Agricultural Development Assistance and Agricultural Production in Zimbabwe

Biatrix S. Makamba
Department of Economics, Great Zimbabwe University, Masvingo, Zimbabwe

Abstract: This paper examined the impact of agricultural development assistance (ODA) on agricultural production in Zimbabwe for the period 1980-2019. The examination is motivated by the volatility of agriculture output despite the steady flow of ODA to Zimbabwe. The study disaggregates and compares the impact of private (ODA) and public (government expenditure) agriculture investment on agriculture output. The study applied the Auto-Regressive Distributed Lag (ARDL) estimation technique on a time series model based on Solow’s (1956) growth theory. Results indicate that both ODA and government spending on agriculture have significantly positive output growth effects. Furthermore, an ARDL Bound Tests for cointegration confirmed the existence of a long run relationship amongst the variables of interest. Findings suggest that both development partners and the government should consider increasing investment in agriculture so as to improve agriculture production and the aggregate economy. Also, Zimbabwe should adopt policies and institutional reforms that create a viable environment for agriculture so as attract donor funding. The government should prioritize to meet the 10% budget goal which is in line with the Maputo declaration so as to increase government spending on agriculture.

Keywords: Official development assistance, Government Spending, Agriculture output, Auto-regressive distributed lag model

JEL: Q14; Q18

1 Introduction

Despite the contribution of agriculture to gross domestic product (GDP) steadily falling globally in the past few decades, promoting agriculture production is still among the key avenues of socio-economic development. Slow growth in agriculture production has intense implications on other sectors of the economy. To outwit this sluggishness in agriculture, regional and global frameworks have reaffirmed the need to increase agriculture productivity and production (Goal 5 Agenda 2063, African Union Commission [AUC], 2021) through employment creation (Goal 1 Agenda 2063, AUC, 2021). This will eradicate poverty (Sustainable Development Goal [SDG] 1, United Nations Development Program [UNDP] 2020), end hunger, achieve food security and improve malnutrition (SDG 2, UNDP, 2021] and ensure healthy lives (SDG 3 UNDP, 2021]. Investment in agriculture productivity is key in achieving these goals.

Investment in agriculture is of special interest in improving agriculture production capacity of an economy, through increased investment in physical and human capital; increased capacity to import capital goods and/or technology; transfer of technology, thus promoting endogenous technical change (Moosey, 2001; Alimu and Lee, 2015). Alibi (2014) argues that this expedites economic growth and raises incomes, essential for domestic savings and economic development. The need for agricultural investment is greater in developing countries. Most developing countries are resource constraint (Nyoni and Bonga, 2017), making it difficult to adequately finance agricultural investments through public finance. Also, the majority of developing countries lack the necessary stimulus to attract significant foreign direct investment (FDI) depriving them of external capital (Kargbo, 2012). On the other hand, gains from international trade are not significant because developing countries cannot sustain the excessive competition common in international markets (UNACTD, 2019). Official development assistance (ODA) frequently remains the only source of external financing available to developing countries.

For this reason, the 2030 Agenda has given emphasis on the importance of ODA in supporting key sectors of the economy (agriculture, health, water, sanitation, clean energy and biodiversity) to achieve sustainable development (UNDP, 2021). ODA provided to government can potentially relax this fiscal gap if it is used for investment purposes (Ighodaro and Nwaogwugwu, 2013). This funding is considered as a robust and predictable
source of finance that complements other sources of funding vital for growth and development (UNACTD, 2019). Regardless of the fact that sizeable amounts of funding comes from public finance, ODA significantly contributes to agriculture investment. Increase in agriculture investment not only promotes production but achieves economic growth and long term poverty reduction (Nyoni and Bonga, 2017). Therefore, an understanding of the scope and nature of impact of ODA as a source of agricultural investment, on agriculture output is imperative.

A rich body of evidence supports ODA as a stimulus in promoting agriculture production (Apokodje and Omojimite, 2008; Adamu and Ighodaro, 2011; Tadese, 2011; Clemens et al., 2012; Kaya et al., 2012; Alabi, 2014; Ssozi et al., 2018, McAuthur and Sachs, 2019, Blizkovsky and Emelin, 2020). These studies support the Chenery-Strout (1966) model that argues that developing nations require ODA to close the savings gap and or the trade gap. The model stipulates that if the investment level of the recipient country is below the optimum level, ODA generates access to new technology and entrepreneurial skills and promote ease access to foreign currency and markets. Furthermore, since ODA is allocated to government, it can finance government spending and compensate for a small local taxbase (Gomanee et al., 2005).

However, this assertion is not short of scholarly objections. Empirical evidence (including Ighodaro and Nwaogwugwu, 2013; Albiman, 2016) has been provided to refute the positive relationship between ODA and economic growth. These studies argue that foreign aid crowds out private sector investment and innovation, encouraging government corruption and rent-seeking behaviour, thus undermining growth and development. Boone, (1996) and Easterly (2003) claim that ODA replaces rather than supplement local resources, promotes importation of inappropriate technology, misrepresents domestic income distribution and encourages an inefficient government.

This study observes that, although studies have been undertaken to assess the impact of agriculture development assistance on agriculture production in Africa, but no empirical attempt has been made to test such effects on the Zimbabwean agricultural sector. Existing studies (Nyoni and Bonga, 2017; Siavhundu, 2020) have emphasized on testing the sensitivity of aggregate ODA to total economic activity. Nyoni and Bonga report a positive relationship while Siavhundu provides evidence for a negative relationship. Clemens et al. (2012) argue if ODA is channelled to productive and growth enhancing sectors of the economy it will stimulate economic growth. There exists considerable evidence to suggest that agricultural growth has significant effects on global poverty reduction (Christiaensen et al., 2011), promoting growth in non-agricultural sectors through channels of structural transformation from agricultural to industrialized economies (McAuthur and McCord, 2017). Clemens et al. (2012) view ODA to agriculture as an early impact aid that boosts growth in the short to medium run. Therefore, there is need to assess if the Zimbabwean agriculture sector is growth enhancing.

Secondly, the study acknowledges that improvement in agriculture production capacity largely depends on a combination of the private and public sector driven solutions, where both external and government support are critical. Accordingly, it views public finance and foreign aid (representing private sector finance) as basic drivers of agricultural production, and therefore, disaggregates and compares the impact of the two on the growth of the agricultural sector.

The paper proceeds as follows. Section 2 gives the background to the study. In section 3, the theoretical framework of the analysis and the econometric procedures employed are detailed. Results presentation and discussion is done in section 4 while section 5 concludes by drawing key recommendations based on findings.

2 Background

2.1 Global Trends in Total Share Official Development Assistance to Agriculture

The agricultural sector is viewed as one of the key productive and growth enhancing sectors of the economy that can stimulate growth (Kaya et al., 2012). Accordingly, the Sustainable Development Goals (SDGs) have appealed to developed countries to share the responsibility of reducing hunger and improving agriculture and food security by increasing their ODA disbursement to developing countries (SDG 17.2). Figure 1 presents the trends in the global and Africa’s total ODA share to agriculture. The total ODA dedicated to agriculture growth rate in Africa is on average higher than the global average growth rate, indicating the significance of ODA in the agricultural sector.
productivity of the economies of the continent. ODA growth rate to Africa has increased by 9.2% and 10.11% in 1986 and 1997 respectively while the global maximum was 8.86% in 1983.

**Figure 1: Total Share of Official Development Assistance of Agriculture for Africa and the World**

*Source: Authors’ Compilations from FAO (2021)*

Despite existence of considerable evidence on the positive link between ODA and agriculture production (Apokodje and Omojimite, 2008; Adamu and Ighodaro, 2011; Tadese, 2011; Clemens *et al*., 2012; Kaya *et al*., 2012; Alabi; 2014; Ssozi *et al*., 2018, McAuthor and Sachs, 2019, Blizkovsky and Emelin, 2020), substantial variations have been displayed in the trend. The data shows variations with a peak of 8.86% in 1983, through a minimum of 2.44% in 1990, to another peak of 7.76% in 2000 and a minimum of 2.61% in 2006, rising again to 4.35% in 2018. This inconsistent behaviour is also prevalent in Africa, with a maximum of 7.61% in 1985 through a minimum of 3.03% in 1988, to another peak of 10.11% in 1997 to a minimum of 2.78% in 1991 rising to 7.82% in 2000 before reaching its lowest of 1.81% in 2006 and rising again to 6.54% in 2014. The allocation has also shown a general decline trend from 2000. This downward trend coupled with erratic supply in the total share of ODA to agriculture could seriously limit agricultural production in Africa.

A global comparison total share of ODA and agriculture output growth indicates a positive relationship between the two as depicted in Figure 2. For the period 1980 to 1982, output increased from 2.67% to 4.76% after a 7% increase in ODA, in 1986 ODA received was 7.04% and output rose from 2.216% to 5.235% in 1988, a sharp increase of ODA in 1996 resulted in an increase in output in 1999.

**Figure 2: A Comparison of Global Official Development Assistance Growth and Agriculture Output Growth**
The noted trend suggests that there exists a positive relationship between ODA and output, though global data seem to indicate a time lag between a change in ODA and the response in output. The decline in the average amount of ODA received is also evident in the gradual decline in output. This might suggest that ODA plays a significant role in boosting agricultural productivity. In the face of this, it is imperative to ascertain if ODA is a driver of economic growth, and if so to what extent.

2.2 Official Development Aid and Agricultural Output Trends in Zimbabwe

Zimbabwe is one of the many developing countries who have a long history of receiving external funding through ODA. Mainly because it attracts little FDI and has neither the capacity to access finance on international capital markets nor mobilize meaningful domestic resources (Siavhundu, 2020). Thus, ODA becomes more important as a source of finance in the agricultural sector. Figure 3 below shows the trends of ODA to agriculture and agriculture output in Zimbabwe for the period 1980 to 2018. It can be observed that there is consistency in the allocation of ODA to agriculture, confirming a dependable supply of funding pertinent in agricultural production.

Figure 3: A Comparison of Official Development Assistance and Agriculture Output Growth in Zimbabwe

Despite the steady supply of ODA in Zimbabwe, there is high volatility agriculture output, with output growth reaching high levels (23% in 1984, 27% in 1993, 22% in 2009 and 23% in 2014) but also experiencing steep declines in some of the years (-15% in 1983, -23% in 1992, -39% in 2008 and -3.9% in 2016). Figure 2 clearly confirms a positive correlation between ODA growth and agriculture output growth. However, this is not evident in figure 3, suggesting that in Zimbabwe there is no association between the two. It is against this background that this study is triggered to examine the relationship between the two.

3 Methods and Data

The study employed time series data covering 39 years from 1980 to 2019. The main variables were gross agriculture production, development flows to agriculture as a share of total official development assistance, total number of full-time equivalent national agricultural researchers, agricultural input index, government expenditure and agricultural trade share. An Auto-Regressive Distributed Lag (ARDL) approach was adopted to test the long-run association and the bound-test co-integration, for analysis executed in STATA 14.

3.1 Theoretical Framework

This study is grounded on Solow (1956)'s growth model which made a significant contribution in explaining long...
run economic growth using key inputs; capital; labour in addition to technological progress. The model expressed the production function as:

\[ Y = A_t f(K, L) \]  

(1)

Where \( Y \) represents output, \( K \) and \( L \) denotes capital and labour and \( A_t \) signifies technological progress which was assumed to depend on time. Solow assumed that capital and labour were endogenous while capital was exogenous. The model assumed that growth owing to capital accumulation is only temporary, due to diminishing marginal returns because the population growth rate and the willingness to save limit output increase, in the absence of technological progress. Although the Solow’s model failed to explain the source of growth, it emphasized its significance in explaining economic growth (Zhao, 2018). The model emphasizes inputs as key to production, therefore this study will adopt agricultural land and fertilizers as key inputs to agricultural output.

The model transforms to:

\[ Y = A_t f(K, L, AGL, FERT) \]  

(2)

Where \( AGL \) denotes agricultural land and \( F \) denotes fertilizers used in production. The study adopts the agriculture input index that measure the total value of agriculture input index.

The model changes to:

\[ Y = A_t f(\text{Inputs}) \]  

(3)

Romer (1996)’s greatest accomplishment was to clear the mist shrouding the source of growth by showing how knowledge creation in production has positive externalities on economic growth. As it is created, it can benefit the whole economy as ideas are spilled over, thus generating increasing returns to scale. He viewed technology as merely ideas to produce goods and services, different from the existing ones. These ideas can be produced with capital and labour, like any other goods, but have some pivotal properties that make them unique (Zhao, 2018). The ideas are non-rivalry and are partially excludable. This implies that, adoption of an idea does not preclude use by others and not all ideas can be excluded. Findings from research are usually available, through discoveries from applied research and development by the private sector which can be precluded through secrecy or patent rights.

The theory makes the technology parameter \( A_t \) be determined by decisions made by firms for profit, instead of exogenously specified as in Solow’s model. The endogenous growth model was presented as:

\[ Y = K^\alpha (A_t L_t)^{1-\alpha} \quad \alpha \in \{0, 1\} \]  

(4)

The Cobb-Douglas production function presented shows \( \alpha \) and \( 1-\alpha \) as share of capital and income in national income. The model assumes increasing returns to scale to all factors taken together and constant returns to a single factor, at least for one. New knowledge is the ultimate determinant of long run economic growth which is determined by investment in research and development. In the face of these assumptions, production of new technology is given by:

\[ \Delta A = f(\text{Inputs}, A) \]  

(5)

Where \( \Delta A \) is production of new technology, \( \text{Inputs} \) represents physical inputs invested in producing new technology or designs and \( A \) is existing technology.

As the rate of technological growth influences economic growth, it is important to know its determinants. Generation of new ideas leading to new discoveries are grounded in scientific research, investment in research and development is critical to ensure an increase in the rate of technical progress. The total number of full-time equivalent researchers is used as a proxy for technological progress. The government and the private sector dedicate significant resources to applied research and development as it results in new goods and services. Private sector contribution, can either be domestic or foreign. Due to non-availability of data, the study proxies official development assistance (ODA) to represent private sector investment on agriculture. ODA not only augments domestic resources that can be channelled to research and development, but also supplements domestic savings which are key in investment and capital formation (Murshed and Khanaum, 2014). Government spending (GE) in
agriculture represents government efforts in supporting applied research and development to stimulate agricultural output. The flow of official development funds is promoted by openness to trade (Trdshre) (Dobre, 2008; Alemu and Lee, 2015).

Therefore, in deriving the empirical model for estimating the ODA-output relationship, the study posits that:

\[ GDP = f(\text{Inputs, Research, Gvtx, ODA, Trdshre}) \] (6)

Where GDP denotes gross agriculture output, inputs represents capital, labour, land and fertilizer used in the agricultural sector, Research is technological progress in agriculture, Gvtx represents Government spending on agriculture, ODA is official development flows to agriculture and Trdshre represents agriculture trade openness. The model becomes:

\[ GDP = \alpha + \beta_1 \text{Inputs} + \beta_2 \text{Research} + \beta_3 \text{Gvtx} + \beta_4 \text{ODA} + \beta_5 \text{Trdshre} + \varepsilon_t \] (7)

To minimise incidences of heteroscedasticity and multicollinearity in the model as well as to allow variable elasticity analysis, equation (7) is transformed into a log-log model (Gujarati, 2004; Shahbaz et al., 2016). The final model becomes:

\[ \log GDP_t = \alpha + \beta_1 \log \text{Inputs}_t + \beta_2 \log \text{Research}_t + \beta_3 \log \text{Gvtx}_t + \beta_4 \log \text{ODA}_t + \beta_5 \log \text{Trdshre}_t + \varepsilon_t \] (8)

### 3.2 Econometric Model

Parameter estimates in (8) are estimated using the ARDL approach originally introduced by Davidson et al. (1978) and further advanced by Pesaran and Shin (1995) and Pesaran et al. (1999). Recently, cointegration analysis and long-run relationship analysis seem to be in favour of ARDL over Vector Error Correction Model and Vector Auto-Regressive, owing to its superiority over the two. ARDL is preferred over the two owing to its superiority on small samples (Pesaran et al., 2001), reduces risk of spurious results (Ghouse et al., 2018), simultaneously provides results for short and long run results and performs the cointegration test using the Bound-Testing approach. The estimation approach allows use of variables that are integrated of order 0 and 1 (Paul, 2014). Generally, the ARDL considers the effect of the lags of both dependent (p) and independent (q) variables on the dependent variable. According to Pesaran et al. (1999), the ARDL (p, q) model therefore takes the form:

\[ y_t = \sum_{j=1}^{p} \lambda_j y_{t-j} + \sum_{j=0}^{q} \delta_j x_{t-j} + \varepsilon_t \] (9)

Where \( y_t \) is the endogenous/dependent variable, \( x_t \) represents a \( k \times 1 \) vector of exogenous variables, \( \delta_j \) is a \( k \times 1 \) parameter vector, \( \lambda_j \) is the scalar vector and \( \varepsilon_t \) is the stochastic. In error correction terms, (7) becomes:

\[ \Delta y_t = \phi y_{t-1} + \beta' x_t + \sum_{j=1}^{p-1} \lambda_j^* \Delta y_{t-j} + \sum_{j=0}^{q-1} \delta_j^* x_{t-j} + \varepsilon_t \] (10)

Where \( \beta' = \sum_{j=0}^{q} \delta_j \); \( \lambda_j^* = \sum_{m=j+1}^{p} \lambda_m, j = 1, 2, \ldots, p - 1 \); \( \delta_j^* = \sum_{m=j+1}^{q} \delta_m, j = 1, 2, \ldots, q - 1 \).

Simplifying (10) gives

\[ \Delta y_t = \phi(y_{t-1} + \theta x_t) + \sum_{j=1}^{p-1} \lambda_j^* \Delta y_{t-j} + \sum_{j=0}^{q-1} \delta_j^* x_{t-j} + \varepsilon_t \] (11)

In (11), \( \theta = -\left[ \frac{\beta'}{\phi} \right] \) shows the long-run elasticities of \( \Delta y_t \) on \( y_t \). \( \phi \) is the speed of adjustment or error correction term. It measures the speed with which \( y_t \) moves back to long-run equilibrium following disturbances in \( x_t \) (Seka et al., 2015). A significantly negative \( \theta \) indicates convergence and stability in the long-run relationship (Ghouse et al., 2018). Short-run elasticities of the endogenous and exogenous variables are shown by their respective lagged
differences, $\lambda^*_j$ and $\delta^*_j$, respectively. Applying (11) to the theoretical model (8) leads to:

$$
\ln Gdp_t = \phi(\ln Gdp_{t-1} - \theta_1 \ln Inputs_t + \theta_2 \ln Research_t + \theta_3 \ln Gvtex_t + \theta_4 \ln ODA_t + \theta_5 \ln Trdshre_t + )
+ \sum_{j=1}^{q-1} \lambda_j \Delta \ln Gdp_{t-j}
+ \sum_{j=1}^{q-1} \beta_{1j} \Delta \ln Inputs_{t-j}
+ \sum_{j=1}^{q-1} \beta_{2j} \Delta \ln Research_{t-j}
+ \sum_{j=1}^{q-1} \beta_{3j} \Delta \ln Gvtex_{t-j}
+ \sum_{j=1}^{q-1} \beta_{4j} \Delta \ln ODA_{t-j}
+ \sum_{j=1}^{q-1} \beta_{5j} \Delta \ln Trdshre_{t-j} + \epsilon_t
$$

(12)

### 3.3 Estimation

Before estimation of equation (10), unit root tests were performed. To ensure robustness, the data was subjected to Augmented Dicky Fuller Test (ADF) by Dickey Fuller (1979) and the Phillips and Perron (PP) (1988) test. For both tests, the null hypothesis ($H_0$) of non-stationarity is tested against the alternative ($H_1$) stationarity. The $H_0$ is rejected if the probability value is less than 0.05. The optimum lag lengths in (10) were chosen using the Akaike Information Criterion (AIC).

### 3.4 Data Description and Sources

The study employed secondary data obtained from Food and Agriculture Organization of the United Nation (FAO), World Bank, USDA and ReSAKSS indicators for the period 1980 to 2019. Interpolation was carried out on $\ln Inputs$ and $\ln Gvtex$ to find some of the missing observations. Data description and sources are given in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Expected Sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Gross Agricultural Production value (constant 2014-2016)</td>
<td>FAO</td>
<td></td>
</tr>
<tr>
<td>Input_Index</td>
<td>Agriculture Input index (land, labour, livestock capital, machinery capital, fertilizers and feed)</td>
<td>positive</td>
<td>USDA</td>
</tr>
<tr>
<td>Research (R1)</td>
<td>Number of researchers (full time equivalent) with official researcher status employed at government, non-profit organizations and higher education agencies.</td>
<td>positive</td>
<td>FAO</td>
</tr>
<tr>
<td>Government Expenditure (Gvtex)</td>
<td>Government expenditure on agriculture as a percentage of total government expenditure</td>
<td>Positive/Negative</td>
<td>ReSakss</td>
</tr>
<tr>
<td>Official Development Assistance (ODA)</td>
<td>Official development assistance flow to agriculture as a share of total</td>
<td>Positive/Negative</td>
<td>FAO</td>
</tr>
<tr>
<td>Trade Openness (Trdshre)</td>
<td>Trade in agriculture as a percentage of total trade</td>
<td>Positive</td>
<td>World Bank</td>
</tr>
</tbody>
</table>

*Source: Researcher Computation*
4 Results Presentation

4.1 Descriptive Statistics

Table 2 gives the summary descriptive statistic of all variables employed in the study.

Table 2 Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observation</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>40</td>
<td>2.23E+09</td>
<td>2.41E+08</td>
<td>1.64E+09</td>
<td>2.66E+09</td>
</tr>
<tr>
<td>ODA_SHARE</td>
<td>40</td>
<td>8.156875</td>
<td>5.507904</td>
<td>1.35</td>
<td>22.99</td>
</tr>
<tr>
<td>Gvtex</td>
<td>40</td>
<td>7.84875</td>
<td>3.415265</td>
<td>2.4</td>
<td>15</td>
</tr>
<tr>
<td>tdshre</td>
<td>40</td>
<td>54.7827</td>
<td>13.71707</td>
<td>34.1139</td>
<td>91.0786</td>
</tr>
<tr>
<td>input_index</td>
<td>38</td>
<td>93.07895</td>
<td>9.248467</td>
<td>75</td>
<td>110</td>
</tr>
<tr>
<td>R1</td>
<td>40</td>
<td>200.3244</td>
<td>43.88637</td>
<td>127.3659</td>
<td>284.9594</td>
</tr>
</tbody>
</table>

Source: Author’s Compilation from STATA Output

Table 2 shows summary statistics for variables under considerations. Of interest is the inconsistencies between agriculture development assistance and agricultural output. In 2004, Zimbabwe had the highest output of $2.7 billion whilst ODA to agriculture was only 6.17%. The data set does not provide evidence to support the widely acknowledged positive relationship between increase in investment and associated increase in output. The highest percentage allocated to agriculture was 23%, received in 1987. The lowest output was realized in 1983, when ODA allocated to agriculture was 15.3%. On the other hand, government expenditure on agriculture reached its maximum of 15% in 2011, which does not correspond to the highest agricultural production. This, in a way suggests that there is no relationship between agriculture investment and agriculture production. Concern can also be put on the number of full time equivalent researchers employed in agriculture. Over the period understudy, the highest number was 285 in 1989 and a minimum in 2007. The next section presents econometric analysis results.

4.2 Unit Root Tests

Table 3 Unit Root Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF Statistic</th>
<th>Stationarity</th>
<th>Phillips-Perron</th>
<th>Stationarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>lgGDP</td>
<td>-4.441***</td>
<td>I(0)</td>
<td>-5.249***</td>
<td>I(0)</td>
</tr>
<tr>
<td>lgInputs</td>
<td>-5.755***</td>
<td>I(1)</td>
<td>-7.106***</td>
<td>I(1)</td>
</tr>
<tr>
<td>lgR1</td>
<td>-1.710**</td>
<td>I(0)</td>
<td>-4.640***</td>
<td>I(1)</td>
</tr>
<tr>
<td>lgODA</td>
<td>-6.235***</td>
<td>I(1)</td>
<td>-3.738**</td>
<td>I(0)</td>
</tr>
<tr>
<td>lgGvtex</td>
<td>-5.356***</td>
<td>I(1)</td>
<td>-7.348***</td>
<td>I(1)</td>
</tr>
<tr>
<td>lgTrdshre</td>
<td>-7.463***</td>
<td>I(1)</td>
<td>-5.115***</td>
<td>I(0)</td>
</tr>
</tbody>
</table>

Critical Values 1% (-4.441); 5% (-1.710); 10% (-3.149)***,** and * denotes 1%, 5% and 1% level of significance respectively

The ADF unit roots show that all variables are stationary after first difference except lgGDP, whilst the Phillip-Perron unit root tests indicates that lgGDP, lgODA and lgTrdshre are stationary at levels. The results authenticate the use of ARDL approach as the variables exhibit mixed order of integration to examine the long-run relationship and the bounds test for co-integration whose results are presented in Table 4.

4.3 Bounds Test for Co-integration

Table 4 displays the results of the Bounds Cointegration test
Table 4: ARDL Bounds Test for Cointegration (Pesaran/Shin/Smith (2001))

<table>
<thead>
<tr>
<th>CALCULATED</th>
<th>STATISTIC</th>
<th>10% CRITICAL VALUE</th>
<th>5% CRITICAL VALUE</th>
<th>1% CRITICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I(0)</td>
<td>I(1)</td>
<td>I(0)</td>
<td>I(1)</td>
</tr>
<tr>
<td>F</td>
<td>364</td>
<td>2.45</td>
<td>3.52</td>
<td>2.86</td>
</tr>
<tr>
<td>t</td>
<td>-4.417</td>
<td>-2.57</td>
<td>-3.66</td>
<td>-2.86</td>
</tr>
</tbody>
</table>

As depicted in table 4, both the F and t statistics are greater than the lower bound I(0) and the upper bound I(1) critical values. Both tests endorse existence of cointegration among variables, and therefore justifies the long-run inference. The long run relationship was tested using the Error Correction Model (ECM). The findings are presented in table 5 and 6.

4.4 Estimation Results and Discussions

Table 5: ARDL (4, 2, 3, 4, 3, and 4) Error Correction Model based on BIC

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Std Error</th>
<th>t-Statistic</th>
<th>Prob</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECT</td>
<td>-2.263</td>
<td>0.246</td>
<td>-9.21</td>
<td>0.000</td>
<td>-2.810 -1.716</td>
</tr>
<tr>
<td>ΔIODA_SHARE</td>
<td>0.029</td>
<td>0.010</td>
<td>2.92</td>
<td>0.015</td>
<td>0.007 0.051</td>
</tr>
<tr>
<td>ΔIR1</td>
<td>0.149</td>
<td>0.041</td>
<td>3.64</td>
<td>0.005</td>
<td>0.058 0.240</td>
</tr>
<tr>
<td>ΔINPUT_INDEX</td>
<td>0.387</td>
<td>0.122</td>
<td>3.16</td>
<td>0.01</td>
<td>0.119 0.660</td>
</tr>
<tr>
<td>ΔGvtex</td>
<td>0.058</td>
<td>0.012</td>
<td>4.73</td>
<td>0.001</td>
<td>0.031 0.085</td>
</tr>
<tr>
<td>Δtrdshre</td>
<td>0.251</td>
<td>0.097</td>
<td>2.58</td>
<td>0.027</td>
<td>0.034 0.468</td>
</tr>
</tbody>
</table>

Observations =36
R² =97.4%
Adjusted R² =90.9%
Log-Likelihood = 88.77
Root MSE =0.039

***,**,* shows level of significance at 1%, 5% and 10%

Table 6 Short Run Estimation Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>D1</th>
<th>LD</th>
<th>L2D</th>
<th>L3D</th>
</tr>
</thead>
<tbody>
<tr>
<td>IY</td>
<td>1.101*** (0.212)</td>
<td>0.778*** (0.173)</td>
<td>0.704*** (0.162)</td>
<td></td>
</tr>
<tr>
<td>IODA_SHARE</td>
<td>-0.042** (0.163)</td>
<td>0.027* (0.153)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR1</td>
<td>0.178 (0.195)</td>
<td>-1.171*** (0.201)</td>
<td>-1.206*** (0.228)</td>
<td></td>
</tr>
<tr>
<td>NInput_Index</td>
<td>-0.510 (0.439)</td>
<td>-0.471 (0.452)</td>
<td>0.177 (0.334)</td>
<td>-0.680 (0.485)</td>
</tr>
<tr>
<td>Gvtex</td>
<td>0.057 (0.039)</td>
<td>0.237*** (0.014)</td>
<td>0.186*** (0.05)</td>
<td></td>
</tr>
<tr>
<td>trdshre</td>
<td>0.4272 (0.184)</td>
<td>0.431 (0.177)</td>
<td>0.650*** (0.134)</td>
<td>0.404*** (0.092)</td>
</tr>
<tr>
<td>Cons</td>
<td>40.3468*** (4.412)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In parenthesis ( ) are standard errors:* , **, *** denote significant at 1%, 5% and 1% statistical significant levels
The results in table 6 depict that all variables, except NInput_Index exerted significant short run influence on agriculture output during the period under review. All lagged values of agriculture output exerted positive effects on agriculture output in Zimbabwe. The slopes of first and second lag of IODA_SHARE (-0.042) were negative and significant at p < 0.05. This implies that in the first lag of ODA flowing to agriculture sector, a 1% change will result in agriculture output declining by 4%. The finding concurs with Ighodaro and Nwagogwugwu (2013)’s
findings, who report a negative relationship between ODA and agriculture output in Nigeria. The negative impact in the short run could be as a result of the time lag that exists between the change in ODA and the response in output. Clemens et al. (2012) put forward the notion that exist different channels through which agriculture ODA can follow. It can either follow an early impact channel where aid is expected to boost productivity within the short to medium term, or follow a late impact channel whose growth effects might be into the future.

The number of full time researchers (lR1) also portrayed a negative influence on agriculture output for both the first and second lags. This results seem to underscore the irrelevancy of research in the Zimbabwean agricultural sector. The negative result could however, be because an investment in research and development will only yield results in the long run. The lagged values of government spending in agriculture showed a positive influence on agriculture output. The coefficients (0.237; 0.186) were both positive and significant at p < 0.01 in the short run, implying that policies that increase government expenditure in agriculture should be adopted as gains are quickly realized. Contrary to expectation, trade in agriculture as a percentage of total trade (ltrdshare) exerts a negative and significant influence on agriculture output, for all lagged values in the short run.

4.4.1 Long run

The error correction term is negative (-2.26) and statistically significant at 1%, implying that the speed of adjustment to agriculture output long run equilibrium following disturbances in the exogenous variables is 226%. This confirms long run association between the independent variables and agriculture output. A high R² of 97.4% signifies high explanatory power, purporting that 97.4% of the variations in agriculture production is explained by the variations in the predictor variables.

The results indicate that both ODA and Gvtxt significantly (1% both) and positively (0.029 and 0.058 respectively) impact on agriculture output. This implies that a 1% increase in the two results in 0.02% and 0.06% in agriculture production, respectively. The findings seem to support Ssozi et al. (2018)’s result, claiming ODA as an enabler of agricultural output growth. ODA not only boosts local sources of finance but increases investment in human and capital investment; ability to import technology and capital goods, thus increasing endogenous technical change (Alimu and Lee, 2015).

The findings suit the Zimbabwean context, as it is an agriculture development centred country, mainly characterised by small-holder production structure, operating well below production capacity. Agriculture is key in providing livelihood to about 70% of the population, contributing 15-20% of national output, 40% of exports and provides 63% of agro-industrial raw materials (GOZ, 2018). After experiencing a series of turmoil over the past 20 years, production was heavily depressed. The country is therefore concerned with promoting economic growth (Benites et al. 2018), which is heavily dependent on agriculture production and productivity. Significant amount of resources need to be mobilized towards agricultural investments, through the adoption 10% budgetary goal spelt out in the Maputo declaration.


Estimations on secondary explanatory variables provided the expected results. The number of equivalent full time researchers was found to exert a statistically significant (0.01) positive (0.387) influence on agriculture output, implying that investment in research and development facilitates use of efficient technologies and skills that generates quantum leap in agriculture output level in Zimbabwe in the long run. As expected, input index picked a statistically significant (0.01) expected positive coefficient (0.387). Finally, agriculture trade share is also positive (0.25) and highly significant (5%). Findings concur to Dobre (2008) and Alemu and Lee (2015), who claim that the flow of aid is promoted by openness to trade. In this regard, trade policies play an important role in promoting ODA which is vital in supplementing domestic resources desired to enhance agriculture output.
5 Conclusion

This study is an empirical investigation of the impact of official development assistance to the Zimbabwean agriculture sector production for the period 1980-2019. Despite the steady flow of agriculture ODA to Zimbabwe, agriculture output varies widely during the period under study. The study is based on the notion that official assistance channelled to productive and growth enhancing sectors of the economy will stimulate economic growth of the nation. The significance of the agriculture sector in addressing key issues within the 17 SDGs has been widely acknowledged, therefore, the sector is crucial in employment creation, raising per capita income and eradicating poverty in Zimbabwe. Nonetheless, no empirical attempt has been made to test the effects of the sector in Zimbabwe. Therefore, the study disaggregates and compares the effects of official development assistance and government expenditure on agriculture on output in Zimbabwe.

Applying the Auto-Regressive Distributed Lag (ARDL) estimation technique on a time series model derived from Solow's (1956) growth model, results show that both official development assistance and government spending on agriculture have significantly positive output growth effects. Furthermore, an ARDL Bound Tests for cointegration confirmed the existence of a long run relationship in the model under study. Findings suggest that both development partners and the government should consider increasing investment in agriculture so as to improve agriculture production and the aggregate economy. The study recommends that Zimbabwe should adopt policies and institutional reforms that create a viable environment for agriculture so as attract donor funding. The government should prioritize to meet the 10% budget goal which is in line with the Maputo declaration so to increase government spending on agriculture, key in stimulating agriculture growth.

References

41. World Bank (2021). World Development Indicators, Zimbabwe