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# The Nexus between Government Spending and Agricultural Output: Evidence from Zimbabwe

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**Abstract**

**Purpose:** This study aims to examine the relationship between government spending and agricultural output in Zimbabwe, while also evaluating the effects of macroeconomic variables such as inflation, carbon emissions, rainfall, population growth, and temperature on agricultural output.

**Methods:** The Autoregressive Distributed Lag (ARDL) model was employed using time-series data from 1980 to 2022. Data were sourced from the World Bank and the IMF. Diagnostic tests, including stationarity checks, cointegration analysis, and stability assessments (CUSUM and CUSUMSQ), were conducted to ensure the robustness of the model.

**Results:** The findings reveal significant short- and long-run relationships between government spending and agricultural output. Government expenditure, rainfall, and population positively influenced agricultural productivity, whereas inflation and carbon emissions had a negative effect. The ARDL model explains 95% of the variation in agricultural output, indicating a strong model fit and predictive power.

**Conclusion:** The Autoregressive Distributed Lag (ARDL) model demonstrated a positive relationship between government spending and agricultural output in both the short and long terms. Based on the results, the study concluded that sustained government support through subsidies, grants, and other resources has the potential to enhance agricultural productivity in Zimbabwe over time.

**Limitations:** The study is limited by the availability and quality of historical data, which may constrain the precision of certain estimates.

**Contributions:** This research assists the Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development in developing targeted interventions to enhance the performance and resilience of Zimbabwe's farmers and agribusinesses. The findings can help the Reserve Bank of Zimbabwe align its policies with the evolving needs of farmers, especially post-COVID-19 and amid the Russia-Ukraine conflict.

**Keywords:** *Agricultural Output, ARDL Model, Macroeconomic Variables and FAO, Public Expenditure, Zimbabwe.*

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## 1. Introduction

The value of agricultural production is vital for assessing the agricultural sector's health compared with other economic sectors (FAO, 2017). It is over two years now since the novel global pandemic ravaged the World and people have been eager to not only return to normalcy but also to thrive (Chika, Oshiogwemoh, & Promise, 2022). Agricultural exports are regarded as the backbone of the Zimbabwean economy and significantly contribute to a country's fiscal output, infrastructure development, and GDP (Hasanov, 2023). However, Smith (2019) and Mujahid, Begum, and Noman (2016) pointed out that even though exports of natural resources is essential in most countries, they cannot help economies gain stabilization due to global commodities price fluctuations. The relationship between government spending and agricultural performance is a complex one. The Keynesian hypothesis suggests that government investment can stimulate agricultural sector growth, with Babatunde (2018) noting that such spending primarily aims to boost the agricultural output. However, Mishra, Behera, and Behera (2023) highlighted that reliance on government spending in emerging nations such as Zimbabwe can lead to inefficiencies and dependency, hindering sustainable growth. In Zimbabwe, agriculture accounts for over 7.19% of the GDP (Manzeke-Kangara et al., 2024). Despite its importance, agricultural growth remains sluggish because of inadequate government funding, severe droughts, and cyclones. Therefore, this study investigates the nature of the relationship between government spending and agricultural output in Zimbabwe.

According to Dube (2021), the government of Zimbabwe has increased spending to combat poverty and food insecurity, with nearly half the population facing food shortages. The country’s agricultural landscape includes small-scale subsistence farms and large agribusinesses. These smallholder farmers have received government support through extension services and credit access, exemplified by the establishment of the AFC bank in 1981 (Bvumbi, 2017; Matandare, 2017). Input subsidy programs, such as the Grain Marketing Board initiative, have also helped improve access to agricultural inputs (Moyo, 2011). The 1980s saw notable increases in tobacco and maize production owing to these efforts (Latief & Zhang, 2024). However, government support fluctuated due to Economic Structural Adjustment Programs (ESAPs), which reduced public investment and emphasized privatization, ultimately harming agricultural productivity (Moyo, 2011). The fast-track land reform program initiated in 2000, aimed at increasing black land ownership, also contributed to the collapse of commercial agriculture and significant food shortages (Musonza & Hlungwani, 2024; Runganga & Mhaka, 2021). In response to declining agricultural output, the Zimbabwean government introduced the Command Agriculture Program in 2016, focusing on targeted funding and technical support for key crops.

The Agricultural Input and Finance Company (AIFCO) was established in 2021 to facilitate access to inputs and financing ( Dube, 2021). The National Development Strategy 1 (NDS1), launched in 2021, outlines plans for infrastructure development and climate resilience to boost productivity and food security. Despite these initiatives, challenges such as limited financing and bureaucratic inefficiencies persist in the sector. Musonza and Hlungwani (2024) and Setoboli, Tshuma, and Sibanda (2024) note that the government continues to invest in agriculture due to its critical role in economic growth. Muwaniki, Wedekind, and McGrath (2024) emphasized the government's commitment to supporting smallholder farmers, particularly through climate-smart practices. The strategy has evolved to focus on both commercial and smallholder farmers, enhancing agricultural infrastructure and ensuring food security in changing political and economic contexts of the country. Implementing meaningful decisions correctly is essential for achieving investment objectives, whereas incorrect decisions can lead to investment failure (Triadji, Busnetty, & Sihombing, 2024). Thus, there is a need to examine the ongoing government spending on agricultural output. Figure 1 shows the trend in government expenditure and agricultural output from 1980 to 2022.

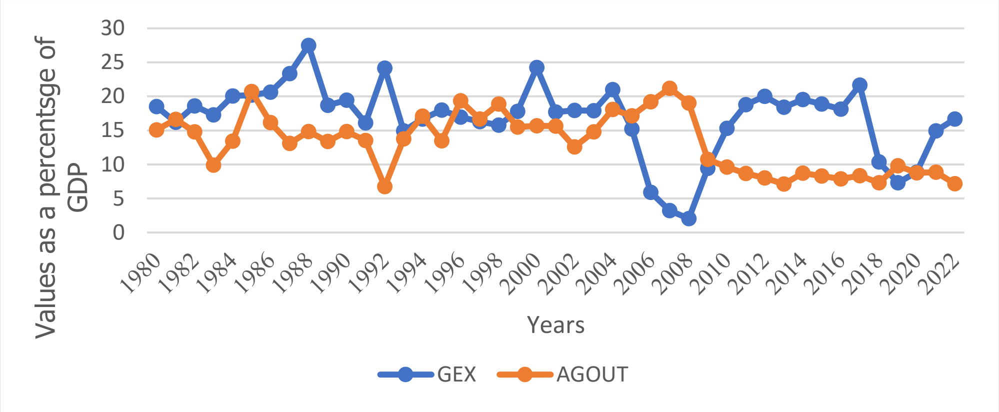


Figure 1: Zimbabwe government spending and agriculture output (1980-2022)
Source: Own Graph with Figures from World Bank

From Figure1, government spending on agriculture rose sharply, peaking in the mid-1980s at approximately 28% of GDP. The government's initiatives were successful in increasing productivity and growth in the agricultural sector, as evidenced by the rise in agricultural output of approximately 16%. The government's strategy changed in the 1990s when it introduced reforms focused on the market through the Economic Structural Adjustment Program (ESAP). Government spending on agriculture and agriculture output decreased throughout, reaching 18% and 13% of GDP in 1995, respectively. Zimbabwe experienced a severe economic crisis from the early 2000 to 2008 as a result of hyperinflation, which negatively impacted both government spending and agricultural productivity. The agricultural sector suffered and saw a substantial decrease in output as government spending on agriculture fell dramatically to a low of about 2% of GDP, and agricultural output continued to fluctuate. The formation of the Government of National Unity (GNU) in 2009 resulted in measures to stimulate the development of the agriculture sector. The government invested in revitalizing the agricultural extension system, supplying farmers with inputs, and repairing irrigation systems. Government spending increased up to 2017, but agricultural output continued to decrease from 10% to 7% during the same period.

Nevertheless, the graph indicates a decline in agricultural output from 2017 to 2022, which accounted for 7% in 2022, even with rising government spending. This could be due to the economic sanctions imposed by different international organizations, which have made it more difficult for the nation to obtain the capital, resources, and technology required for developing agriculture. Moreover, the COVID-19 outbreak has hampered farmers' access to markets, upended international supply networks, and reduced the cost and availability of agricultural inputs, all of which have contributed to the fall in agricultural output. Recent ELNINO, extreme droughts, and flooding have negatively affected agricultural output and productivity. Although the government has implemented several interventions and support programs targeted to increase agricultural productivity, especially for smallholder farmers, the results of these initiatives are still unknown, and it is unclear how government spending on agriculture relates to actual agricultural output. Despite notable and substantial government spending on agriculture, the country is among the emerging nations with low agricultural output. Of particular interest is the decrease in agricultural output since 2019, as shown in Figure 1. However, as Figure 1 illustrates, government spending has been rising during the same period (from 2019 to date). Such observations raise doubts and uncertainties about the contribution of government spending to boosting agricultural output. Thus, this study aims to determine the immediate and remote causes of this mismatch by evaluating the relationship between government spending and agricultural output in Zimbabwe from 1980 to 2022.The study will be guided by the hypothesis that government spending has no impact on agricultural output in Zimbabwe, or government spending has an impact on agricultural output in Zimbabwe.

***Research gap***
A significant research gap exists in understanding the specific mechanisms through which government spending translates into tangible gains in agricultural output, productivity, and income. The existing literature often overlooks the specific mechanisms by which public expenditure affects various segments of the agricultural value chain. Notably, previous studies have emphasized aggregate economic impacts rather than delving into nuanced influences on agricultural sectors, particularly in the context of Zimbabwe's fluctuating funding and productivity challenges. This raises important questions about the effectiveness and efficiency of the government's spending priorities and the extent to which these investments translate into tangible improvements in agricultural performance and rural livelihoods. It is important to highlight that Zimbabwe's agricultural sector is being narrowly focused on a number of issues, from the point of production to the point of marketing. These issues have been primarily caused by past policy missteps, which have led to the sector's subpar performance.

Over time, the sector's inadequate funding framework has worsened the situation. While there have been reports that funding for agriculture has recently increased across several government departments, there has not been a corresponding growth in output. This study aims to fill this gap by employing the Autoregressive Distributed Lag (ARDL) model to uniquely examine both the short-run and long-run impacts of government spending, alongside other critical macroeconomic variables, on agricultural output. The ARDL model's ability to handle variables with mixed orders of integration and its suitability for analyzing short- and long-term relationships in a dynamic framework make it particularly well-suited to address the identified research gap. This study is different from others because it examines how government spending affects certain sectors of the economy, such as the agriculture sector, as opposed to the whole economy. The remainder of the review is structured as follows: a theoretical and empirical literature review linking the topic is presented in the following section. The study methodology is outlined in Section 3, with a focus on the necessary diagnostic tests. The diagnostic test results and policy recommendations are provided in Section 4.

## 2. Literature review
The literature on the relationship between government spending and agricultural output presents varied views. Existing theories include the Wagner (1958) hypothesis and Musgrave (1969) theory, among others. Empirical evidence supports and refutes these theories. These are summarized below.

### *2.1 Theoretical Framework*
Wagner (1958) suggests that public spending is an endogenous variable that acts as an economic stimulant rather than a driver of growth. Furthermore, Wagner (1958) suggested that, contrary to the Keynesian theory, the causal relationship between public spending and economic growth runs from economic growth to public spending. This means that during economic development, the rate of public spending increases faster than the rate of economic growth. This theory agrees with Lencucha, Pal, Appau, Thow, and Drope (2020), who argue that strengthening the agricultural sector and its contribution to economic growth requires appropriate measures, in light of this research and with the understanding that sectoral expansion contributes to the overall growth of an economy, such as public spending, which is made possible by fiscal policy. Raising government spending on significant economic areas, such as agriculture, eventually boosts the economy and creates more jobs. According to the Keynesian school of thought, there is general agreement that government spending plays a substantial role in supporting economic growth, which leads to the demand for higher government spending (Dynan & Sheiner, 2018).

The allocation, distribution, and stability responsibilities of the government are highlighted in Musgrave's (1969) theory of public finance, which offers a helpful framework for comprehending how government spending affects agricultural output, especially in countries like Zimbabwe. Infrastructure is a priority for the government because it increases agricultural productivity. This can improve the overall efficiency of the agricultural supply chain and facilitate access to markets. Government support for agricultural research and extension services, as noted by Hasanov (2023), can leverage development through enhanced crop varieties and farming practices. According to Musgrave's theory, government spending can also aid in resource redistribution to assist smallholder farmers, who frequently do not have access to financing or contemporary agricultural inputs. Programs that offer low-interest loans, grants, or subsidies help empower farmers and boost food security and production. According to Ewubare and Udo (2017), who supported this theory, agricultural output is frequently vulnerable to shocks from pests, market volatility, and climate change. Consequently, government spending can be allocated toward disaster relief and recovery programs to assist farmers in times of need, stabilize production levels, and safeguard livelihoods. Counter-cyclical fiscal policies can be used to support the agricultural sector during downturns to ensure that investment in agriculture continues even in the face of negative economic conditions (Anoke, Odo, Chukwu, & Agbi, 2016). This is especially crucial in Zimbabwe, where agricultural productivity has historically been affected by economic instability.

*2.1.1 Empirical Studies*

Most studies conducted in Zimbabwe, for example, Runganga and Mhaka (2021) and Mapfumo et al. (2012), focus on the impact of government agricultural spending on poverty and economic growth. A related study is that of Makamba (2021), who examined the impact of agricultural development assistance (ODA) on agricultural production in Zimbabwe from 1980 to 2019. Using the ARDL estimation technique, this study found that both ODA and government spending on agriculture have significantly positive output growth effects. Kadir and Tunggal (2015) investigated the effects of macroeconomic factors on agricultural productivity in Malaysia using time-series data from 1980 to 2014. They employed the ARDL model to analyze the data, and the results showed that increased government spending, exports, and money supply led to improved agricultural productivity, while the exchange rate and inflation reduced agricultural productivity. Using the same method (ARDL approach), Uzaifa (2024) and Olubokun, Ayooluwade, and Fawehinmi (2016) analyzed government spending and growth variables in Ethiopia with data spanning from 1983 to 2019. These studies reveal that government spending in Ethiopia is significant in promoting economic growth.

Chandio, Yuansheng, and Magsi (2016) used time-series data to examine how government spending affected Pakistan's agriculture sector and economic growth from 1983 to 2011. The present study employed analytical data analysis techniques, namely the ordinary least squares (OLS) approach, Johansen Co-integration test, and augmented Dickey-Fuller (ADF) unit root test. The Johansen cointegration test results indicate a long-term correlation between Pakistan's economic growth, agricultural development, and government spending on agriculture. However, the regression analysis findings demonstrated that the economic development of Pakistan is significantly influenced by both government spending and agricultural output. Using the same method, Matthew and Mordecai (2016), together with the Error Correction Method (ECM) and Granger Causality test, revealed a long-term relationship between agricultural production, public agricultural expenditure, agricultural sector commercial bank loans, and interest rates in Nigeria. The parsimonious error correction model (ECM) results showed that public agricultural spending has a major negative impact on agricultural production, while agricultural sector commercial bank loans and interest rates have marginal positive effects on agricultural output in Nigeria.

Ewubare and Udo (2017) examined the impact of public sector financing on agricultural output in Nigeria between 1980 and 2014. Through the application of Johansen co-integration and error correction model approaches, they ascertain that agricultural output during this era was substantially impacted by public sector financing. To achieve sustained economic growth, the report suggests that government expenditure is important for agricultural output; hence, the government should expand its spending in the agriculture sector. However, Okunlola, Osuma, and Omankhanlen (2019) used the ARDL approach to investigate the association between agricultural finance and economic growth in Nigeria. Findings from both short-run and long-run models are confirmed by the Wald test, which shows that none of the guaranteed agricultural finance is statistically significant to real gross domestic product. Therefore, this study recommends increased funding and deliberate efforts to determine which of the nominated agricultural spending has the most contributory impact on growth.

Bathla (2017) analyzed time-series data from 17 major states between 1981 and 2014 to examine the empirical relationship between public agricultural spending and agricultural growth in India. He utilized ordinary least squares (OLS) and generalized methods of moments (GMM) techniques. The results indicate that low and inadequate public capital formation negatively impacts farmers' investments, hindering technological advancement and agricultural growth in the region. Using the same method, Ogboru, Abdulmalik, and Park (2018) investigate the effects of government spending on agriculture in Nigeria from 1999 to 2015. The study found that both government recurrent and capital expenditures had positive effects, but the relationships with unemployment rates were insignificant. Meanwhile, GDP exhibited a negative and significant relationship with unemployment rates in Nigeria, suggesting that government spending on agriculture does not significantly reduce unemployment, indicating no directional relationship between agricultural expenditure and unemployment. Aragie and Balié (2021) analyzed the influence of public spending on agricultural productivity in India using an economy-wide general equilibrium model calibrated to a detailed social accounting matrix from 2010. Their findings demonstrate that overall public spending has a positive and significant relationship with agricultural production. These benefits are particularly pronounced in rural households, highlighting the positive role of such spending in enhancing food security and reducing poverty. Their comparison of policy efficiencies revealed that supporting farmers through input subsidies is the most effective approach in terms of output.

Chamba and Tarirai (2024) investigated the effectiveness of agricultural financing in enhancing agricultural production in Zimbabwe. The study used the Autoregressive Distributed Lag (ARDL) model to analyze the short- and long-term relationships among agricultural output, agricultural loans, foreign direct investment (FDI), and domestic agricultural capital. The findings indicate a robust positive correlation between agricultural loans and output. Increased access to financing enables farmers to invest in inputs, machinery, and technology, leading to significant increases in productivity. While FDI has the potential to introduce advanced technologies and capital, the findings suggest a non-significant direct impact on production. However, it may indirectly contribute to improved infrastructure and market access. Additionally, the study confirms a significant positive link between domestic agricultural capital and agricultural production. Sufficient availability of capital for land improvement, irrigation, and modern techniques is strongly linked to increased production. This emphasizes the need for strategic investments and supportive infrastructure to maximize the benefits of FDI.

## 3. Research Method

The current study makes use of Autoregressive Distributed Lag (ARDL) cointegration technique, which was proposed by Pesaran, Shin, and Smith (2001); Pesaran, Shin, and Smith (1999). Compared to other approaches, the ARDL model offers greater versatility because it is an OLS-based method that can handle variables with mixed orders of integration, I (0) and I (1)). The ARDL model is a dynamic model that assumes that the dependent variable is a function of both its own lags and the past and present values of the independent variables. The ARDL approach is thought to be more suitable when working with small sample sizes and a single long-run relationship between the variables (Shrestha & Bhatta, 2018). The strength of the ARDL model lies in its capacity to represent both short- and long-term interactions between agricultural output and government spending. The ARDL framework offers a more comprehensive explanation by integrating the lagged values of the explanatory and dependent variables. This econometric technique is used because of its simplicity and relevance in time-series data, as well as its ability to confirm stationary and long-run and short-run relationships among variables (Ahmad & Dahalan, 2020). This study follow Peacock and Wiseman version and Muhammad, Egwaikhide, and Alexander (2020) and modified it to suit the current study as follows:

$$\Delta Y_t = \alpha_{0t} + \sum_{i=1}^{p} \delta_1 \Delta Y_{t-i} + \sum_{i=0}^{q} \beta_t' X_{t-1} + \varepsilon_{it}$$

From the above multiple ARDL regression model, Y represent Agricultural output (AGOUT) treated as the dependent variable, X represent , GEX, Infl, Temp, Rainf, Pop and CO2 which stands for, Government spending, Inflation measured using CPI, Temperature, rainfall, Population and Carbon emission respectively being treated as explanatory variables and $\mu$ represent white noise.$\Delta\, in$: Represents the change in the natural logarithm of the variable. $\beta$ measures the parameters for the change terms. $\gamma$ is the parameter for the levels of the variables and m is the number of lags considered in the model.

### *3.1 Data Sources*

Secondary data from the World Bank and IMF were used in this study, and the accessibility of data in this period and the significance of the sample size, in accordance with Gujarati and Porter (2012), paved the way for the determination of this period.

### *3.2 Post diagnostic test*

According to Brooks (2019) and Kondo and Mutsvangwa (2025), one should perform diagnostic tests to ensure that data are available that meet the assumptions of the selected parameter estimation process, such as the Gauss Markov assumptions when using OLS, before evaluating the results. If these presumptions are not met, the researcher must choose an alternative assessment approach without stringent requirements. Traditional and necessary data analysis tests, including those for unit root, heteroscedasticity, autocorrelation, normality, stability tests, and model specifications, will be performed. Assuming that at least one variable is not stationary at I (0), a cointegration test utilizing the Auto Regressive Distributed Lag (ARDL) bound test model will be employed as recommended by Pesaran et al. (2001).

## 4. Results and discussions

The ARDL econometric model and diagnostic test are presented and logically examined in this section, building on the methods covered in Section 3. The required pre- and post-regression estimation tests were completed in compliance with the guidelines provided by Diebold (2017) and Enders (2015), and the outcomes were presented logically.

### *4.1 Descriptive statistics*

To understand the nature of the data on agricultural output, government spending, inflation, carbon emissions, temperature, rainfall, and population, this study used descriptive statistics on the collected data.

Table 1. Descriptive statistics

| | AGR OUTPUT | INF | GVT EXP | CO2 | TEM | RAINF | POP |
|---|---|---|---|---|---|---|---|
| Mean | 2.04 | 9158.53 | 15.75 | 12355.45 | 658.06 | 639.18 | 85.72 |
| Median | 1.99 | 27.60 | 16.94 | 11988.70 | 657.00 | 649.12 | 81.47 |
| Maximum | 3.38 | 231501 | 24.27 | 18469.60 | 692.00 | 875.65 | 11.03 |
| Minimum | 1.02 | 7.95 | 2.05 | 7572.70 | 657.00 | 429.72 | 71.82 |
| Std. Dev. | 5.45 | 41537.50 | 5.42 | 2947.06 | 6.09 | 121.57 | 11.40 |
| Skewness | 0.39 | 4.94 | -0.98 | 0.44 | 5.48 | 0.09 | 0.79 |
| Kurtosis | 2.74 | 26.57 | 3.45 | 2.35 | 31.03 | 2.43 | 2.34 |
| Jarque-Bera | 0.95 | 898.32 | 5.61 | 1.65 | 1245.58 | 0.49 | 4.01 |
| Probability | 0.06 | 0.00 | 0.06 | 0.04 | 0.00 | 0.05 | 0.01 |
| Observations | 33 | 33 | 33 | 33 | 33 | 33 | 33 |

Table 1 presents the mean values for population, government spending (GVT EXP), and agricultural output as 2.04, 15.75, and 85.72, respectively. In contrast, the mean values for rainfall, temperature, carbon emissions and inflation exceeded 500. Among these, inflation is the most volatile, with a standard deviation of 41,537.5, whereas agricultural output exhibits the least volatility at 5.45. The skewness statistics indicate that government spending is negatively skewed, suggesting insufficient support from the Zimbabwean government for the agricultural sector. Conversely, population, temperature, rainfall, carbon emissions, inflation, and agricultural output showed positive skewness. The kurtosis results reveal that population, rainfall, carbon emissions, and agricultural output are leptokurtic, indicating a flatter distribution than a normal distribution. In contrast, temperature and government spending are leptokurtic, reflecting a more peaked distribution than normal. The kurtosis of inflation is monotokurtic, suggesting that it follows a normal distribution with a bell-shaped curve. Additionally, the Jarque-Bera statistic indicates that the null hypothesis of normal distribution is rejected for all variables at the 5% significance level.

### *4.2 Unit root test*

According to Gujarati and Porter (2012), all variables should be evaluated for stationarity to prevent spurious results.

Table 2. Unit Root Test Results.

| Variable | ADF Test Statistic | Critical value at 5% level | Probability value | Order of integration |
|---|---|---|---|---|
| Agric output | -5.7677 | -1.9520 | 0.0000 | I (1) |
| Gvt exp | -5.6733 | -1.9520 | 0.0000 | I (1) |
| Pop | -4.1027 | -2.9639 | 0.0034 | I (1) |
| Infla | -4.3436 | -2.9571 | 0.0017 | I (0) |
| Rainf | -4.8890 | -2.9571 | 0.0004 | I (0) |
| Temp | -5.6568 | -2.9571 | 0.0000 | I (0) |
| Co2 | -5.5708 | -2.9604 | 0.0001 | I (1) |

The results of the Unit Root tests for the variables under study are shown in Table 2. The data indicate that each variable, I (0) and I (1), is steady at a separate level. It follows that every variable is mean-reverting over time. The variables must be tested for cointegration because there is a variation in the order of integration (Enders 2015).

### *4.3 Cointergration*

The researcher can test for a long-run relationship between agricultural output, government spending, and other explanatory variables because there are no I (2) variables in the model. The researcher employed Pesaran tables in conjunction with the ARDL bound test approach (Pesaran et al., 2001). To determine if there is a long-term link among variables, the values of the upper and lower bound are fundamental. Unlike Shiyalini and Bhavan (2021), which require all variables to be integrated at the same order, the ARDL bounds test can be applied irrespective of whether the variables are I(0), I(1), or a combination of both. Table 3 presents the results of the ARDL Bounds Test for co-integration.

Table 3. Cointegrations Results.

| Test Statistics | Values | K |
|---|---|---|
| F- Test Statistics | 15.27218 | 6 |
| Significance | Lower bound | Upper bound |
| 5% | 2.27 | 3.28 |

The scholar received positive results on the ARDL bound test, as shown in Table 3. The number of independent variables (regressors) in the model is indicated by variable K. At the 5% significance level, the F-statistic is greater than the upper and lower bound values, indicating that the variables under investigation are related to each other.

### *4.4 Post Diagnostic test*

Whenever the Autoregressive Distributed Lag (ARDL) technique is used, it is important to conduct a series of diagnostic tests to ensure the reliability and validity of the results. Meintanis, Ngatchou-Wandji, and Allison (2018) stressed the significance of ensuring that the residuals from vector autoregressive models are distributed randomly throughout the dataset; as a result, the study concludes that serial correlation is absent. The results from homoscedasticity indicated that the model residuals had a similar distribution, and the Ramsey Reset test results concluded that the model was correctly specified.

Table 4. Post-diagnostic test results.

| Diagnostic test | P-value | F-statistics |
|---|---|---|
| Godfrey LM test | 0.1007 | 48.8176 |
| Pagan-Godfrey test | 0.9535 | 0.3281 |
| Ramsey RESET test | 0.3222 | 0.5463 |

Source; Authors own computation

### *4.5 Lag Length Criteria*

Using three different information criteria, this study establishes the proper lag time for the ARDL model.

Table 5. Lag Length Criteria Test Results.

| Lag | AIC | SC | HQ |
|---|---|---|---|
| 0 | 139.6554 | 139.9854 | 139.7588 |
| 1 | 130.5792 | 133.2195 | 131.4061 |
| 2 | 127.4417 | 132.3922 | 128.9921 |
| 3 | 118.1136 | 125.3744 | 120.3876 |
| 4 | -196.9737* | -187.4027* | -193.9762* |

Table 5 presents the results of the ARDL lag length selection process. The Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ) are presented in the table. For the ARDL analysis, it is essential to determine the appropriate lag length before estimating the multi-equation system. Following the guideline that the optimal lag length is identified by the lowest values across most information criteria, the study concluded that a lag length of four was optimal for the ARDL model.

### *4.6 Stability Test*

To evaluate the stability of the model, the current study utilized the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests, as recommended by Pesaran et al. (1999). Figures 2 and 3 display the plots of the CUSUM and CUSUMSQ tests, respectively. In both Figure 2and 3, the plotted values remain within the critical boundaries at the 5% significance level, indicating that the coefficients are stable over time. After conducting various diagnostic tests, stability checks further validated the adequacy of the ARDL model. This confirms that the long-run and short-run coefficients effectively influence agricultural output, reinforcing the model's reliability and robustness. In addition to passing various diagnostic tests, the stability checks further affirmed the adequacy of the ARDL model, confirming that the long- and short-run coefficients significantly impact agricultural output, thus enhancing the model's reliability and effectiveness.

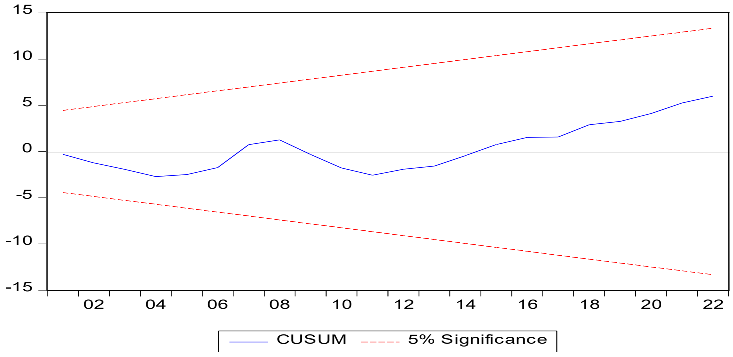

Figure 2. CUSUM Test Results

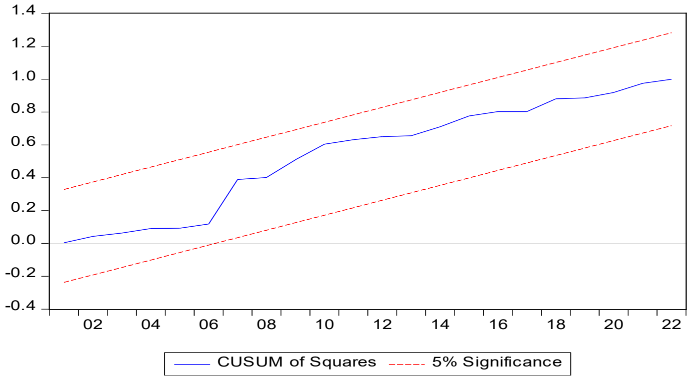

Figure 3. CUSUM of Squares Test Results

### *4.7 ARDL Results*

The results of the ARDL model address the objective of examining the relationships between agricultural output, government spending, and the other variables under investigation. Table 4.7 presents the findings of the ARDL model analysis.

Table 6. ARDL Results

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| | Short run Equation | | | |
| D(EX) | 2.0793 | 5.29985 | 0.0000 | 0.0000 |
| D(EX(-1)) | 1.8060 | 5.7615 | 0.0000 | 0.0000 |
| D(CO2) | -6.6381.8901 | 2.0660.6442 | 3.2129 | 0.0048 |
| D(CO2(-1)) | -9.3282.9125 | 1.8480.9701 | -5.0475 | 0.0001 |
| D(RAINF) | 1.0693 | 1.66666.7635 | 6.4160 | 0.0000 |
| CointEq(-1)* | -0.2994 | 0.0373 | -8.0137 | 0.0000 |
| | Long Run Equation | | | |
| EX | 6.7174 | 3.9527 | -1.6994 | 0.1065 |
| CO2 | -2.97086.1841 | 7.5046.6373 | 3.9586 | 0.0009 |
| INF | -8.183.1043 | 3.691.1951 | -2.2169 | 0.0397 |
| POP | 3.26.7485 | 1.42.0406 | 2.3003 | 0.0336 |
| RAINF | 4.9207 | 1.4033 | 3.5065 | 0.0025 |
| TEM | 2.3455 | 2.0697 | 1.1332 | 0.272 |
| C | -2.1910 | 1.3710 | -1.5989 | 0.1272 |

| | |
|---|---|
| R-squared | 0.9538 |
| Adjusted R-squared | 0.9231 |
| F-statistic | 31.020 |
| Prob(F-statistic) | 0.0000 |

Durbin-Watson stat 2.2650

The analysis shows that 95% of the variation in agricultural output can be explained by the combined effects of the independent variables, as indicated by the R-squared value. The F-statistic of 31.0209 confirms the statistical significance of these variables at the 5% level, suggesting that they meaningfully contribute to changes in agricultural output during the study period. The Durbin-Watson statistic of 2.27 indicates a moderate level of autocorrelation, while the serial correlation LM test confirms the absence of autocorrelation in the model. Additionally, there is evidence of both short-run and long-run relationships among the variables, with a short-run adjustment speed of 29.9%.

The results indicate that lagged government spending positively influences current agricultural output in the short run, supported by the ARDL results, which confirm that past spending impacts present outcomes. Investments in research and development promote innovative farming practices, enhance crop yields, and create an enabling environment for agricultural growth in Zimbabwe (Anderu & Omotayo, 2020). This aligns with Wagner's Law, which posits that increasing agricultural output typically leads to higher government investment in the sector, including infrastructure funding and subsidies. Anderu and Omotayo (2020) further support this by noting that financial assistance, such as subsidies, helps reduce production costs, particularly for smallholder farmers with limited access to credit. Favorable policies that stabilize prices also encourage investments. Conversely, carbon emissions negatively affect agricultural output both currently and in the lagged periods. Significant coefficients (below 0.05) indicate that emissions contribute to climate change, resulting in unpredictable weather patterns and increased vulnerability for farmers (Zhu and Huo, 2022). Long-run analyses have shown that elevated carbon levels disrupt crop growth cycles and increase pest prevalence (Sibanda & Ndlela, 2020). Rainfall positively influenced agricultural output in both the short and long run, with the Wald test confirming its critical role in ensuring adequate soil moisture for crops. This finding aligns with Ciccone and Ismailov (2022), who emphasized that sufficient rainfall prevents drought stress (Bhanumurthy and Kumar, 2018) and enhances soil health, contributing to productivity. Inflation negatively correlates with agricultural output, with long-run significance, indicating that rising inflation adversely affects productivity. This is consistent with the Phillips curve theory, which suggests an inverse relationship between inflation and output (McLeay and Tenreyro, 2020). High inflation reduces consumer purchasing power and decreases aggregate demand and agricultural activity (Mekonen, 2020). There is a positive long-run relationship between population growth and agricultural output, with significant statistical results. A growing population increases food demand, prompting farmers to enhance their production and invest in better practices. Hayami and Ruttan (2020) note that a larger population can provide a more abundant labor force, which is crucial for increasing efficiency in labor-intensive sectors and facilitating diversification into various crops and livestock.

## 5. Conclusion

This study's main goal was to close the knowledge gap on the connection and causation between Zimbabwe's agricultural output and government expenditure. Furthermore, this study examined how temperature, population, rainfall, inflation, carbon emissions, and inflation affect agricultural output. A thorough examination of the theoretical and empirical literature was conducted to determine the relationships between these variables. The objectives of the review were achieved through the application of the Autoregressive Distributed Lag (ARDL) model, which demonstrated a positive relationship between government spending and agricultural output in both the short and long terms. The researcher is encouraged by the findings, particularly considering that since Zimbabwe gained independence, various programs have been launched to support the agricultural sector. These results suggest that sustained government support through subsidies, grants, and other resources can enhance agricultural productivity in Zimbabwe over time. Additionally, the study found that other factors, such as rainfall, population growth, carbon emissions, and inflation, exhibited varying effects on agricultural output during the analyzed period. Beyond these key government institutions, the findings of this study will help international development agencies, non-governmental organizations, and private sector stakeholders operating in Zimbabwe's agricultural ecosystem design and implement collaborative development programs, investment strategies, and public-private partnerships aimed at strengthening the sector's performance and resilience.

### *5.1 Policy and Practical Implications*

This study highlights the value of expenditures in research and development by demonstrating how past government funding positively impacts current agricultural productivity. Increased agricultural yields result from these investments' facilitating the adoption of creative farming techniques. Government spending helps improve agricultural productivity by fostering an environment that supports the use of modern techniques by farmers. This is in line with the tenets of Education 5.0, which supports innovation and practical skills in agriculture to develop a workforce with the knowledge to propel economic growth. The results emphasize the importance of incorporating climate education into agricultural curricula so that aspiring farmers are prepared to adjust to shifting climatic conditions and lessen their carbon impact. Understanding the importance of rainfall patterns can assist farmers in making informed choices regarding crop selection and management practices. This knowledge is crucial for promoting resilience in agricultural systems, aligning with Education 5.0's focus on sustainability and environmental stewardship. Therefore, this will support the Economic Growth and Stability priority area of the National Development Strategy (NDS2) and Vision 2030 of Middle Income Status targeted by the Republic of Zimbabwe.

Therefore, the study recommends that the government collaborate with commercial banks to facilitate the mobilization of affordable and long-term lines of credit from both domestic and international markets. This promotes private sector participation in funding agriculture, including joint agribusiness ventures with local and international partners. This will increase the capacity to improve the relevance of loan product designs and financial packages for the agricultural sector. Capacitating and enhancing skills for public and private sector players to sustainably enhance Agricultural Value Chain performance. Such collaboration can create a supportive financial ecosystem that empowers the agricultural sector, leading to enhanced economic performance and improved livelihoods for communities.

The government can promote the creation of strong input distribution networks by providing more funding to input distributors, such as chain leaders, local traders, and agrodealers. This will ensure that farmers have timely access to essential supplies, improving agricultural productivity, enhancing the development of input distribution networks, and providing support for geographic soil fertility and water quality mapping. It is recommended that the government implement market information systems to oversee the supply and demand of inputs, prices, and services. This will enable farmers and distributors to make knowledgeable decisions and lower market inefficiencies.
The Reserve Bank of Zimbabwe is recommended to facilitate money supply for both domestic and foreign currency allocation to financial markets and reduce the discount rate for commercial banks to borrow in order to facilitate leading to farmers for inputs buying. However, the foreign currency and domestic disbursement processes need to be expedited so that farmers perceive farming in Zimbabwe as an easy and unhindered process. The net effect of this measure is that agricultural output will increase.

### *5.2 Areas for further studies*

The current study uses only the ARDL technique to examine the relationship between government spending and agricultural output in Zimbabwe. Therefore, the researcher suggests that future studies use family models, such as the REM model, to examine government spending and agricultural output in a panel analysis. It is crucial that additional writers employ different approaches, such as primary techniques, and conduct this research at the local level.

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