fell short in recognizing the positive effect of education in the agricultural sector by denying a descent education to the majority of non-whites which were farm labourers or small scale farmers. This study provides some policy recommendations.

Key words: agricultural productivity, apartheid, bounds test, education

The contribution of agriculture to the national GDP has been declining over the past decades and it was about 2.3% in 2010 from about 9% in 1960. Employment in the sector has also been declining over the decades (www.daff.gov.za). Apartheid[1] system ensured that non-whites within the country are highly limited in their participation in the economy, such that their potential contribution in the economy was controlled as well. Due to apartheid laws, South Africa found itself with high levels of unskilled labour force. The system continued to have a negative effect in all aspects, including the agricultural sector on which the marginalized majority was highly dependent, as labourers and subsistence farmers. These negative effects were visible in the few numbers of non-white farmers that make the transition from subsistence to commercial farming. The management style, market accessibility as well as land management in the small scale farming due to lack of education (formal and/or informal) also saw the sector poorly operated. With all these being in effect, the living standards of the marginalized majority became poorer. The lack of good capital – physical and human – and knowledge advancement towards the non-white majority ensured that the country continued with two levels of farming that may never converge.

Furthermore, a progressive and effective industrialization requires a solid foundation in the primary economy, in which the agricultural sector plays a very important role. An economy that encourages a transformation from small scale to commercial farming through a supportive climate ensures a lively and efficient agricultural sector. However, the apartheid regime through their laws minimised this transition and the results are still prevalent in the current period. According to the World Bank report (2000), the agricultural sector employs approximately half of the work force in the world, with developing nations

[1]A system of racial segregation enforced through legislation by the National Party governments, who were the ruling party from 1948 to 1994, of South Africa, under which the rights of the majority black inhabitants of South Africa were curtailed and white supremacy and Afrikaner minority rule was maintained.

(including South Africa) having almost two thirds of work force in agriculture. Therefore, access to descent education and development programs towards the rural majority who are mostly in agriculture could have been beneficial to the economy at large and agriculture specifically. Formal education[2] plays a crucial role in a life of a person in terms of obtaining knowledge that provides a platform for development. Most importantly is the ability to apply this knowledge in one's life that makes a difference in achieving objectives and goals, better livelihoods and better levels of productivity. Seeing the importance of agriculture in South Africa, to what extent then does education impact on agricultural production? What effect does human development index (HDI) have on agriculture? This study seeks to answer these questions by employing the bounds test approach to co-integration to determine the short-run and long-run effects of these variables on agricultural productivity.

Furthermore, the commercial farming was developed in a way as to provide for the entire domestic agricultural production (Lipton and Lipton 2004), leaving the non-white small scale farming as an unimportant side sector that got none if any attention from the state. Lack of support in the non-white small scale farming was visible through the poor infrastructure and limited programs for training or mentoring in order to position these farmers towards improvement and transition into commercial farming. This type of model in itself was not sustainable in the long term. As a result, the small scale farming was underdeveloped (Lipton and Lipton 2004) and most of its produce was not meant for the markets.

As most production did not make it to the market, it is possible to assume that the quality of the produce did not matter because inputs are also of less quality. Through laws such as the Natives Land Act, No 27 of 1913[3] and the Natives (Urban Areas) Act of 1923[4], apartheid policies played a severe role in suppressing the contribution of the non-whites small scale farming, as the farming operated on a small percentage of land. Due to the Acts mentioned above, most of the land was in large scale production and/or in private hands of white residential places. The fact that this section of farming was less organized also had an impact in its underdevelopment.

Furthermore, the years of incentives and support that the apartheid state meted out to the commercial farming resulted in this farming continuing as the major producer in the current period as it was then. This farming was mainly capital intensive and very protected, unlike the non-white small scale farming (Lipton and Lipton 1994). It therefore was not surprising to see the negative effects that came with this protection including high prices for some of the consumer products. By maintaining the status quo, too much of rural non-white labour was left out of the economy as few could be absorbed by capital intensive large scale farming while the small scale farming was not a viable option. Also, most of the pricing and marketing in the apartheid regime was biased in favour of the large scale farming (Lipton and Lipton 1994).

In theory, education is known to have a positive return in improving productivity in all spheres of activities, including agriculture. Asadullah and Rahman (2005) affirmed that educated farmers are better managers, adopt more modern farm inputs and prefer risky (high-return) production technologies. In agriculture, better education will mean better ways of generating income, better adoption of technology to improve production and better wages in the case of labour (Yasmeen et al. 2011), including better marketing channels. Also, Yasmeen et al. (2011) found that educated farmers have a highly positive and significant impact on agricultural production in their study for Mailsi District, Pakistan.

Furthermore, this impact is seen specifically where household head or average household has a better educational basis, as found in a study by Olujenyo (2008), asserting that education is positively related to total maize output in Akoko Land, Nigeria. In a study in rural Bangladesh, Asadullah and Rahman (2005) found that the ability to process agricultural information, as well as improved literacy and numeracy skills are increased by schooling, indicating that a school curriculum design need not be agriculture-oriented to have a positive effect on agriculture. Furthermore, their study disputes a commonly held view that household investment in children's schooling in agrarian societies is discouraged by a lack of return to education in farm work. Onphanhdala (2009) found that the support policy on farmer education is as much important for the success of the agrarian transition process, as it is for the long term development of the country.

[2]Formal education - curriculum forming the set of courses and their content offered at a school or higher education institution.

[3]The Act made it illegal for blacks to purchase or lease land from whites except in reserves; restricting black occupancy to less than eight per cent of South Africa's land.

[4]The Act laid the foundations for residential segregation in urban areas.

Huffman (2000) confirmed that even in a society that is being modernised, there is a high need to invest in school going rural children as this investment will improve their long-term prospects for better living stands, more so those who may be employed within the agricultural sector. Furthermore, new technologies and communication methods will require that farm labourers or small scale farmers have a basic education in order to improve productivity. In another study by Onphanhdala (2009), general schooling showed a strong positive effect on the rice production, with an emphasis that primary schooling has a large effect on productivity. Furthermore, technology and communication methods have evolved in the past several years such that farm labourers or small scale farmers need to have a basic education in order to understand some of these inventions in the agricultural sector.

Studies on the effects of literacy rate on agriculture in South Africa are lacking as this was experienced while searching for literature. Human Development Index impact on agriculture is unavailable. Literature on the relationship between HDI and agricultural production is hardly available. However, in a closely related study Ranis (2004) found that human development, using HDI, has a positive effect on a long term sustainable GDP growth in a country.

The layout of the study is as follows: the following section reports the method and data used, followed by results and discussion. The last section presents the conclusion and recommendations.

METHOD AND DATA

This study estimates the short and long run effects of literacy rate and HDI on agricultural production in South Africa. This study will improve upon literature by estimating the effect of HDI, in addition to the literacy rate, on agricultural production, thereby providing a significant contribution towards understanding the impacts that literacy and HDI have on agricultural production.

Model

The model is normally specified using the Cobb-Douglas production function as used by Hoque and Yusop (2010). This is simplistic and is commonly used in one-output multi-input production relationship. The production function is expressed in natural logarithms as follows:

$$lGDPA_t = \beta_0 + \beta_1 lLRA_t + \beta_2 lHDI_t + \mu_t \quad (1)$$

where *GDPA* is the agriculture GDP; *LRA* is literacy rate index and *HDI* is Human Development Index; while the parameters to be estimated are β_0, β_1 and $\beta_{2;}$ μ_i is the disturbance term. The analysis will be done using Eviews7. The expected sign for the literacy rate is positive, as it is expected that high levels of literacy rate will impact positively on the agricultural production. As pointed out in the literature section, a farm labourer or a farmer with a level of education or schooling should be able to make sound decisions that will improve production and income generation. In addition, a positive sign is expected for HDI as high rate of HDI indicates a developing nation that is able to produce well informed and healthy human capital that will contribute positively towards agricultural production.

Method – ARDL Bounds test to level relationships (based on Pesaran et al. 2001)

The ARDL technique tests the existence of a level relationship between a dependent variable and explanatory variables when it is not known with certainty that these explanatory variables are trend – I(0) – or first difference – I(1) or mutually co-integrated. Furthermore, the pre-testing of explanatory variables for the order of integration before co-integration analysis is not necessary, however, it is important that the variables are not I(2). It uses the ordinary least square (OLS) estimation of a conditional unrestricted error correction model (UECM). The Autoregressive Distributed Lag of Equation 1 is expressed as:

$$D(lGDPA)_t = \lambda_0 + \lambda_1 lGDPA_{t-1} + \lambda_2 lLRA_{t-1} + \lambda_3 lHDI_{t-1} + \sum_{i-1}^{m} \lambda_4 D(lGDPA)_{t-i} + \sum_{j-0}^{n} \lambda_5 D(lLRA)_{t-j} + \sum_{k-0}^{p} \lambda_6 D(lHDI)_{t-k} \quad (2)$$

The variables are as earlier defined. *D* denotes first difference, the parameters λ_1, λ_2, and λ_3 capture the long run multipliers, while λ_4, λ_5, and λ_6 capture the short run coefficients. The null hypothesis of 'no co-integration' means that there exists no level relationship between the dependent and the explanatory variables, that is $H_0 = \lambda_1 = \lambda_2 = \lambda_3 = 0$ and *t*-statistics are used to test the significance of lagged levels of the variables. The Wald test of the *F*-statistic tests the joint significance of the coefficients of the one lagged level of the variables. The two sets of critical values for I(0) and I(1) calculated by Narayan (2005) for small sample sizes of between 30 and 80 observations will be used to test the computed *F*-statistic, such that if the computed

F-statistic is larger than the upper bound I(1) of the critical values, the null hypothesis of no co-integration is rejected. However, the null hypothesis cannot be rejected if the computed *F*-statistic is smaller than the lower bound I(0) of the critical values and the result is inconclusive if the computed *F*-statistic falls between the lower and upper bounds.

Data

The measure of agricultural production is agricultural GDP at 2005 constant prices. This data was sourced from the South African Reserve Bank (SARB). The literacy rate[5] is an index categorized as a percentage of population 15 years and above who can read and write a statement on their everyday life with an understanding (UNESCO.org). The literacy rate data was obtained from Statistics South Africa database. HDI is computed from indices of life expectancy at birth, average and expected years of schooling and per capita Gross National Income (GDI) for South Africa. The index has been increasing over the past decades, indicating a positive commitment by the state to improve the levels of life expectancy at birth, average and expected years of schooling and per capita GNI. HDI data was sourced from the Human Development Reports of the United Nations Development Program (UNDP). The study adopts annual data for the period 1980 to 2010.

RESULTS AND DISCUSSION

As mentioned in the section above, the pre-testing of the order of integration of the variables is not important, though all the variables are expected to be of order zero I(0) or one I(1) to continue with the estimation. However, the variables were tested for unit root using the Phillip-Peron (PP) test. To obtain the optimum lag, the Akaike Information Criteria (AIC) was used, where the optimum lag of 2 was selected (Table A1 in Appendix A). Testing the variables with (1) intercept and (2) trend and intercept at level and first difference, the results indicated that all the variables were non-stationary at level, but stationary at first difference, they are thus integrated of order one, I(1). The result of the bounds test is reported in Table 1. The computed *F*-statistic is larger than the upper bounds of the critical values at 1%, 5% and 10%. The results indicate that the null hypothesis of 'no co-integration' is rejected, confirming the existence of a long run relationship among agricultural production, literacy rate and the human development index.

The long run elasticities of the explanatory variables are calculated by dividing the coefficient of the lag one level explanatory variables with the coefficient of the one-period lag level dependent variable and then multiply by a negative sign. However, the short run elasticies are directly taken from the coefficients of the first difference variables in the estimated equation. Where two or more coefficients of the first difference of an explanatory variable are present, their sum is calculated to obtain the short-run elasticity and the Wald-coefficient test is used to test their joint significance (Appendix A). The short-run and long-run elasticities are therefore reported in Table 2.

Table 2 shows that literacy rate and human development index have positive effects on agricultural production as expected both in the short-run and long-run. The results are in line with literature. A 1% improvement in the literacy rate will result in a significant 3.18% increase in agricultural production in the long run and this is significant at all levels, although it does not have a short-run effect on agricultural production. This indicates a need to invest in school going children, especially in the rural areas, as this investment will improve their long-term prospects for better living stands, more so those who may be employed within the agricultural sector.

Furthermore, Table 2 shows that a 1% improvement in HDI will lead to a 1.65% increase in agricultural production in the long run, although not significant. On

Table 1. Co-integration test results

Critical value bounds: Intercept and no trend	99%		95%		90%	
Computed *F*-Statistic	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
8.8412***	6.183	7.873	4.267	5.473	3.437	4.470

Level of significance: * = 10%; ** = 5%; *** = 1%. Critical values obtained from Narayan (2005), Case II, p.1987. I(0) – lower bound; I(1) – upper bound

Source: own calculations

[5]The literacy rate in South Africa is scarce as only three periods (1980, 1996 and 2007) were obtained. Therefore, to obtain missing data interpolation was done with two assumptions that change between periods is (1) linear and (2) insignificant.

Table 2. Long and short run elasticities (dependent variable – lGDPA)

Variables	Short run	Long run
lGHDI(–1)	7.1494 *	1.6522
lGLRA(–1)	–	3.1758 ***

Level of significance: * = 10%; *** = 1%

Source: own calculations

the short run elasticities, only the HDI has a short run impact on the agricultural production and is significant at 10%. As shown in Table 2, a 1% increase in HDI will result in a significant 7.15% increase in agricultural production in the short run. Although literacy rate does not have any effect on agricultural production in the short-run, it has a positively significant effect in the long-run. Improving the HDI of the country will increase its agricultural productivity, especially in the short-run. We further tested the null hypothesis for stability (Figure 1 in Appendix), autocorrelation and heteroscedasticity and according to our results; we failed to reject these null hypotheses. This shows that the results are robust and reliable. Our results therefore show the importance of literacy rate and HDI on agricultural production in South Africa.

CONCLUSION

Due to apartheid laws, South Africa found itself with high levels of unskilled labour force. By limiting quality education which resulted in poor health and living standards to the then rural majority, the apartheid regime fell short in recognizing the positive effects of education (formal and/or informal) and human development. The apartheid state restricted the impact that high levels of literacy, knowledge, healthy living and descent living standards would have brought to the agricultural sector. This would have been experienced in the small scale farming and farm labour where the majority of non-white rural dwellers were found. In a country with a good weather for farming, agricultural production has not maintained a steady trend, and one reason may be that the non-white majority were not exposed to the viability of agriculture as a source of income as most were then, simple labourers.

In the light of the above effects of apartheid laws on agricultural production, this study utilized annual data on agricultural production, literacy rate index and HDI. The ARDL approach to co-integration, using bounds test was adopted to estimate the effect of literacy index and HDI on agricultural production. The bounds test result showed that a long-run relationship existed among all these variables. While literacy rate had a positive and significant effect on agricultural production in the long-run, the effect of HDI on agricultural productivity was also positively significant, but in the short-run. Some data points in literacy rates were interpolated, which could have resulted in the problem of autocorrelation with overestimated *t*-stats, although with unbiased estimated coefficients. This study therefore carried out a set of diagnostic tests of stability using the recursive residual test and the result showed that our results are stable. A test for mis-specification was also carried out, as well as the test for serial correlation and heteroscedasticity and we failed to reject their null hypotheses.

Moving forward, this study provides a guide on policy direction that the current government should pursue. Improvement in the components of HDI, that is longevity, knowledge and descent standard of living (preservearticles.com), must be targeted through a rigorous policy and implementation. The majorities that are still in the rural, farming areas must be granted opportunities through programs to better themselves via improved healthy living, education (both formal and informal) and channels to generate income for descent living.

Appendix

Table A1. VAR lag length selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	148.8731	NA	5.99e-09	–10.41951	–10.27677	–10.37587
1	236.9933	151.0632*	2.12e-11	–16.07095	–15.50001*	–15.89641
2	248.2034	16.81513	1.86e-11*	–16.22882*	–15.22966	–15.92336*
3	252.9596	6.115143	2.69e-11	–15.92569	–14.49833	–15.48933

*indicates lag order selected by the criterion: LR = sequential modified LR test statistic (each test at 5% level); FPE = final prediction error; AIC = Akaike information criterion; SC = Schwarz information criterion; HQ = Hannan-Quinn information criterion

Table A2. Estimated ARDL model for agricultural productivity production function

Variable	Coefficient	*t*-statistic
D(lHDI)	2.676738	0.980231
$D(lHDI_{t-1})$	4.472697	1.768868*
$lGDPA_{t-1}$	–0.856048	–4.794547***
$lHDI_{t-1}$	1.414376	1.344966
$lLRA_{t-1}$	2.718669	4.023860***
Constant	–8.928176	–2.180463**
Adjusted R^2	0.43	
F-statistic	5.214***	
S.E. of regression	0.205	

Level of significance: * = 10%; ** = 5%; *** = 1%

Source: own calculations

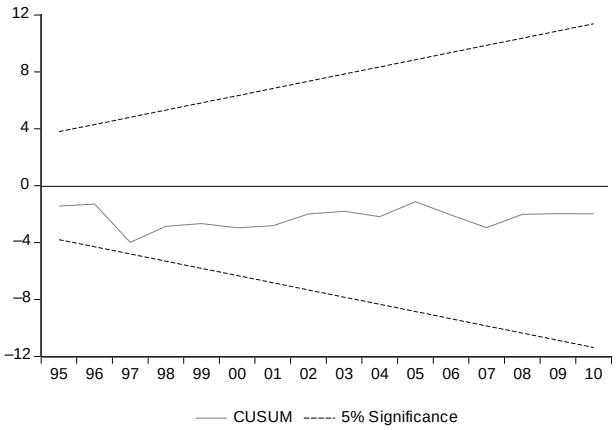

Figure 1. CUSUM test for Equation 2

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