IDR : VOL. 15, NO. 1, (JANUARY-JUNE, 2017) : 57-70 | ISSN : 0972-9437 |

# GOVERNMENT EXPENDITUREAND ECONOMIC GROWTH IN BOTSWANA: 1981-2014

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**ABSTRACT**

*The Autoregressive Distributed Lag bounds approachis used to examine the empirical relationship between government expenditure on agriculture, education, health, electricity and water, and economic growth in Botswana for the period 1981-2014. A positive relationship is estimated for expenditure on agriculture, suggesting economic gains can be expected from policies aimed at improving productivity in the sector. A positive relationship is also estimated for expenditure on health. However,a negative relationship is estimated for expenditure on water and electricity, suggestingpoor quality in spending. Improving the quality of spendingon water and electricity is essential.A result that warrants further investigation is the estimated relationship for expenditure on education. The estimated relationship is insignificant.*

***Keywords:*** *Government Expenditure, Economic Growth*

***JEL classification:*** *O40, O47*

## 1. INTRODUCTION

Botswana is adeveloping country heavily dependent on mineral resources. The single most important of these resources is diamond[1]. Diamondsconstitute the country's principal export commodity. During the month of September 2016 for example, 90.6 percent of the country's total exports was attributed to diamonds (see Statistics Botswana 2016). In addition, diamonds area principal source of fiscal revenues for the country. During the 2014/15 fiscal year for example, mining revenues (largely from diamonds) accounted for over 40 percent of fiscal revenues, followed by customs & excise at about 30 percent (see Bank of Botswana 2016). It is true that Botswana has achieved the level of economic development it has

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(upper-middle income), primarily because of diamonds.However, it must be acknowledged that as a non-renewable resource,'diamonds are not forever' and as emphasized by the World Bank (2010), a crucial policy question facing mineral dependent economies such as Botswana, is whether mineral assets are transformed into productive sources of income rather than consumed by the current generation. With diamond production, and consequently diamond related revenues, expected to decline considerably over the next decade, this is apertinent policy issue for Botswana. This paper is situated in this context. The paper seeks to contribute to the policy debate on this important issue, particularly given the expected decline in diamond production in the country in the coming years.

According to Basdevant (2008), diamond production in Botswana is expected to decreasemarkedlybetween 2021 and 2029, asdiamond reserves are drawn down[2]. The economy is projected to go through a steep recession in 2022 as diamond production falls sharply. During the period 2021-2029, fiscal revenues are expected to shrink by two-thirds, with consequences on per capita government revenue. While fiscal adjustments will be necessary,improving productivity of spending in the short and medium term is essential. This paper contributes to the debate on ways to improve productivity of spending. The paper estimates the impact of government expenditure and economic growth in Botswana for the period 1981-2014. The paper focuses sharply on expenditures on agriculture, education, health, water and electricity. An examination ofgovernment expenditure patterns shows an upward trend in expenditure on these sectors (see Bank of Botswana 2016). Analysis of the impact of this spending is worthwhile. The Autoregressive Distributed Lag approach due to Pesaran*et al.* (2001) and annual time series data for the period 1981 - 2014 are used in the analysis.

## 2. OVERVIEW OF THE LITERATURE

The effects of government expenditure on economic growth have been examined by manyempirical studies using various testing procedures (unit root, cointegration, causality) and different measures of government spending (see for example, Aschauer 1989, Devarajan*et al*. 1996, Baffes*et al*. 1998, Saad 2009, Kapundaand Topera 2013, Muthui*et al.* 2013, Aschenke 2014, Aremu*et al.* 2015, and Salimi2016).These studies have generally focused on the impact of government expenditure on infrastructure, education, health,agriculture, *inter alia*, on economic growth. However, there is an apparent lack of regularity in results.This applies to both developed and developing countries. For example, for infrastructure, Aschauer (1989), Kapunda and Topera (2013), Muthui *et al.* (2013) and Aremu *et al.* (2015), found that expenditure on infrastructure had a positive impact on economic growth, while Devarajan *et al.* (1996) found contrasting results.

For education, while Baffes *et al.* (1998), Saad (2009) and Aschenke (2014) found that expenditure on education had a positive impact on growth, Aschauer (1989), Devarajan *et al.* (1996), Kapunda and Topera (2013) and Aremu *et al.* (2015) and Salimi (2016) found no evidence to that effect. For health, Baffes *et al.* (1998), Kapunda and Topera (2013), Muthui *et al.* (2013) and Salimi (2016) found that expenditure on health had a positive impact on growth, while Devarajan *et al.* (1996) and Saad (2009) found no evidence of such. Finally, Kapunda and Topera (2013) and Aremu *et al.* (2015) found that expenditure on agriculture had a positive impact on growth, while Saad (2009) and Aschenke (2014) found an insignificant relationship.As can be seen from the overview, there is lack of uniformity in findings, underlining the importance of country specific studies to avoid erroneous policies.

While limited, empirical studies have also been conducted for Botswana, on which this paper sharply focuses. In the two studies encountered in the review of the literature, expenditure on education and health were found to have a negative impact on economic growth (see Chepete 1997 and Botshelo 2010).This paper relies on these two studies as a point of departure. However, it deviatesfrom the two in the econometric approach used in the analysis. Thepaper employs the Autoregressive Distributed Lag (ARDL) approach due toPesaran*et al*. (2001). The technique permits analysis of variables of different order of integration which avoids volatile results, and is suitable for small samples.

## 3. ECONOMETRIC METHODOLOGY

### 3.1.The Conceptual Model

The econometric analysis carried out in this paper is premised on the assumed relationship between government sectorand economic growth due to Barro (1990). In the Barro (1990) model, government is incorporated into an economy's production function as an input, such that any change in employment of inputs is expected to have an impact on the level of output. Based on this argument, an economy's production function can be expressed:

$$Y_{(t)} = f\left(K_{(t),}L_{(t),}G_{(t)}\right) \tag{1}$$

Where, Y is output, K is capital, L is labour and G is government spending.Equation (1) specifies output as a function of capital, labour and government spending.Since this study considers expenditure on a number of sectors(health, education, agriculture, water and electricity), G is specified as a vector to account for the different sectors. In the estimation of the relationship between government expenditure and economic growth, it is customary to include some conditioning variables to account for factors (e.g. terms of trade, consumer price index, real exchange rate etc.) that may influence output. Equation (1) may thus be modified to include a vector X, of these factors (see Equation 2).

$$Y_t = f(L_t, K_t, G_t, X_t) \quad (2)$$

### 3.2.The Econometric Model

After some logarithmic transformation of equation (2), the basic econometric model used in the study can be expressed as:

$$lnY = \beta_0 + \beta_1 lnK_t + \beta_2 lnL_t + \sum_{i=1}^{m} \beta_{3i}\, lnG_{it} + \sum_{i=1}^{m} \beta_{4i}\, lnX_{it} + u_t \quad (3)$$

Where Y is output, K is capital, L is labour, G is a vector of expenditures on agriculture, education, health, transport, and water and electricity, X is a vector of control variables, (consumer price index and terms of trade), and $u_t$ is the error term.

#### *Definition of Variables*

*Output (Y)* ismeasured as per capita GDP.*Capital (K)* ismeasured as gross fixed capital formation. *Labour (L)* is measured as labour force. *Expenditure on Education (Edu)* is measured as share of expenditure on education. Itis expected to raise productivity of labour, soa positive sign is expected. *Expenditure on Health (Hea)* is measured as share of public expenditure on health. It is expected to increase productivity of labour. A positive sign is thus expected. *Expenditure on Agriculture (Agr)* is share of expenditure on agriculture (includes expenditures on agricultural equipment, training and research and development). A positive sign is expected. *Expenditure on Electricity and Water (EW)*is treated as investment on infrastructure. A positive sign is expected. For control variables,*consumer price index (CPI)*and *terms of trade (ToT)*a negative and an ambiguous sign are expected (respectively).

### 3.3.Data Analysis

The first step in the analysis is to test for unit root to ascertain the time series properties of the data. The unit root tests are followed by cointegration tests to determine the existence of a long-run relationship between the variables. If a long run relationship exists, the Autoregressive Distributed Lag approach is used to estimate the coefficients of the variables in the model. Diagnostic tests are also carried out test validity of the model.

#### *3.3.1. Unit root and Cointegration tests*

*Unit root tests*

The study uses time series data which may inherently exhibit trends. Time series data is considered stationary if its properties are independent of time(Hamilton, 1994). If the data has unit root, the regression would produce spurious results. This study relies on thePhillips-Perron (PP) andKwiatkowski-Phillips-Schmidt-Shin (KPSS) to test for stationarity of the series. DeJong and Whiteman (1991) emphasize that the KPSS test should be used in conjunction with the PP test to overcome their tendency of having low power if the process is stationary, but with a root close to the non- stationary boundary.

*Cointegration tests*

The Autoregressive Distributed Lag (ARDL)testing procedure requires that the variables used in the model be cointegrated. Once stationarity of the variables has been tested, the next step is to test for the existence of a long run relationship among the variables. The test is carried out using the bounds approach due toPesaran*et al.* (2001). An advantage of the approach is that it is does not require variables to be integrated of the same order. The model can be applied for I(0) and I(1) variables. The test involvesconducting a Wald test and comparing the estimated F-statisticwith the critical lower and upper bound. TheAkaike Information Criterion (AIC)is used to select the appropriate lag to use in the model.

The ARDL equation for regressionof order (P, q1, q2, q3, q4, q5, q6, q7, q8) is:

$$\Delta lnGDP_t = \alpha_0 + \beta_1 lnGDP_{t-1} + \beta_2 lnK_{t-1} + \beta_3 lnL_{t-1} + \beta_4 lnAgr_{t-1} + \beta_5 lnEdu_{t-1} + \beta_6 lnHea_{t-1} + \beta_7 lnEWs_{t-1} + \beta_8 lnCPI_{t-1} + \beta_9 lnTOT_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta lnGDP_{t-i} + \sum_{i=1}^{q1} \alpha_{2i} \Delta lnK_{t-i} + \sum_{i=1}^{q2} \alpha_{3i} \Delta lnL_{t-i} + \sum_{i=1}^{q3} \alpha_{4i} \Delta lnAgr_{t-i} + \sum_{i=1}^{q4} \alpha_{5i} \Delta lnEdu_{t-i} + \sum_{i=1}^{q5} \alpha_{6i} \Delta lnHea_{t-i} + \sum_{i=1}^{q6} \alpha_{7i} \Delta lnEWs_{t-i} + \sum_{i=1}^{q7} \alpha_{8i} \Delta lnCPI_{t-i} + \sum_{i=1}^{q8} \alpha_{9i} \Delta lnTOT_{t-i} + \varepsilon_t \quad (5)$$

Where: $\Delta$ is first difference operator, $p$ is lag order of dependent variable and $qi$ is the lag orders of independent variables. The expressions with the summation sign ($a_1 - a_9$) signify the short run dynamics of the model while the long run multipliers are given by the coefficients of the lagged-levels variables ($\beta_1 - \beta_9$). $\varepsilon_t$ is the error term. All the other terms are as defined before. The null hypothesis of no long run relationship is tested against the alternative that a long run relationship exists. If the lower critical bound value is greater than computed F-statistic then we fail to reject the null hypothesis.

### *3.3.2. Estimation ofLong Run Relationships and Short Run Dynamics*

*Long-run Relationships*

After establishing that a long-run relationship existsfor the variables in model, the next step is to estimate the coefficients of the variables. This is carried out using equation (6).

$$lnGDP_t = \alpha_0 + \beta_1 lnK_{t-1} + \beta_2 lnL_{t-1} + \beta_3 lnAgr_{t-i} + \beta_4 lnEdu_{t-i} + \beta_5 lnHea_{t-1} + \beta_6 lnEWs_{t-1} + \beta_7 lnCPI_{t-1} + \beta_8 lnTOT_{t-1} + \varepsilon_t \quad (6)$$

*Short-run dynamics*

The unrestricted error correction representation of the ARDL model used to estimate the short-run coefficients can be expressed as:

$$\Delta lnGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\,\Delta lnGDP_{t-i} + \sum_{i=1}^{q1} \alpha_{2i}\,\Delta lnK_{t-i} + \sum_{i=1}^{q2} \alpha_{3i}\Delta lnL_{t-i} + \sum_{i=1}^{q3} \alpha_{4i}\, lnAgr_{t-i} + \sum_{i=1}^{q4} \alpha_{5i}\,\Delta lnEdu_{t-i} + \sum_{i=1}^{q5} \alpha_{6i}\,\Delta lnHea_{t-i} + \sum_{i=1}^{q6} \alpha_{7i}\,\Delta lnEWs_{t-i} + \sum_{i=1}^{q7} \alpha_{8i}\,\Delta lnCPI_{t-i} + \sum_{t-i}^{q8} \alpha_{9i}\,\Delta lnTOT_{t-i} + \delta ECT_{t-1} + \varepsilon_t \quad (7)$$

Where; $ECT_{t-1}$ is the error correction term, $\delta$ is the coefficient of adjustment, $\alpha_0$ is the intercept, $\alpha_i$ are short-run dynamics coefficients.

*Data type and Sources*

The studyusesannual time series data for the period 1981 - 2014.The data was obtained from Bank of Botswana and World Bank databases.

*Diagnostic Tests*

The Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squared Recursive Residuals (CUSUMQ) are applied to examine stability of the parameters.The parameters are considered stable if the plot of both the CUSUM and CUSUMQ statistics lie within the 5 percent critical band confidence interval.The model is also verified by residual tests such as serial correlation test, heteroskedasticity tests and JarqueBera test for normality. If the probabilities of the test statistics are insignificant, then we fail to reject the null hypotheses of no serial correlation, no heteroskedasticity and non-normality respectively. The model is also tested for multicollinearity among variables.

## 4. RESULTS

### Unit root test results

The results of unit roots tests based on the Phillips- Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS)tests are summarised in Tables 1 and 2 respectively.The PP unit root test results indicate that labour, capital, consumer price index, expenditures on education and electricity and water are stationary at levels. The per capita GDP, terms of trade and expenditures on agriculture and health become stationary after first difference. The KPSS unit root test results show that capital,labour, term of trade, expenditures on agriculture, education, health and electricity and water supply are stationary at levels.

**Table 1**
**PP Unit Root Test Results**

| *Phillips -Perron (PP)* | | | | | |
|---|---|---|---|---|---|
| *Variable* | *Levels* | | *First Difference* | | *Integration order* |
| | *Constant* | *Constant and trend* | *Constant* | *Constant and trend* | *I (d)* |
| | t-statistic | t-statistic | t-statistic | t-statistic | |
| lnGDP | -4.845212 | -3.895124 | -2.946834*** | | I(1) |
| lnK | -3.0275** | | | | I(0) |
| lnL | 0.5247 | -3.4572*** | | | I(0) |
| lnAgr | -2.3521 | -2.2326 | -7.0043* | | I(1) |
| lnEdu | -0.6949 | -4.0235** | | | I(0) |
| lnHea | 0.1337 | -3.1101 | -6.2646* | | I(1) |
| lnEw | -1.9414 | -3.28401*** | | | I(0) |
| lnCpi | -3.6826* | | | | I(0) |
| lnTot | -1.9397 | -1.8158 | -4.6493* | | I(1) |

*Note:**, **, *** implies significant at 1%, 5% and 10%.

**Table 2**
**KPSS Unit Root Test Results**

| *KPSS* | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Variable* | *Levels* | | *First Difference* | | *Second Difference* | | *Integrated order* |
| | *Constant* | *Constant and trend* | *Constant* | *Constant and trend* | *Constant* | *Constant and trend* | *I (d)* |
| | *LM-statistic* | *LM-statistic* | *LM-statistics* | | *LM-statistics* | | |
| lnGDP | 0.1838 | 0.1299*** | | | | | I(0) |
| lnK | 0.1878 | 0.1282*** | | | | | I(0) |
| lnL | 0.6454** | | | | | | I(0) |
| lnAgr | 0.4890** | | | | | | I(0) |
| lnEdu | 0.6830** | | | | | | I(0) |
| lnHea | 0.5862** | | | | | | I(0) |
| lnEW | 0.5072** | | | | | | I(0) |
| lnTot | 0.2116 | 0.1642** | | | | | I(0) |

*Note:* *, **, *** implies significant at 1%, 5% and 10%.

### *Cointegration test results*

The first step is to estimate equation 5 and select the optimal lag length of the variables in the model. This was carried out using Akaike Information Criteria (AIC).A model ARDL (1,1,0,1,1,1,1,1) with the minimum AIC was selected. Thenumbersshowthe optimal lag lengths of the variables in the model.

**Wald test for Cointegration**

From the ARDL(1, 1, 0, 1, 1, 1, 1, 1) model, a Wald test is carried out to determine the existence of a long-run relationship between thevariables.The results of the test are summarised in Table 3.

**Table 3**
**Wald test results**

| *Test Statistic* | *Value* | *Df* | *Probability* |
|---|---|---|---|
| F-statistic | 3.798870 | (8, 13) | 0.0163 |
| Chi-square | 30.39096 | 8 | 0.0002 |

*Source:* Estimated from Eviews7.

The computed F-statisticexceedsthe lower bound critical value (2.21) and theupper bound critical value (3.39) at 10 percent. The critical values are obtained from Narayan (2005)[3]. The null hypothesis of no long run relationship is thus rejected.

*Long-runrelationships*

Results are summarised in Table 4. Results show a positive and significant impact of government expenditure on agriculture (*p-value* = 0.0003). This result is consistent with Aremu *et al. (*2015), Musaba *et al.* (2013) and Chidoko (2012). The estimated relationship suggests that a 1 percent increase in expenditure on agriculture is likely to increase economic growth by an estimated 3.4 per cent. Results also show a positive impact of expenditure on health on economic growth (*p-value*= 0.0035). This result is consistent with Baffes (1998), Ebiringa and Charles (2012), Muthui *et al.*(2013) and Salimi (2016). However, the result is in contrast to the relationships estimated in Chepete(1997)andBotshelo (2010). The differences could be explained by the differences in the econometric methods applied.

Against expectation, results show that expenditure on electricity and water has a negative impact on growth (*p-value* = 0.0014). The estimated relationship suggests that 1 percent increase in expenditure on electricity and water is likely to reduce economic growth by 3.0 percent. The result suggests that expenditure on electricity and water has not been productive. This is consistent with the water and electricity supply problems that the country has encountered over the past few decades. A result which warrants further research is the estimated relationship between expenditure on education and economic growth. Against expectation, results show a positive but insignificant impact of expenditure on education on economic growth (*p-value* = 0.1175). For the terms of trade and the consumer price index, a negative and significant impact is estimated.

**Table 4**
**Estimation of Long run Relationships**

| *Variable* | *long run elasticity* | *t-statistic* | *std error* | *probability* |
|---|---|---|---|---|
| Intercept | 24.84 | 2.832 | 8.772 | 0.0141 |
| Lnagr | 3.376 | 4.982 | 0.677 | 0.0003 |
| Lnedu | 2.152 | 1.676 | 1.283 | 0.1175 |
| Lnhea | 1.764 | 3.551 | 0.496 | 0.0035 |
| Lnew | -3.016 | -4.054 | 0.743 | 0.0014 |
| Lnk | -2.108 | -1.324 | 1.592 | 0.2082 |
| Lncpi | -1.909 | -2.581 | 0.755 | 0.0252 |
| Lntot | -4.190 | -2.245 | 1.866 | 0.0428 |

*Source:* Authors computation using Eviews7.

### *Short run dynamics*

The existence of long run relationships among the variables makes it possible to estimate the error correction model. The error correction model illustrates the shortrun dynamics of the model. The coefficients measure the speed of adjustment to equilibrium. Results are summarised in Table 5. The error correction termECT (-1) is significant at 1 percent, and the coefficient is negative, suggesting the feedback mechanism is effective. The speed of adjustment is1.40. Results also show that only expenditure on agriculture has a positive and significant influence on growth in the short run. Expenditures on education, health, electricity and water have an insignificant impact on growth in the short run.Insignificant relationships are also estimated for control variables, terms of trade and consumer price index.

**Table 5**
**Estimation of Short Run Dynamics**

Dependent Variable: D(LNGDP)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| C | 0.081630 | 0.214510 | 0.380543 | 0.7083 |
| D(LNGDP(-1)) | -0.258033 | 0.160876 | -1.603925 | 0.1271 |
| D(LNAGR(-1)) | 3.031672 | 1.173779 | 2.582831 | 0.0194 |
| D(LNEDU(-1)) | -2.231552 | 2.728019 | -0.818012 | 0.4247 |
| D(LNHEA(-1)) | 1.897388 | 1.530284 | 1.239893 | 0.2319 |
| D(LNEWS(-1)) | -1.032177 | 0.742880 | -1.389427 | 0.1826 |
| D(LNK(-1)) | 2.242602 | 2.503418 | 0.895816 | 0.3829 |
| D(LNCPI(-1)) | -1.264587 | 0.996738 | -1.268726 | 0.2216 |
| D(LNTOT(-1)) | -1.238053 | 3.867866 | -0.320087 | 0.7528 |
| ECT(-1) | -1.400526 | 0.420691 | -3.329111 | 0.0040 |
| R-squared | 0.739064 | Mean dependent var | | -0.034326 |
| Adjusted R-squared | 0.600921 | S.D. dependent var | | 1.591927 |
| F-statistic | 5.350001 | Akaike info criterion | | 3.127288 |
| Prob(F-statistic) | 0.001501 | Schwarz criterion | | 3.607228 |
| | | Hannan-Quinn criter. | | 3.269999 |
| | | Durbin-Watson stat | | 2.287344 |

*Source:* Computed by Authors using Eviews7.

### *Diagnostic tests*

Table 6 shows results from the Breusch-Godfrey LM test for serial correlation, the Breusch-Pagan-Godfrey test for heteroscedasticity, and the JarqueBera test for normality.The Breusch-Godfrey LM test for serial correlation shows an F-statistic with p-value of 0.363. We therefore fail to reject the null hypothesis of no serial correlation. The Breusch –Pagan-Godfrey test for heteroskedasticity has an F-statistic with a p-value of 0.462. We also fail to reject the null hypothesis of no heteroskedasticity.The Ramsey RESET test results show an F-statistic with a p-value of 0.312, suggestingthe model is correctly specified. The normality results (presented in appendixA1) show that the JarqueBera statistic is 0.414 with a p-value of 0.812. This implies that the residuals are normally distributed. The results of the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMQ) tests indicate stability of the coefficients. This is shown by the plot of the CUSUM and CUSUMQ which lie within the critical bands of the 5 percent confidence interval of the parameter stability (see appendicesA2 and A3).In addition, the correlation matrix shown in appendixA4 suggests that multicollinearity is not a problem.

**Table 6**
**Diagnostic tests**

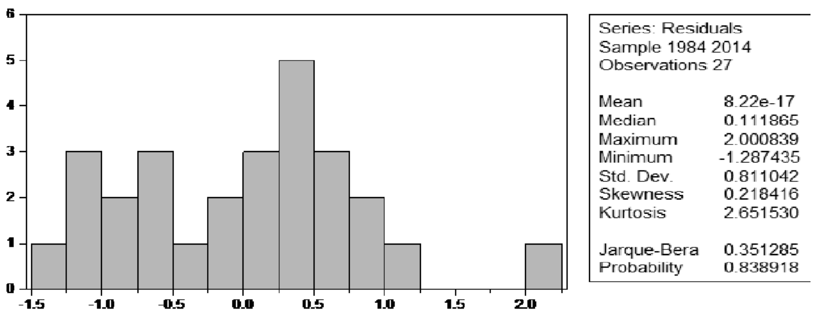
| *Diagnostic Test* | *Test statistic* | *Probability* |
|---|---|---|
| Breusch-Godfrey Serial Correlation LM test | 1.085 | 0.363 |
| Breusch-Pagan-Godfrey Heteroskedasticity test | 1.020 | 0.462 |
| Ramsey RESET Test | 0.312 | 0.583 |
| Normality test | 0.414 | 0.812 |
| Stability test: CUSUM test | Stable | |
| CUSUM of squares test | Stable | |

## 5. CONCLUSIONS AND POLICY IMPLICATIONS

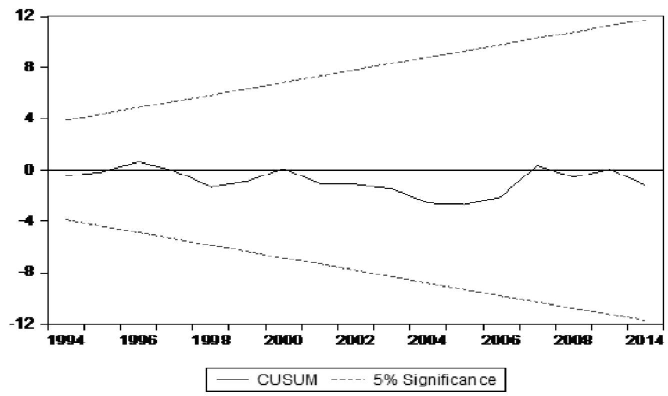
The objective of this paper was to examine the impact of government expenditure on economic growth in Botswana (1981-2014). The analysis is relevant considering that the country's main stay and principal source of fiscal revenues (diamonds) is expected to decline considerably over the next decade, underlining the importance ensuring that government expenditure is productive in the coming years. The Autoregressive Distributed Lag (ARDL) technique was used to carry out the analysis. Results showed a positive and significant impact of expenditure on agriculture on growth, suggesting that economic gains can be expected from policies designed to enhance productivity in the sector. Results also showed a positive and significant impact of investment in health on growth. Economic gains can also be expected from policies geared towards improving the health of the labour force. Against expectation, results showed a negative impact of expenditure on water and electricity on economic growth, suggesting poor quality of spending. Improving productivity of spending is essential going forward. A result that warrants further investigation is the estimated impact of expenditure on education of economic growth. Results showed an positive but insignificant impact of spending on education on growth.

## APPENDICES

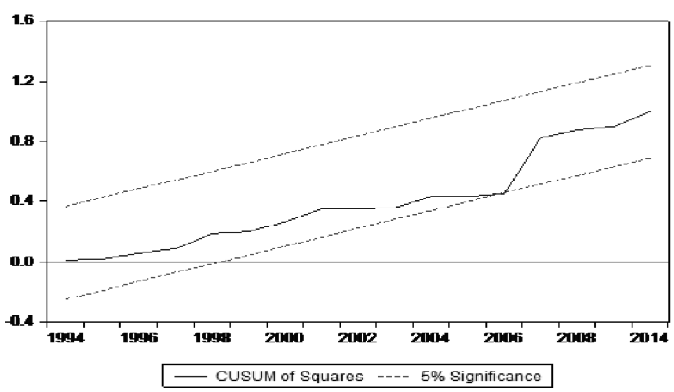
**Appendix A1: Normality Test results**




**Appendix A2: CUSUM Test for Stability**




**Appendix A3: CUSUM of Squares Test for Stability**



**Appendix A4: Matrix Correlations**

| | *D(LNGDP(-1))* | *D(LNAGR(-1))* | *D(LNEDU(-1))* | *D(LNHEA(-1))* | *D(LNEWS(-1))* | *D(LNK(-1))* | *D(LNCPI(-1))* | *D(LNTOT(-1))* | *ECT(-1)* |
|---|---|---|---|---|---|---|---|---|---|
| D(LNGDP(-1)) | 1 | | | | | | | | |
| D(LNAGR(-1)) | -0.017608418 | 1 | | | | | | | |
| D(LNEDU(-1)) | -0.137838353 | 0.375835214 | 1 | | | | | | |
| D(LNHEA(-1)) | 0.000631824 | 0.093278467 | 0.525794771 | 1 | | | | | |
| D(LNEWS(-1)) | 0.329043529 | 0.257033063 | 0.093367552 | 0.262734145 | 1 | | | | |
| D(LNK(-1)) | 0.037864036 | -0.115373377 | 0.309830449 | 0.261078359 | 0.1396089 | 1 | | | |
| D(LNCPI(-1)) | -0.016567054 | 0.293926155 | 0.123159796 | 0.178816495 | 0.3135488 | -0.0244824 | 1 | | |
| D(LNTOT(-1)) | 0.137728509 | -0.210183728 | -0.21805385 | -0.280023348 | -0.4438165 | 0.03534133 | -0.50314009 | 1 | |
| ECT(-1) | 0.350338925 | -0.33423046 | -0.17111101 | -0.140464848 | -0.1411159 | -0.0318546 | -0.06738247 | 0.0936092 | 1 |

**Appendix A5: Critical values for the Bounds test: restricted intercept and no trend 10 percent level**

| *N* | *k=0* | | *k=1* | | *k=2* | | *k=3* | | *k=4* | | *k=5* | | *k=6* | | *k=7* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* | *I(0)* | *I(1)* |
| **30** | 4.025 | 4.025 | 3.303 | 3.797 | 2.915 | 3.695 | 2.676 | 3.586 | 2.525 | 3.560 | 2.407 | 3.517 | 2.334 | 3.515 | 2.277 | 3.498 |
| **31** | 4.020 | 4.020 | 3.273 | 3.800 | 2.890 | 3.680 | 2.662 | 3.578 | 2.518 | 3.513 | 2.386 | 3.479 | 2.303 | 3.483 | 2.256 | 3.454 |
| **32** | 4.030 | 4.030 | 3.273 | 3.780 | 2.885 | 3.670 | 2.646 | 3.566 | 2.493 | 3.497 | 2.384 | 3.469 | 2.293 | 3.448 | 2.238 | 3.443 |
| **33** | 4.025 | 4.025 | 3.260 | 3.780 | 2.880 | 3.653 | 2.644 | 3.548 | 2.482 | 3.472 | 2.367 | 3.447 | 2.284 | 3.428 | 2.229 | 3.399 |
| **34** | 4.005 | 4.005 | 3.240 | 3.767 | 2.868 | 3.633 | 2.626 | 3.550 | 2.465 | 3.472 | 2.361 | 3.433 | 2.274 | 3.399 | 2.216 | 3.392 |
| **35** | 3.980 | 3.980 | 3.223 | 3.757 | 2.845 | 3.623 | 2.618 | 3.532 | 2.460 | 3.460 | 2.331 | 3.417 | 2.254 | 3.388 | 2.196 | 3.370 |
| **36** | 3.995 | 3.995 | 3.247 | 3.773 | 2.863 | 3.610 | 2.618 | 3.502 | 2.460 | 3.435 | 2.346 | 3.384 | 2.264 | 3.369 | 2.206 | 3.360 |
| **37** | 3.980 | 3.980 | 3.253 | 3.747 | 2.865 | 3.608 | 2.622 | 3.506 | 2.458 | 3.432 | 2.339 | 3.396 | 2.240 | 3.361 | 2.187 | 3.336 |
| **38** | 3.995 | 3.995 | 3.243 | 3.730 | 2.838 | 3.590 | 2.598 | 3.484 | 2.448 | 3.418 | 2.323 | 3.376 | 2.233 | 3.354 | 2.172 | 3.321 |
| **39** | 3.985 | 3.985 | 3.230 | 3.727 | 2.833 | 3.570 | 2.596 | 3.474 | 2.442 | 3.400 | 2.316 | 3.371 | 2.224 | 3.339 | 2.169 | 3.306 |
| **40** | 3.955 | 3.955 | 3.210 | 3.730 | 2.835 | 3.585 | 2.592 | 3.454 | 2.427 | 3.395 | 2.306 | 3.353 | 2.218 | 3.314 | 2.152 | 3.296 |
| **45** | 3.950 | 3.950 | 3.190 | 3.730 | 2.788 | 3.540 | 2.560 | 3.428 | 2.402 | 3.345 | 2.276 | 3.297 | 2.188 | 3.254 | 2.131 | 3.223 |
| **50** | 3.935 | 3.935 | 3.177 | 3.653 | 2.788 | 3.513 | 2.538 | 3.398 | 2.372 | 3.320 | 2.259 | 3.264 | 2.170 | 3.220 | 2.099 | 3.181 |
| **55** | 3.900 | 3.900 | 3.143 | 3.670 | 2.748 | 3.495 | 2.508 | 3.356 | 2.345 | 3.280 | 2.226 | 3.241 | 2.139 | 3.204 | 2.069 | 3.148 |
| **60** | 3.880 | 3.880 | 3.127 | 3.650 | 2.738 | 3.465 | 2.496 | 3.346 | 2.323 | 3.273 | 2.204 | 3.210 | 2.114 | 3.153 | 2.044 | 3.104 |
| **65** | 3.880 | 3.880 | 3.143 | 3.623 | 2.740 | 3.455 | 2.492 | 3.350 | 2.335 | 3.252 | 2.209 | 3.201 | 2.120 | 3.145 | 2.043 | 3.094 |
| **70** | 3.875 | 3.875 | 3.120 | 3.623 | 2.730 | 3.445 | 2.482 | 3.310 | 2.320 | 3.232 | 2.193 | 3.161 | 2.100 | 3.121 | 2.024 | 3.079 |
| **75** | 3.895 | 3.895 | 3.133 | 3.597 | 2.725 | 3.455 | 2.482 | 3.334 | 2.313 | 3.228 | 2.196 | 3.166 | 2.103 | 3.111 | 2.023 | 3.068 |
| **80** | 3.807 | 3.870 | 3.113 | 3.610 | 2.713 | 3.453 | 2.474 | 3.312 | 2.303 | 3.220 | 2.303 | 3.154 | 2.088 | 3.103 | 2.017 | 3.052 |

## *Notes*

1. Other mineral resources include soda ash, salt, coal, base metals (copper and nickel) and to a lesser extent precious metals (e.g. gold).
2. These projections do not account for recent explorations.
3. See Appendix A5.

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