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DETERMINANTS OF AGRICULTURAL PRODUCTIVITY GROWTH: A CASE STUDY OF SOUTH AFRICA FROM 1994 TO 2018

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Abstract

This paper applies the Autoregressive Distributed Lag model to analyse the long-run and short-run determinants of agricultural productivity growth in South Africa. The regressor variables are labour, fertilizer, agricultural land, and government expenditure in agriculture regressed against agricultural total factor productivity. In the long run, agricultural land and government expenditure had a positive relationship with agricultural productivity while labour produced negative results. In the short-run period, only government expenditure had a significant effect on agricultural productivity. Pertaining to the paper's results it is recommended that the government effectively spend money on redistributing land equitably among South African farmers to bridge the gap between smallholder farmers and commercial farmers. This will curb the inefficiency of labour on farms caused by the dualistic structure of the agricultural sector. Spending more on increasing agricultural land to make labour efficient will have a net positive effect on agricultural productivity growth in South Africa.

1. Introduction

The agricultural sector is vital for the socio-economic development in South Africa. The sector employs people from rural areas, supplying food either through domestic production or foreign exchange by using the money earned from exports of agricultural produce to afford food imports. The primary agricultural sector contributes about 3% to South Africa's gross domestic product (GDP). It employs about 5.28% of the formal labour (O'Neill, 2022). However, the entire value chain of agriculture contributes about 12% to the national GDP (GCIS, 2020). In 2020 the sector's exports grew by 3% and imports fell by 8%, thus defining itself as the country's net exporter with its export volumes generating $10.2 billion (ITA, 2021). However, there is a worry that South Africa will become a net food importer in the future (Ololade et al., 2017) because the sector's productivity is declining (Mbatha, 2020).

According to Ramaila et al. (2011), agricultural productivity has been stagnant in South Africa since the twenty-first century, posing challenges such as unemployment and food insecurity. However, the literature shows that potential productivity improvement can help developing nations mitigate these challenges (Amone, 2014). This is because agricultural productivity is used to measure the performance and efficiency of the agricultural sector (Thirtle et al., 2005). According to the Organization of Economic Cooperation and Development (OECD 2001), productivity is the ratio of the volume outputs to volume inputs. Therefore, agricultural productivity is the ratio of agricultural outputs to agricultural inputs. It measures how well the agricultural sector uses its inputs to produce agricultural output. Hence, it is a crucial component of food security (Mbow et al., 2019).

According to Kumar and Mosfeq (2012), food prices decrease relative to an increase in agricultural productivity, thus making food affordable for consumers to combat hunger. Christiaensen and Martin (2018) argue that growth in the agricultural sector has the highest potential to reduce poverty than any other economic sector; therefore, it should be the primary focus of eradicating poverty. However, Greyling (2012) found that the South African agricultural sector has not met the demand for main food items consumed domestically since 2000. A food security report by Stats SA (2019) reports that 20% of households in South Africa have impeded access to food and about 1,7 million households experienced hunger in 2017. This is alarming because the South African population is increasing at nearly 2% a year and is estimated to reach 82 million by 2035 (WWF, 2020). These people will need sufficient edible food and jobs to earn an income that can be provided through exceptional agricultural performance.

Several studies (Thirtle et al., 1993; Conradie et al., 2009; Liebenberg and Pardey, 2010) have estimated agricultural productivity in South Africa and found that it has fluctuated over the years. However, there is less information on factors determining agricultural productivity growth in South Africa. Hence, this study aims to determine the determinants of agricultural productivity growth in South Africa to recommend appropriate policies that can increase agricultural productivity and food supplies in the country since part of the primary aims of the National Development Plan (NDP) is to eradicate poverty and increase net exports by 2030.

2. Literature Review

This section reviews the literature associated with the present research topic and is divided into two subsections. Section 2.1 discusses factors that affect agricultural productivity growth from various local, regional, and international literature studies. Section 2.2 describes agricultural productivity growth in South Africa from the 2paper's results,0th century to the 21st century.

2.1. Factors affecting agricultural productivity growth

The purpose of this section is to establish relevant factors that could affect agricultural productivity growth in South Africa according to the available literature. Setshedi and Mosikari (2019) studied the impact of macroeconomic variables on agricultural productivity in South Africa. They employed the vector error correction model (VECM) to analyse time-series data for the period 1975 to 2016. The VECM results showed that an increase in government expenditure, gross capital formation, agricultural exports, gross domestic product, and money supply will increase agricultural productivity in South Africa. Teweldemedhin and Van Schalkwyk (2010) examined the relationship between trade and agricultural productivity using both a cross-sectional analysis (across nine agricultural commodities) and a time-series analysis. The results of the error correction model of ordinary least squares from the cross-sectional analysis showed that trade liberalization increased agricultural productivity as the net effect of export and import shares was positive. The results from time-series analysis reached the same conclusion, confirming that trade liberalization does cause productivity gains. Ebenezer et al. (2019) utilized the autoregressive distributed lag model (ARDL) to analyse the impact of government expenditure on agricultural productivity in South Africa. The study found that in the long-run a unit increase in government expenditure will increase agricultural productivity by 0.11%. This impact shows that the current spending is insufficient to increase agricultural productivity at a significant sizeable rate. In the short-run, the impact was not instantaneous, as it took two years for government expenditure on agriculture in South Africa to affect agricultural productivity.

Bellora et al. (2019) used the ecological model of crop production to estimate the impact of crop diversity on agricultural productivity in South Africa. Their results showed that crop diversification can be used to increase agricultural productivity while decreasing the use of pesticides. Muraya (2017) used the Cobb-Douglas and the Ordinary Least Square (OLS) estimation techniques to analyse the determinants of agricultural productivity in Kenya. The regressors of the model were labour force, inflation, real exchange rate, government expenditure, and rainfall while the regressed agricultural productivity. To establish whether the effect of each regressor on agricultural productivity was long-run or short-run, the study employed the Johansen-Granger Cointegration method of analysis and the Error Correction Model (ECM) respectively. The results showed that a unit increase in government expenditure, annual rainfall, and labour force will increase agricultural productivity by 0.06%, 0.09%, and 0.20% respectively. However, a unit increase in the inflation rate, and the exchange rate will cause a decrease in agricultural productivity by 0.02% and 0.41% respectively. Onogwu et al. (2017) analysed factors influencing the agricultural productivity of smallholder farmers in Taraba State, Nigeria. The study uses the binary logistic model to analyse access to credit, farmer age, experience, farm size, farm-based organization (FBO) membership, years in school, and gender against farmers' productivity. According to the finding of this study, a decrease in access to credit will decrease farmers' productivity by 0.375 units while an increase in farm size increases it by 1.458 units when other factors are held constant. A farmer's membership in FBO was likely to increase productivity by 1.170 units whereas the number of years spent in school by farmers was likely to increase productivity by 0.462 units all things being equal.

Fuglie and Rada (2013) study agricultural productivity at the regional level in Africa with the region of interest being Sub-Saharan Africa (SSA). Their study used econometric estimates of a production function for a panel of SSA countries and found that investment in agriculture research and development, economic and trade reform policies, farmer education, and irrigation improved agricultural productivity in SSA countries. The inhibiting factors against productivity growth were a lack of investment in land improvement and fertilizer use, incessant civil unrest, and HIV/AIDS. Djoumessi (2021) studied innovations that affect agricultural productivity and SSA. The study found that a unit increase in the use of pesticides and irrigation will increase agricultural productivity by 0.08 and 0.0005, respectively. Whereas a point increase in profit-enhancing innovations such as crop diversification will increase agricultural productivity by 0.017 and 0.03, with respect to country-specific effects. On labour cost-saving innovations, only tractors and harvesting machines had a significant positive effect on agricultural productivity in SSA.

Ahmed and Heng (2012) analysed Pakistan's agricultural productivity determinants. Their study used the ARDL model to regress human capital (education of farmers), fertilizer, agriculture credit, and area under cultivation against agricultural productivity. In the long-run, only human capital, fertilizer, and agriculture credit were statistically significant. A 10% increase in either fertilizer, human capital, and agricultural credit increased agricultural productivity in Pakistan by 1.6%, 1.4%, and 1% respectively when all other factors are held constant. In the short-run, fertilizer was still the most important factor as it increased agricultural productivity by 2% when increased by 10% holding other factors constant. It was then followed by human capital at 0.9% holding other factors constant. Another study of interest in Pakistan is by Kakar et al. (2016) which utilized the ARDL to analyse determinants of agricultural productivity in Pakistan. The regressors of interest were agriculture employment, the area under cultivation, fertilizer consumption, agriculture credit, consumption of pesticides, and rainfall regressed against Pakistan's agricultural productivity. In the long-run area under cultivation, fertilizer consumption, agriculture credit, and rainfall positively affected agricultural productivity. The area under cultivation had the largest impact, showing that a unit increase in the size of arable land will increase agricultural productivity by 9%. The smallest impact came from agriculture credit with an increasing effect of 0.000168% on agricultural productivity If increased by 1 million. In the short-run, a unit increase in the size of arable land increased agricultural productivity by 2.80% compared to 9% in the long-run while agricultural employment decreased agricultural productivity by -2.34%.

2.2. Trends of agricultural productivity growth in South Africa

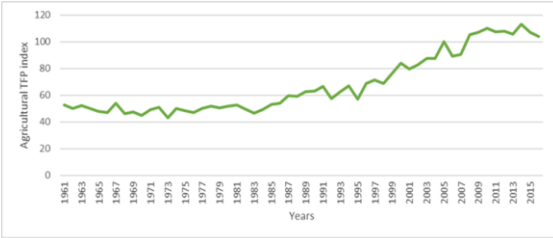

Figure 1. Agricultural Total Factor Productivity Index in South Africa: 1961-2016

The study by Thirtle et al. (1993), titled "Total Factor Productivity in South Africa: 1947-91," estimated agricultural productivity in South Africa during the 1947-91 period and found that TFP increased by an average of 1.3% per annum. However, the policy reforms of the early 1980s caused a significant increase in agricultural TFP growth compared to the 1970s. In the 1970s, intensive government intervention led to high input costs relative to producer prices (Kirsten et al., 1994; Jones and Inggs, 1999). During this time, producer prices increased by 9% per annum while production prices increased by 15% per year. This led to a large farm debt of about R2 621 million in 1978 and poor financial performance in the agricultural sector due to the cost-price squeeze, which reduced farm investment returns (Kirsten et al., 1994). This event occurred after 1973, with the worst financial performance recorded in 1983. Hence, Figure 3.4 above illustrates that the agricultural TFP index declined in the 1970s, with the lowest TFP being in 1973.

In the 1980s, the apartheid government started deregulating the agricultural sector. Labour controls were loosened, some marketing boards were abolished while some power was reduced, the fiscal policy was readjusted to discourage farmers from taking loans and wasteful spending capital, and the market was partially liberalized (Inggs, 1994). However, because not all marketing boards were abolished, the government used some of them, like import protection and the pricing policy, to deal with unfavourable trade balances and maintain profit growth (Barret and Mutambatsere, 2008). This deregulation decision by the government saw agricultural productivity rise by 4.6% per annum after 1983 (Inngs, 1994). This trend can be seen in Figure 3.4, where the spike in the agricultural TFP index started an upward trend in the 1980s. According to Thirtle et al. (1993), the decline in agricultural productivity from 1989-1994 was due to the peak of the inflation rate and the negative net farm income experienced during this period. After 1994, agricultural productivity recovered from its decline due to positive farm income (Schimmelpfenning et al., 2000). The improvement can be attributed to policy changes that were introduced in the 1990s such as the marketing and trading policy changes and land reform policy. From 1995 to 2004, agricultural productivity growth was 3.4% and started to decline around 2005 to 2014, thus sparking curiosity in identifying the factors that contribute to this decline and addressing them to halt the decline (Arndt and Pratt, 2020).

3. Methodology

3.1. Sources of data

This study used publicly available time-series annual data for the period 1994 to 2018. The data used in this study were publicly available and obtained from the Food and Agriculture Organization (FAO), the South African Reserve Bank (SARB), and the United States Department of Agriculture (USDA). The Total Factor Productivity index was sourced from USDA, government spending was sourced from SARB, and agricultural land, fertilizer, and labour were publicly available at FAO.

3.2. Data analysis

The Autoregressive Distributed Lag model (ARDL) was adopted to analyze the determinants of agricultural productivity growth in South Africa. The econometric model for agricultural productivity to estimate the coefficients is written as follows:

$$ln\, ln\,(Y_t) = \beta_0 + \beta_1\, ln\, ln\,(L_t) + \beta_2\, ln\, ln\,(F_t) + \beta_3\, ln\, ln\,(AL_t) + \beta_4\, ln\, ln\,(GE_t) + \varepsilon_t$$

Where $Y_t, L_t, F_t, AL_t, GE_t,$ and R_t are explained in Table 1 and ln is the natural logarithms of variables. B_i refers to long-run coefficients to be estimated, ε_t is the error term and t is the period.

Table 1. Description of variables

	Variable	Description	Unit of measure	Expected sign
Dependent variable				
Y_t	Agricultural productivity	Measured as Total Factor Productivity.	Index numbers	
Independent variables				
L_t	Labour	Total employment in agriculture	Percentages	+
F_t	Fertilizer	Amount of plant nutrients used per unit of arable land.	Kilograms per hectare of arable land	+
AL_t	Agricultural Land	Arable land under permanent crop cultivation and pastures.	Percentage of land area	+
GE_t	Government expenditure in agriculture	State subsidies, investment, extension services, etc.	Millions of Rands (R)	+

The study used EViews 12 to analyse the time series data with a sample size of 25 years. Before applying the ARDL model to time series data, it was important to check for the order of integration for all variables of the specified model because ARDL is not an appropriate model for variables that are integrated of order 2 ($I(2)$). The ARDL model is only applicable when the order of integration of either of the variables is 0 or 1, that is $I(0)$ or $I(1)$. Hence, ARDL is popular for being more flexible than other models of cointegration analysis, such as the Johansen Cointegration test and the Engle-Granger cointegration test, which require all variables to be integrated of order 1 (Ahmad, 2012). Furthermore, ARDL gives efficient results in a smaller sample size (Nkoro and Uko, 2016). To check for the order of integration, the study employed the Augmented Dickey-Fuller test and the Philip-Perron test. The estimate equation of the ARDL technique in this study can be written as:

$$\Delta\, ln\, ln\, (Y_t) = \beta_0 + \sum_{i=1}^{q_1} \beta_{1i}\Delta\, ln\, ln\, (Y_{t-i}) + \sum_{i=0}^{q_2} \beta_{2i}\Delta\, ln\, ln\, (L_{t-i}) + \sum_{i=0}^{q_3} \beta_{3i}\Delta\, ln\, ln\, (F_{t-i}) + \sum_{i=0}^{q_4} \beta_{4i}\Delta\, ln\, ln\, (AL_{t-i}) + \sum_{i=0}^{q_5} \beta_{5i}\Delta\, ln\, ln\, (GE_{t-i}) + \beta_6\, ln\, ln\, (Y_{t-1}) + \beta_7\, ln\, ln\, (L_{t-1}) + \beta_8\, ln\, ln\, (F_{t-1}) + \beta_9 ln(AL_{t-1}) + \beta_{10}\, ln\, ln\, (GE_{t-1}) + \varepsilon_t$$

Where Δ is the difference operator, β_0 is the intercept, and β_1 through β_5 constitute the short-run elasticities of the model. The last part, β_7 through β_{10} represents the long-run dynamics of the model. After applying the ARDL technique, the next step was to perform the bounded F-test. The bounded F-statistics were used to determine whether there is a long-run relationship between agricultural productivity and its specified determinants or not.

The hypothesis of the bounded F-test was as follows:

$H_0: \delta_1 = \delta_2 = 0$ (the long-run relationship does not exist)

$H_1: \delta_1 \neq \delta_2 \neq 0$ (the long-run relationship exists)

The decision rule was that, if the observed F-statistics is greater than the upper bound critical value, then the null hypothesis (H_0) is rejected. If the observed F-statistics fall between the upper and lower bound critical values, then the test is inconclusive. However, if the observed F-statistics fall below the lower bound critical value, the null hypothesis cannot be rejected. To get the short-run elasticities from the ARDL model, the above ARDL equation was reparametrized into Error Correction Model (ECM). The ECM equation of this study is expressed as follows:

$$\Delta\, ln\, ln\, (Y_t) = \beta_0 + \sum_{i=1}^{q_1} \beta_{1i}\Delta\, ln\, ln\, (Y_{t-i}) + \sum_{i=0}^{q_2} \beta_{2i}\Delta\, ln\, ln\, (L_{t-i}) + \sum_{i=0}^{q_3} \beta_{3i}\Delta\, ln\, ln\, (F_{t-i}) + \sum_{i=0}^{q_4} \beta_{4i}\Delta\, ln\, ln\, (AL_{t-i}) + \sum_{i=0}^{q_5} \beta_{5i}\Delta\, ln\, ln\, (GE_{t-i}) + \lambda EC_t + \varepsilon_t$$

Where q_i represents the optimum lag length of the relevant variable, λ is the speed of adjustment, and EC represents the error correction term derived from the long-run equilibrium relationship as given in the ARDL equation above.

4. Results

4.1. Unit root test

Table 2 shows the unit root test results of the Philip-Perron test and the Augmented Dickey-Fuller test. These tests aid the researcher in knowing the order of integration before applying ARDL regression. The null hypothesis for these tests was that "there is a unit root," while the alternative hypothesis stated that "the time series data has trend stationarity." Therefore, the rule of thumb is that the probability value of the Philip-Peron test or the Augmented Dickey-Fuller test must be less than or equal to 5% to reject the null hypothesis.

Table 2. Results of unit roots

Var	P-P Test Statistic (At Level)	P-P Test Statistic (At First Difference)	ADF Test Statistic (At Level)	ADF Test Statistic (At First Difference)
$ln\,(Y)$	-1.384033	-8.076762*	-2.785467**	-8.035044*
$ln\,(L)$	-1.155667	-3.837843*	-1.192764	-4.565918*
$ln\,(F)$	-3.242324**	-14.09454*	2.444788	-5.860157*
$ln\,(AL)$	-0.439654	-3.647594*	-0.209074	-3.688421*
$ln\,(GE)$	-0.302947	-5.342284*	-0.287606	-5.408191*

Note: *, ** and *** Show significance level at 1%, 5% and 10% levels, respectively.

According to the unit root tests results, only Agricultural TFP and fertilizer were found to be stationary at level ($I(0)$) at a 5% level of significance, while the other variables were stationary at the first difference ($I(1)$) at 1% level of significance. Thus, ARDL is a suitable regression model for this time series data.

Table 3. Bound test with 2 lags

Test statistic	Value	Level of significance	$I(0)$	$I(1)$
F-statistic	9.374070	5%	2.56	3.49

Table 3 shows the results of the bounded F-test. This test indicates whether there is a long-run relationship between the agricultural TFP and the regressor variables. The hypothesis test for the bounded F-test is as follows:

$H_0: \delta_1 = \delta_2 = 0$ (the long-run relationship does not exist)

$H_1: \delta_1 \neq \delta_2 \neq 0$ (the long-run relationship exists)

According to the results in Table 3, it is safe to reject the null hypothesis (H_0) since the F-statistic (9.374070) is greater than the upper-bound critical value (3.49) and not lower than the lower-bound critical value (2.56) nor falls in between bound critical values. Therefore, there is a long-run relationship between the study's independent variable and its specified dependent variables.

Table 4. *Estimated Long Run Coefficients Using the ARDL Approach (Dependent Variable [ln(Y)])*

Regressor	**Coefficient**	**Standard error**	**T-statistic**	**Probability**
$\boldsymbol{ln(L)}$	-0.400294**	0.149871	-2.670915	0.0161
$\boldsymbol{ln(F)}$	-0.203969	0.169126	-1.206019	0.2443
$\boldsymbol{ln(AL)}$	23.32441*	6.303886	3.700006	0.0018
$\boldsymbol{ln(GE)}$	0.313786*	0.089803	3.494140	0.0028
Constant	-98.96565*	28.19974	-3.509452	0.0027

Note: *, ** and *** Show significance level at 1%, 5% and 10% levels, respectively.

Agricultural land has the highest effect on agricultural TFP in South Africa. Agricultural land is positive and statistically significant at 1%, which shows that a 1% increase in agricultural land will increase agricultural productivity by 23.3% in the long-run, holding other factors constant. One possible reason for this high potential for agricultural land could be land inequality in South Africa. Minority farmers own most of the available farmland while most own less of it. Ngepah's (2010) study on inequality and agricultural production in South Africa found that land inequality causes a decline in agricultural productivity and that land redistribution slightly increases it coupled with factors like fertilizer, irrigation, chemicals, and human capital.

The second most influential factor is labour which is statistically significant at a 5% level and negatively correlated with the dependent variable. This result contradicts the expectation of this study, a positive relationship as highlighted in Table 1. Holding other factors constant, a 1% increase in labour force within the agricultural sector decreases agricultural productivity by 0.4% in the long-run. A possible explanation could be that the smallholder farmers in South Africa are experiencing a drawback when they continue to add labour on fixed inputs such as land. Smallholder farmers in South Africa cannot easily increase the size of their land in the long-run because of barriers to accessing commercial land for expansion, such as affordability (high property prices). This creates a situation where a unit increase in labour on the available plot of land to increase output ends up yielding diminishing output. At this production stage, the farmer experiences a negative marginal productivity of labour, meaning that a unit increase of labour leads to an absolute decline in total output.

The third significant variable is government expenditure at a 1% level of significance. A 1% increase in government expenditure on the South African agricultural sector will increase agricultural productivity by 0.3% when other factors are held constant. This concurs with the findings of Ebenezer *et al.* (2019), as detailed in the literature review Figure 1 explaining government spending on agriculture in South Africa. Thus, the finding agrees with the theory that government investment in agriculture boosts agricultural productivity. The Fertiliser variable was found to be insignificant, suggesting that in the long-run it does not have a relationship with agricultural productivity growth in South Africa.

Table 5. Error Correction Representation of the Selected (1, 0, 1, 0, 0) ARDL Model approach (Dependent Variable [ln(Y)])

Regressor	Coefficient	Standard error	T-statistic	Probability
$ln(GE)$	0.194176*	0.063323	3.066425	0.0070
ECM (-1)	-0.863194	0.101171	-8.531524	0.0000
R-Squared	0.761739	Adjusted R-Squared		0.750909
S.E. Regression	0.039424	Durbin-Watson		1.701701

Note: *, ** and *** Show significance level at 1%, 5% and 10% levels, respectively.

Table 5 shows short-run relationship results between agricultural productivity and its regressor variables from the Error Correction Model. It was found that only government expenditure has a short-run relationship with agricultural productivity. A 1% increase in government expenditure causes an immediate increase in agricultural productivity by 0.2% in the short-run, *ceteris paribus*. This finding is in line with the findings of Ebenezer *et al.* (2019). However, Ebenezer *et al.* (2019) found that the impact of government expenditure on agricultural productivity in South Africa happened after two years in the short-run contrast to the immediate impact that is found in this study.

According to the results in Table 5, the model fits data since an R-squared of 0.761739 shows that 76.2% of the variation on the dependent variable is explained by the specified regressor variables of this study. The standard error of regression shows how far the observed values fall from the regression line. Therefore, a standard error of regression value of 0.039424 shows that the distance between the regression line and the observed value of the study is very close to approaching perfect correlation, thus, making the model fit the data used in this study.

The Durbin-Watson statistic of the value that falls between 1.5 to 2.5 is relatively normal. Therefore, the model used in this study is not autocorrelated since the test statistic is equal to 1.701701. ECM (-1) is the error correction term known as the speed of adjustment. It must be negative and between -1 and 0; otherwise, the results will not converge toward equilibrium in the long-run. This might mean that the model is misspecified, autocorrelated or there are other issues with the data. Therefore, an error term of -0.863194 means the system corrects its previous period of disequilibrium at a speed of 86.3% to readjust to equilibrium again.

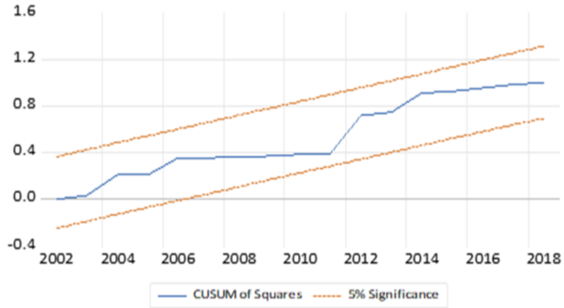

Figure 2. The CUSUM Test

The CUSUM test by Brown et al. (1975) informs about the stability of the model. The CUSUM stands for Cumulative Sum. A cumulative sum is the sum of a specified sequence that increases with more additions over time. According to the CUSUM test, the ARDL model specified in this study is stable since the sequence of the CUSUM test statistic is within the critical lines at a 5% level of significance as shown in figure 2.
The CUSUM of Squares solidifies the CUSUM test in Figure 2. The sequence of the CUSUM of Squares test statistic is within the critical lines at a 5% level of significance. This confirms that the model is stable over time, and the results can be trusted for policy recommendations.

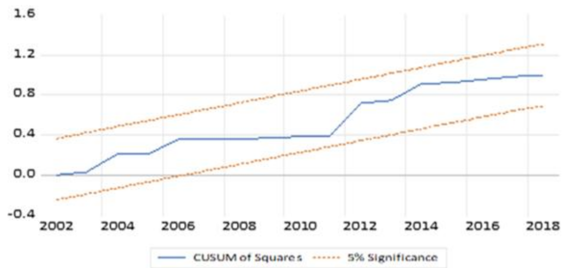

Figure 3. The CUSUM Square Test

5. Conclusion

This paper aimed to analyse the short-run and long-run determinants of agricultural productivity growth in South Africa. The study attempted to solve the lack of information about factors affecting agricultural productivity growth in South Africa. The

South African agricultural productivity growth was found to be fluctuating from 1961 to 2016. This trend was attributed to the apartheid government policies such as the market control boards and trade barriers that were enforced to protect white farmers before democracy in South Africa, and the substantial policy changes that were enacted after apartheid such as the trade and market policy changes in the 1990s. The findings of this study proved that the specified determinant factors (i.e., agricultural land, labour, fertilizer, and government expenditure) influence agricultural productivity growth in South Africa in the short-run and long-run.

Based on this finding, the paper recommends that the government increase the available land for agricultural production by spending more on land acquisitions from private owners of big farms and redistributing the farmlands to qualifying beneficiaries to close the gap between commercial farmers and smallholder farmers to reduce production inefficiencies caused by land inequality in South Africa. Another way the government can increase agricultural land is to secure property rights for traditional lands through tokenization using Non-Fungible Tokens as digital title deeds.

Declaration of interest

The authors declare no conflict of interest.

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