The impact of fiscal policy on total factor productivity growth in a developing economy: evidence from Botswana

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Abstract:

We analyzed the impact of fiscal policy on total factor productivity (TFP) of primary, secondary and tertiary economic sectors in Botswana between 1984 and 2016. We used an Autoregressive Distributive Lag (ARDL) estimation technique which allows for long run and short run impact of fiscal policy on these sectors. The results show that, mineral tax have significant long run positive impact on the TFP growth in the primary sector only while a negative impact is witnessed in the secondary and tertiary sectors. Similarly, other tax revenue and expenditure on social services have positive impact on TFP growth only in the primary sector while a negative impact is recorded in the secondary and tertiary sectors. SACU revenue has positive impact on TFP growth in both the primary and tertiary sectors only while productive spending boosts TFP growth across all sectors. In addition, Non-mineral income tax and value added tax have a negative impact on TFP growth across all sectors. The results also show that the speed of adjustment for the primary sector's TFP growth is high compared to that of the secondary and tertiary sector. A key policy implication deduced from these results is the need to take into account specific factors underpinning the impacts that fiscal policy has on various sectoral TFP growth. This suggests that these policies can be growth enhancing as opposed to the current practice of booting TFP growth through blanket policies.

Key Words: Fiscal policy, total factor productivity, ARDL, Botswana

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Introduction

The pursuit of long-term sustainable economic growth has continued to dominate the policy space for both developed and developing nations. The divergence in the pursuance of this policy agenda is through the execution framework adopted by these nations. For instance, Total Factor Productivity (TFP) growth is the main source of growth for developed nations while the natural resource driven growth model has been widely adopted by most countries in the Sub-Saharan African region (SSA). Easterly and Levine (2001), point out that that TFP growth provides an opportunity to accelerate long-run economic growth and generate sustainable increases in incomes. In the same vein, Issaksson (2007), adds that TFP growth provides nations with the opportunity to increase the welfare of its people, while the Solow-Swan (1956) model suggests that countries will not achieve long-term economic growth without TFP growth. In this regard, an introspection of the benefits associated with TFP growth suggest that the factor growth led model adopted in most developing countries like Botswana might be unsustainable in the long run.

The economic success story of Botswana that occurred for decades after independence was due to discovery of minerals, prudent macroeconomic management of receipts and significant investment in physical and human capital. However, the share of the mining sector to Gross Domestic Product (GDP) has been declining over the years. The share of this sector reduced from over 50 percent in the mid-1980s to just above 20 percent by 2013, (Statistics Botswana, 2016). This decline is attributed to some of the challenges that the sector faced over the years, such as fluctuations of commodity prices and weakened global demand. This has reversed the successive growth experienced in earlier years suggesting that this factor led economic model might be running its course.

This situation provides a serious economic challenge for the country, especially with the anticipated depletion of mineral resources in late 2020s. This is worsened by the fact that TFP, which is believed to be a more sustainable driver of growth has slowed over the years. According to the Government Budget Strategy Paper of 2015/16 TFP growth averaged -1.45 percent in the period 1991 to 2001, and declined further to an average of -1.64 percent in the period 2001 to 2011. These TFP trends are in line with Abdychev et al., (2015) who suggest that the declines in TFP growth affects international competitiveness.

Given the significance and dividends of TFP growth, its recent downward trend is a concern for Botswana and undermines potential gains from some of government socio-economic developmental objectives. In view of this challenge, Government reignited its focus on TFP growth and identified the improvement of TFP growth as a key national priority area, (Budget Strategy Paper, 2016/17). The slowdown in TFP growth led to Botswana's inability to operate at full potential. In addition, the International Monetary Fund Country Report No. 14/204 of 2014 indicates that in order to return to periods of strong growth and accelerate the county's convergence to higher income levels, Botswana requires deliberate policies that will reinvigorate TFP growth.

Empirical evidence on TFP growth in both developed and developing countries such as Danquah et al., (2011) and Njikam et al., (2006) agree on the benefits of TFP growth but mainly focus on analysing its determinants and decomposing the sources of growth. Only a handful of studies like Evaraet et al., (2015) and Schoonackers and Heylen, (2011) go beyond this scope by analysing the direct and indirect effects of fiscal policy on TFP growth and conclude that fiscal policy may have a significant impact on TFP growth. However, these studies are focused on developed economies and also do not disaggregate TFP growth per economic sector in their analysis. The lack of analysis on the sectoral TFP growth disadvantages countries like Botswana whose mineral-led growth economic model seem to be slowing down at the same time with an overall TFP growth decline.

A prime question that arises, predominantly in the TFP literature is: how fiscal policy affects TFP growth of the various economic sectors in the context of a mineral led economy. It is in this regard that this study seeks to contribute to literature by analysing the impact of fiscal policy on TFP growth, specifically focusing on non-mining, non-government economic sectors in Botswana. The study deliberately focuses on these sectors as they are anticipated to be main drivers of economic activity after the deterioration of minerals. These sectors are classified into a three categories of primary (agriculture), secondary (manufacturing, construction and water & electricity) and tertiary sectors (trade, hotels & restaurants, transport & communication, finance & business services and social & personal services).

To conduct this analysis, the study applies the ARDL methodology developed by Pesaran and Shin (1998) and improved by Pesaran et al., (2001). Nkoro and Uko (2016) indicates that the ARDL method has more advantages compared to other techniques other cointegration techniques such as Engle-Granger (1987) and Johansen (1991, 1995) as it does not require prior testing of variables for stationary and can be used for small sample sizes such as in this study.

The analysis in this study is expected to assist fiscal authorities to implement targeted polices as opposed to the approach of addressing the declining TFP growth at the aggregate level. This may foster long-term sustainable growth and contribute to higher living standards for the people of Botswana. The findings of this study may also be used as a reference point for other developing nations in the SSA region which may face similar economic challenges in the long run.

The rest of the study proceeds as follows. The section that follows discusses selected economic developments in Botswana. Section 3 reviews theoretical and empirical literature while section 4 presents the methodology. Estimation results are discussed in section 5. Section 6 concludes the study by highlighting some important policy implications.

2. Economic Developments in Botswana

The significance of the mining sector in Botswana cannot be over emphasised. In addition to dominance in the trade, balance of payments and total output, the importance of this sector can also be traced to the government resource envelope as shown in Figure 1. This figure shows that, despite declining over the years, mineral revenue still accounts for the largest share of total government revenue. Figure 1 also shows that the second largest share to government revenue is the SACU revenue which started showing significant growth after 2002, on the backdrop of the revised revenue sharing mechanism during this period. However, both these two major sources of revenue have been showing signs of decline since 2014.

Figure 1 also shows that the Non-Mining Income Tax[2] (NMIT) and Value Added Tax (VAT) are the third and fourth largest contributors to the government revenue, respectively, while the contribution of Other Tax Revenue[3] (OTR) has reduced over the years while.

[2] This covers personal income tax and corporate tax

[3] Other Tax Revenue include, amongst others, airport tax; business and license fees; other property income and export duties.

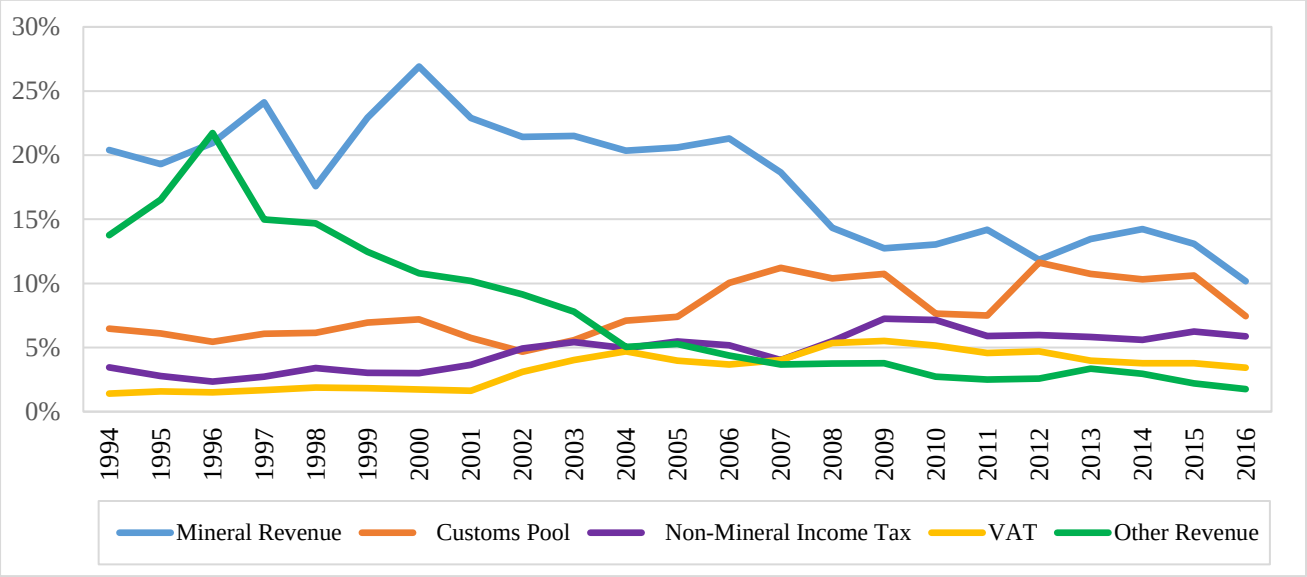

Figure 1: Percentage Share of sources of revenue to total revenue, 1994-2016
Source: Ministry of Finance and Economic Development - Financial Statement of the Consolidated Fund, 2017

Functional classification of expenditure shown in Figure 2 indicate that much of government expenditure has been channelled towards productive spending[4]. Dhont and Heylen (2008), suggests that such productive expenditure is important for propelling economic growth. Figure 2 also show that on average, between 1999 and 2011, both these expenditure components moved in the same direction. However, thereafter, productive spending declined while expenditure on social services trended upwards. These trends suggests a shift in government spending priorities over the last decade.

[4] This includes education, Research and Development (R&D) and investment in infrastructure

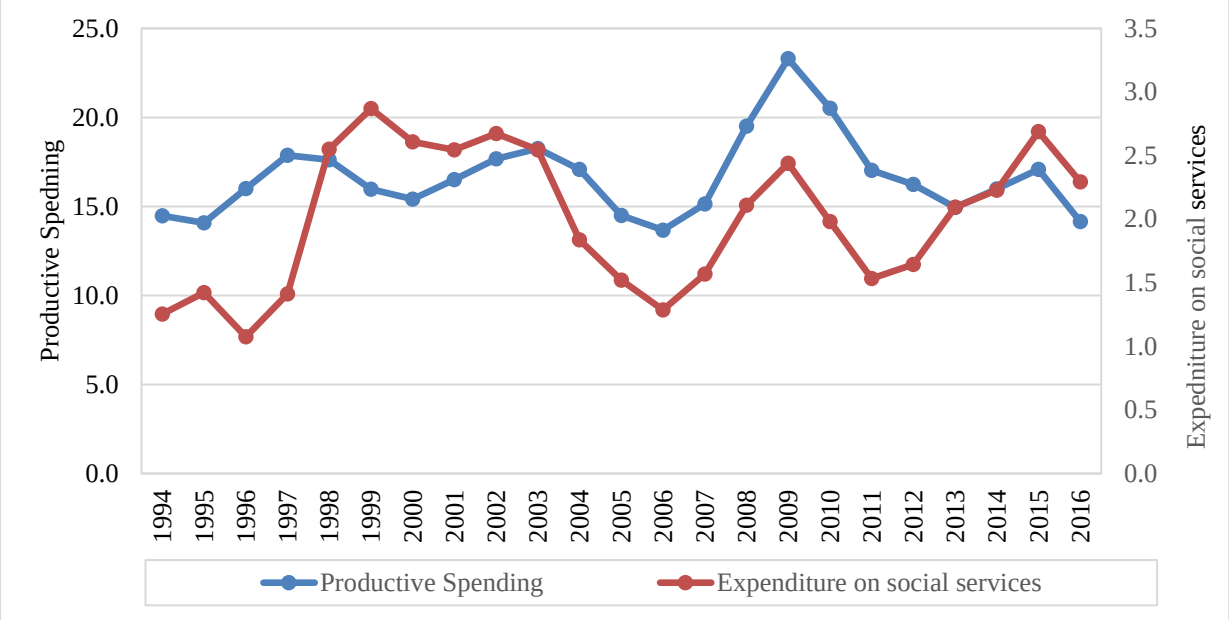

Figure 2: Productive spending vs. Expenditure on social services, as percent of non-mining GDP, 1994-2016
Source: a) Ministry of Finance and Economic Development - Financial Statement of the Consolidated Fund, 2017 and Statistics Botswana - National. Accounts Statistics Report, 2016.

3. Literature Review

3.1.Theoretical Review

Various schools of thought have attempted to describe sources of long term economic growth. The classical economist suggest that the economy is characterised by surplus labour, constant return to inputs of production, and that technological progress is endogenously linked to investment or public spending. Harrod (1939) and Domar (1946) assumed that growth was proportional to capital accumulation and therefore made emphasis on the role of saving rate.

The neo-classical models differed by indicating that economies were characterised by diminishing marginal returns. The models of Solow (1956) and Swan (1956) presents a framework for discussing TFP and suggested labour was a limited resource in the production function.

The endogenous growth models of Lucus (1988) and Mankiw et al., (1992) extended the Solow-Swan (1956) growth model by incorporating the role played by human capital in the production process. Schumpeter (1974) and Romer (1990), presented the impact of innovation in the production function and suggested that innovative ideas propel economic growth. In addition, Baier and Glomm (2001); Romer (1990) factored in the government expenditure on R&D and conclude that it enhanced TFP, leading to long run economic growth.

3.2.Empirical Review

On the empirical side, a handful of studies have analysed the impact of fiscal policy on TFP growth. However, these studies have been done in the context of developed countries. Little or no research in this area has been done in the SSA region, particularly Botswana. For instance, Dar and Amirkhalkhali (2017), analysed the impact of fiscal policy on the economy through TFP growth between 2000 2015 for 27 Organisation for Economic Cooperation and Development (OECD) countries. The study applied an aggregate production function and included variables such as employment, export growth, public investment, human capital expenditures and social transfers. The results showed that government consumption and investment had positive impact on TFP. Expenditure on human capital and social grants were also found to have similar impacts on TFP. The study associated the reduction in economic growth between 2008 and 2015 to the reduction in TFP growth. .

Evaraet et al., (2015), applied the Common Correlated Effects Pool estimator and analysed directed and indirect effects of fiscal policy between 1970 and 2012 for 15 OECD countries. The direct channel of was measured through variables such as spending on R&D, education and infrastructure, social contribution as well as total tax, corporate and consumption taxes. The indirect channel was measured through imports and FDI.

The findings of the direct channel revealed that government expenditure on R&D, education and infrastructure raised TFP growth while expenditures on social programs produced opposite results. The study also found total taxes and consumption taxes to have negative impacts on TFP growth. With respect to the indirect channel, the study found increases in corporate tax rates to hinder countries to access global technology while openness to trade improved TFP growth, particularly due to some spill over to the host country.

Hansson and Henrekson (1994) evaluated the impact of fiscal policy on TFP growth for the private sector industries in 14 OECD countries between 1970 and 1987. The study also used the Cobb - Douglas production function and found no effects of government investment on TFP growth. The study also found government spending to have move effect on the economy more through the TFP channel than on other inputs of production.

With respect to Botswana, a few studies (Matovu and Yuguda, 1999; Bank of Botswana Annual Report, 2004; Leith, 2005 and Sediakgotla and Mokoti, 2014) on TFP growth mainly focused on estimating the sources of economic growth rather than the impact of fiscal policy on TFP growth. They all applied the Cobb-Douglas production function and commonly found a downward trend of TFP growth in Botswana. These finding are in line with those of Aka et al., (2004), who also Cobb-Douglas production function and Botswana in their analysis. They analysed sources of growth for the SSA region between 1960 and 2002 and concluded that the downward trend in TFP was the main factor in dragging down the overall growth in the SSA region.

From the reviewed literature, empirical studies that estimated the impact of fiscal policy on TFP growth focused on a panel of OECD countries at the aggregate output level. They did not take into account the possible impact of fiscal policy on TFP of individual economic sectors. The lack of analysis on the sectoral TFP growth, therefore hinders the design of evidence based policies, especially those related to growth in these sectors. For natural resource endowed countries in the SSA region, there may be need to go beyond the aggregate TFP and focus on sector specific measures in order to support the economy post the natural resource era. Similarly, studies on Botswana also focus on sources of growth and this could undermine economic diversification agenda. This study therefore attempts to fills this gap by estimating the impact of fiscal policy on TFP of the non-mining, non-government sectors of the economy.

4. Methodology

4.1.Model specification

The study specifies a log-linear empirical model as presented in equation 1.

$$lTFP_t = \beta_0 + \beta_1 lmt_t + \beta_2 lsacu_t + \beta_3 lnmit_t + \beta_4 lvat_t + \beta_5 lotr_t + \beta_6 lss_t + \beta_7 lpro_t + \varepsilon_t \quad (1)$$

The variables are transformed into logs in order to interpret the coefficients as elasticities.The dependant variable in equation 1 is the log of total factor productivity (lTFP). The right hand side of this equation presents fiscal policy variables that might have an impact on TFP growth in Botswana. These are: log of mineral tax (lmt), log of SACU revenue (lsacu), log of non-mineral income tax (lnmit), log of value added tax (lvat), log of other taxes (lotr), log of expenditure on social services (lss) and log of productive expenditure (lpro). ε_t is the error term and is assumed to be a white noise process..

To achieve its objective, the study disaggregates total TFP growth in equation 1 into three sectors as presented in equations 2, equation 3 and equation 4. Where: lpr_TFP_t is the log of TFP in the primary sector; $lsec\_TFP_t$ is the log of TFP in the secondary sector and $lter\_TFP_t$ is the log of TFP in the tertiary sector. The impact of fiscal policy on these sectoral TFP growth is then modelled separately with the same variables which appear on right hand side of equation 1.

$$lpr\_TFP_t = \alpha_0 + \alpha_1 lmt_t + \alpha_2 lsacu_t + \alpha_3 lnmit_t + \alpha_4 lvat_t + \alpha_5 lotr_t + \alpha_6 lss_t + \alpha_7 lpro_t + \nu_t \quad (2)$$

$$lsec\_TFP_t = \zeta_0 + \zeta_1 lmt_t + \zeta_2 lsacu_t + \zeta_3 lnmit_t + \zeta_4 lvat_t + \zeta_5 lotr_t + \zeta_6 lss_t + \zeta_7 lpro_t + \omega_t \quad (3)$$

$$lter\_TFP_t = \lambda_2 + \lambda_1 lmt_t + \lambda_2 lsacu_t + \lambda_3 lnmit_t + \lambda_4 lvat_t + \lambda_5 lotr_t + \lambda_6 lss_t + \lambda_7 lpro_t + \rho_t \quad (4)$$

As a mineral led economy, tax revenue derived from these resources respond to developments on taxes and external factors such as demand and prices. These factors have an impact on how local industry perceives the relationship between government and exporters. The evolution of mineral tax may also directly affect other economic sectors due to the low level of economic diversification. In this regard, as a proxy for global developments, the impact of mineral tax on TFP growth is expected to be either negative or positive. Likewise, SACU revenue responds to developments on industrial policy, common external tariffs as well as regional trade. For this chapter, they are treated as a proxy for regional developments and their growth signal positive developments. Their impact on sectoral TFP growth is expected to be positive.

Increases in non-mineral income taxes may impact tax compliance and promote tax evasion and avoidance in the long run. Specifically, a rise in corporate tax may reduce the after tax profits, discourage FDI and in turn, limit prospects of technological creation and transfer. A rise in personal income tax is viewed as a disincentive to work and also reduce the individual's disposable incomes. Higher VAT rates and other taxes may also alter consumption and investment patters. In the long run, the impact of the increases in all these taxes may adversely affect TFP growth.

In this study, the impact an increase in productive spending is expected to boost TFP growth in the long run. This expectation is in line with Issakson (2007), who found knowledge to have a direct effect on TFP growth. With respect to the impact of an increase in social spending on TFP growth, literature has concluded in two ways. On the negative side, Lindbeck (2006), suggests it will lead to an inefficient use of factors of production which will deter TFP growth in the long run while on the positive side, Zhang (1995), associates it with human capital investment, which is key for TFP growth.

4.2.Estimation Technique

This study applies the ARDL model which involves the establishment of a long run relationship and can also be reparametrized into an Error Correction Model (ECM). In the short run, the speed of adjustment towards equilibrium can also be traced through the Error Correction Term (ECT). Despite Nkoro and Uko (2016) suggestion that, the ARDL methodology is suitable when dealing with a variables with different order of integration, Chigusiwa et al., (2011) argue that the this methodology will be ineffective if any of the selected variables are integrated an

order higher than 1. It is in this regard that, in this study, the first step involves checking the presence of a unit root, the study applies the Augmented Dickey-Fuller (ADF), (1981) test and the Phillips-Perron (1988) tests to confirming that none of the selected variables are integrated of the order 2.

The second step is to test for the existence of a long run relationship between the selected variables. To do this, using equation 2 (Primary sector TFP growth) as an example, the study specifies the long run relationship as presented by equation 5.

$$lpr\_TFP_t = \alpha_0 + \sum_{i=1}^{k} \alpha_1 pr\_TFP_{t-i} + \sum_{i=0}^{k} \alpha_2 lmt_{t-i} + \sum_{i=0}^{k} \alpha_3 lsacu_{t-i} + \sum_{i=0}^{k} \alpha_4 lnmit_{t-i} + \sum_{i=0}^{k} \alpha_5 lvat_{t-i} + \sum_{i=0}^{k} \alpha_6 lotr_{t-i} + \sum_{i=0}^{k} \alpha_7 lss_{t-i} + \sum_{i=0}^{k} \alpha_8 lpro_{t-i} + \nu_t \quad (5)$$

Where k is the maximum lag order selected by various information criteria such the Akaike Information Criterion (AIC); the Schwarz Bayesian Criterion (SBC); Final Prediction Editor (FPE) and Hanna-Quinn Criterion (HQC). α_1 to α_8 are the long run parameters to be estimated while *t* and ν are the time period and white noise error term, respectively. All variables in equation 5 are as previously explained.

The existence of a long run relationship between the selected variables is based on the results of the F-tests from the bounds testing procedure. The null hypothesis, is that the coefficients of the variables to be tested are jointly equal to zero against an alternative that there are not. Still using equation 5 as an example, the hypothesis for F-test between the variables in will be denoted as follows:

$H_o: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = \alpha_8 = 0$ (long run relationship exists amongst the selected variables)

$H_1: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq \alpha_8 \neq 0$ (long run relationship does not exists selected amongst the variables)

Once the long run relationship is established, the third step is to reparametrized equation 5 into the ECM through equation 6.

$$\Delta lpr\_TFP_t = \alpha_9 + \sum_{i=1}^{k} \alpha_{10}\Delta lpr\_TFP_{t-i} + \sum_{i=0}^{k} \alpha_{11}\Delta lmt_{t-i} + \sum_{i=0}^{k} \alpha_{12}\Delta lsacu_{t-i} + \sum_{i=0}^{k} \alpha_{13}\Delta lnmit_{t-i} + \sum_{i=0}^{k} \alpha_{14}\Delta lvat_{t-i} + \sum_{i=0}^{k} \alpha_{15}\Delta lotr_{t-i} + \sum_{i=0}^{k} \alpha_{16}\Delta lss_{t-i} + \sum_{i=0}^{k} \alpha_{17}\Delta lpro_{t-i} + \varphi ECT_{t-i} + \mu_t \quad (6)$$

Where α_{10} to α_{17} captures short run dynamics of the model. φ is the coefficient of the speed of adjustment of the ECT which is excepted to be negative and statistically significant.

The analysis of the ARDL residuals is also important to ensure suitability for policy analysis and recommendation. Therefore the residuals are expected to be homoscedastic, normally distributed, and serially uncorrelated. In this regard, to establish the properties of the residuals, this study conducts diagnostic tests which include, the Breusch-Pagan-Godfrey heteroskedasticity test, the Jarque-Bera normality test and the Breusch-Godfrey serial correlation LM test. In addition, the study also uses the the adjusted R-squared to determine the goodness of fit of the model. To check for model stability, the CUSUM and CUSUM sum of squares are also examined. The ARDL estimation technique is then replicated for equations 3 and 4.

4.3.Data Description and Sources

Guided by the extent of data disaggregation, this study employs annual data for the period 1984 – 2016. Fiscal data covers revenue and expenditure variables. The revenue side includes, mineral tax, SACU revenue, non-mineral income tax, VAT and other taxes revenue while the expenditure side concentrates on productive spending and government expenditure on social services. To get a proxy for actual tax rates, the study is guided by literature such as Evaraet et al., (2015) where tax revenue is divided by the appropriate tax base. For instance, mineral tax revenue is divided by mining GDP while SACU revenue, non-mineral income tax, VAT and other tax revenues are divided by non-mining GDP[5].

In line with the reviewed literature, TFP in this study is calculated by the Cobb-Douglas production function represented in equation 7.

5 Non-mining GDP is calculated by subtracting mining GDP from total GDP

$$Y_t = \mathrm{A}L_t^{\propto}K_t^{(1-\propto)} \quad (7)$$

Where Y_t is sectoral output; L_t and K_t are the amount of labour and inputs capital used in production while A is the sectoral TFP. $\propto$ and $(1-\propto)$ are the shares of labour and capital respectively and ranges between 0 and 1. Equation 7 can be re-written in logs and also be transformed into equation 8 such that TFP becomes subject of the formula. All variables in equation 2 are as previously explained.

$$lnA_t = \ln Y_t - [\propto_1 \mathrm{In}l_t - (1-\propto_2)\ln K_t] \quad (8)$$

All fiscal data is sourced from the Ministry of Finance and Economic Development. Other data used in the study includes such as capital stock and investment, employment, compensation of employees and GDP are collected from various statistical bulletins from Statistics Botswana and Bank of Botswana Annual reports (2001 – 2015). Table A1 of Appendix A provides a detailed description of the data and their sources.

5. Empirical Results

Table A2 in the Appendix A presents results of the unit root tests.[6]. The results show that, none of the variables are integrated at an order above 1. In addition, only SACU revenue is stationary in levels at 5 percent level of significance using the ADF test. The results also showed that all the dependent variables (i.e. lpr_TFP_t ; $lsec\_TFP_t$ *and* $lter\_TFP_t$) are stationary after first difference. The study therefore concludes that, the ARDL econometric approach is suitable to conduct the analysis.

For the bounds test, the Narayan (2005) critical values which are suitable for small sample sizes between 30 to 80 observations are used, instead of the Pesaran (2001) critical values for large sample data set. The sectoral bounds test results are reported in Figures A3, A4 and A5 of the Appendix A and shows that the F-statistics for primary sector (11.36752), secondary sector (5.695741) and the tertiary sectors (5.624215), are all above the Narayan (2005) critical

[6] The Phillips-Perron test was conducted to supplement where the ADF test may fall short

values at 1, 5 and 10 percent significant levels. This suggests that a long run relationship between the dependent and independent variables in all the models exists.

The optimal lag length and stability results for all estimations is also presented in Figures A3, A4 and A5 of the Appendix A. The results suggests optimal lag length of k=2 for all three models. All models seem to be stable as indicated by CUSUM and the CUSUM sum of squares which fall within the 5 percent level of significance. This suggests that the three models are suitable for policy analysis. In this regard, the sub section that follows discusses long run and short run results of the estimated models. For the short run results, change in the variable is represented by the letter D.

5.1.Results of the impact of fiscal policy on primary sector TFP in Botswana

The results of the long run and short run estimations for the impact of fiscal policy on the primary sector TFP growth are presented in Tables 1 and Table 2, respectively. Table 1 shows that, value added tax has a very high negative and statistically significant impact on primary sector TFP growth. In this regard, 1 percentage point rise in VAT triggers a 0.87 percent reduction in primary sector TFP growth. With respect to non-mining tax, the results shows that the negative impact it has on primary sector TFP growth is in-line with the study expectation. An increase in non- mineral tax reduces savings and resources needed for the productive sector. These results are similar to Vartia (2008), who found similar evidence.

Table 1 also shows that mineral tax and SACU receipts have a positive and significant impact on primary sector TFP growth. However, much significance is recorded in the former while larger impact is seen in the latter. U revenue. In this connection, a 1 percentage point increase in mineral tax and SACU revenue improves TFP growth in this sector by 0.88 percent and 1.4 percent, respectively. These results suggest that the primary sector responds positively to external and regional developments. This, to some extent is not surprising because beef production is the second largest exports after the mineral exports. Table 1 also show that, against expectation, a 1 percentage increase in other taxes will improve TFP by 1.4 percent.

With respect to expenditure, Table 1 shows that, a 1 percentage point increase in social spending will boost TFP growth in the long run by 0.72 percent. This effect is statistically

significant at 10 percent level. This result is consistent with the strand of literature which link the increase in social spending to an improvement in human capital. In addition, in line with the study expectation, an increase in productive spending has a positive impact on TFP growth in the primary sector. A 1 percentage increase in productive spending boosts TFP growth significantly by 1.1 percent. With respect to the goodness of fit, the results suggest that, the selected explanatory variables are responsible for 98 percent on changes in primary sector TFP growth.

Table 1: Long run-model estimation results for impact of fiscal policy on primary sector TFP growth in Botswana

ARDL (2,2,2,2,2,2,2,2,) selected based on AIC.				
Dependent variable: lpr_tfp				
Independent Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
LMT	0.884999	0.242727	3.646070	0.0356*
LSACU	1.415378	0.530443	2.668293	0.0758*
LNMIT	-0.723098	0.193378	-3.739288	0.0334**
LVAT	-0.874898	0.163472	-5.351979	0.0128**
LOTR	1.405952	0.315725	4.453088	0.0211**
LSS	0.721495	0.257646	2.800333	0.0678*
LPRO	1.118598	0.268127	4.171892	0.0251**
C	-1.121522	2.148600	-0.521978	0.6378
R-squared= 0.998138				
Adj R-squared = 0.983863				

Source: Author's Computation

*Note: The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively*

Table 2 presents the results of the estimated short run model. The table shows that all variables are highly significant in the short run compared to the long run. However, other taxes and government expenditure on social services are significant after the first lag. Table 2 also shows that the coefficient of the ECT has a correct negative sign, and is highly significant. The ECT coefficient suggests that 86 percent of disequilibrium will be corrected in the first year when the economy is hit by a shock. The rest of the disequilibrium will be corrected within 2 months

of the second year. This high speed of convergence implies this model will take around 1 year and 2 months (or 14 months) to revert to equilibrium after a shock.

Table 2: Short run model estimation results for the impact of fiscal policy on the primary sector TFP growth in Botswana

ARDL (2,2,2,2,2,2,2,2,) selected based on AIC.				
Dependent Variable: Dlpr_tfp				
Independent variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
D(LPR_TFP(-1))	0.258986	0.059755	4.334117	0.0227**
D(LMT)	-0.211481	0.025753	-8.211922	0.0038*
D(LMT(-1))	-1.053778	0.048527	-21.715385	0.0002*
D(LSACU)	0.923928	0.057166	16.162113	0.0005*
D(LSACU(-1))	-0.702891	0.047043	-14.941582	0.0007*
D(LNMIT)	-0.488614	0.059901	-8.157022	0.0039*
D(LNMIT(-1))	-0.286618	0.051638	-5.550556	0.0115**
D(LVAT)	-0.490313	0.035845	-13.678837	0.0008*
D(LVAT(-1))	0.545105	0.043894	12.418762	0.0011*
D(LOTR)	-0.028357	0.080719	-0.351304	0.7486
D(LOTR(-1))	-0.243994	0.048757	-5.004259	0.0154**
D(LSS)	-0.039445	0.029732	-1.326671	0.2766
D(LSS(-1))	-0.578008	0.034919	-16.552969	0.0005*
D(LPRO)	1.593228	0.118077	13.493083	0.0009*
D(LPRO(-1))	-2.193000	0.142029	-15.440556	0.0006*
ECT(-1)	-0.867535	0.044792	-19.368223	0.0003*
*Ecm = lpr_tfp-0.8849*lmt-1.4154*lsacu+0.7231*lnmit+0.8749*lvat-1.4059*lotr-0.7215*lss-1.1186*lpro+1.2152*c*				

Source: Author's Computation

*Note: The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively*

The diagnostic tests are presented in Table 3. With P-values greater than 0.05, the results suggests that the model does not suffer from serial correlation, heteroscedasticity and the residuals are normally distributed.

Table 3: Diagnostics Tests for the ARDL model of the impact of fiscal policy on the primary sector TFP growth in Botswana

Durbin-Watson = 2.498900	*Jarque-Bera = [3.718569] (0.155784)*
*Wald Test =[2979580] (0.0000)****	*Breusch-Godfrey Serial Correlation LM Test = [1.272235] (0.5312)*
	Heteroskedasticity Test: Breusch-Pagan-Godfrey = [0.218447] (0.9882)

Source: Author's Computation

*Note: Values in brackets are F-statistics while values in parentheses are p-values.The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

5.2.Results of the impact of fiscal policy on secondary sector TFP in Botswana

Table 4 shows that productive expenditure is the most significant and has largest impact on TFP growth in the long run. A 1 percentage point increase in productive spending increases TFP growth in the secondary sector by 1.05 percent in the long run. Table 4 also indicate that a 1 percentage point increase in expenditure on social services has adverse effects on TFP growth in the secondary as it reduces it by 0.46 percent. These results are in line with Romero-Avila and Strauch (2008).

On the revenue items, increases in SACU revenue and non-mineral income tax have a positive and negative impact on TFP growth in the secondary sector, respectively. However, even though these results are in line with expectation, they are not significant. This suggests that decisions in the manufacturing, construction and water & electricity sectors, to some extent, take into accounts regional developments. This is not surprising as some of the raw materials in this sector are imported from the region, mainly South Africa.

The non-significance of non-mining income tax is surprising. However, it may also reflect that the dominance of government in this sector, through state owned enterprises particularly in construction and water and electricity sub sector. This therefore suggest that a large share of changes in non-mineral tax will be absorbed by government in the long run.

With respect to VAT and other tax revenue, their negative impact on TFP growth in the secondary sector are significant and consistent with the study expectations. Specifically, a 1 percentage point increase in VAT reduces TFP growth by 0.21 percent while a 1 percentage point rise in other tax revenue deters TFP growth by 0.64 percent. The impact of VAT on TFP growth is more pronounced in the primary sector TFP growth model than in the secondary sector TFP growth model. This suggest that most products that are zero rated and/or exempted from VAT may be concentrated more in the primary sector than in the secondary sector. The results also show that changes in the mining taxes have a significant negative impact on in the TFP growth in secondary sector in the long run. In this regard, a 1 percentage point increase in mineral tax reduces TFP growth in the secondary sector by 0.53 percent. Furthermore, the adjusted R-squared in Table 4 suggests that 73 percent of changes in the TFP growth in the secondary sector is due to all the selected independent variables.

Table 4: Long run model estimation results for the impact of fiscal policy on the secondary sector TFP growth in Botswana

ARDL (1,1,0,0,0,1,1,0) selected based on AIC.				
Dependent variable is lsec_tfp				
Independent Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
LMT	-0.525397	0.116230	-4.520319	0.0002***
LSACU	0.095841	0.178929	0.535635	0.5984
LNMIT	-0.026233	0.188247	-0.139353	0.8906
LVAT	-0.218160	0.068627	-3.178916	0.0049***
LOTR	-0.642528	0.180268	-3.564287	0.0021***
LSS	-0.457990	0.105681	-4.333713	0.0004***
LPRO	1.053047	0.198536	5.304070	0.0000***
C	3.109709	0.848872	3.663342	0.0017***
R-squared = 0.830668				
Adj R-squared = 0.732634				

Source: Author's Computation

*Note: The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

Results of the short run models are given in Table 5 and only VAT and productive spending variables are significant at 5 percent and 1 percent level of significance, respectively. The ECT coefficient shows that 61 percent of short run shocks will be adjusted towards the long trajectory after an economic shock. This suggest that, it takes about and 1 year and 8 months (or 20 months) for the TFP growth of the secondary sectors to revert to equilibrium.

Table 5: Short run model estimation results for the impact of fiscal policy on the secondary sector TFP growth in Botswana

ARDL (1,1,0,0,0,1,1,0) selected based on AIC.

Dependent Variable is Dlsec_tfp

Independent Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
D(LMT)	-0.049981	0.040302	-1.240171	0.2300
D(LSACU)	0.124293	0.075536	1.645472	0.1163
D(LNMIT)	0.043530	0.099603	0.437033	0.6670
D(LVAT)	-0.144303	0.068291	-2.113069	0.0481*
D(LOTR)	-0.094414	0.111729	-0.845028	0.4086
D(LSS)	-0.016000	0.057215	-0.279647	0.7828
D(LPRO)	0.656382	0.175651	3.736843	0.0014*
ECT(-1)	-0.615440	0.080316	-7.662729	0.0000***

*Ecm = lsec_tfp+0.5254*lmt-0.0958*lsacu+0.0262*lnmit+0.2182 *lvat+0.6425*ltor+0.4579*lss-1.053*lpro-3.1097*c*

Source: Author's Computation

*Note: The asterisks ****, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

Table 6 presents diagnostic tests for the ARDL model of the secondary sector TFP growth. The results shows P-values are greater than 0.05 suggesting that the model passes the tests of no serial correlation, homoscedasticity, and normality of error terms.

Table 6: Diagnostics Tests for the ARDL model of the impact of fiscal policy on the secondary sector TFP growth in Botswana

Durbin-Watson = 2.323227	*Jarque-Bera = [0.119792] (0.941862)*

*Wald Test =[85239.17] (0.0000)****	*Breusch-Godfrey Serial Correlation LM Test = [1.159820] (0.3372)*
	Heteroskedasticity Test: Breusch-Pagan-Godfrey = [0.862510] (0.5876)

Source: Author's Computation

*Note: Values in brackets are F-statistics while values in parentheses are p-values.The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively*

5.3.Results of the impact of fiscal policy on tertiary sector TFP in Botswana

Table 7 shows that in the long run, changes in non-mineral income tax have are more detrimental to TFP growth. In this instance, a 1 percentage point rise in non-mineral income tax reduces TFP growth by 0.62 percent. This is expected as the tax burden associated with corporate and personal income taxes may affect employment and in turn reduce productivity. These findings are in line with Pombo and Galindo (2011), who found out that corporate taxes have an adverse effect on investment and productivity. The results also indicate that other tax revenue and mineral tax also have significant negative impact on TFP growth in the tertiary sector. A 1 percentage point increase in these taxes will lower TFP by 0.58 percent and 0.41 percent, respectively. However, compared to the secondary sector TFP growth model, these results indicate that increases in mineral tax and other tax revenue seem to have less impact on the tertiary sector TFP growth model. The results of a change in mineral tax re-affirms the influence and dominance of the mining sector in the economy of Botswana. Table 7 also show that SACU revenue has the least significant impact on TFP growth of the tertiary sector in the long run. A 1 percentage point increase in SACU revenue improves TFP growth in this sector by 0.24 percent. This results are consistent with the study expectation and suggests that decisions on productivity in the tertiary sector take into consideration regional economic developments. To some extent this is not surprising as most economic entities that operate in the sector have parent companies based in South Africa.

The impact of VAT on TFP growth is negative in the long run. For instance, a 1 percentage point increase in VAT reduces TFP growth by 0.32 percent in long run. This impact of VAT is larger in this model than in the primary and the secondary sectors TFP growth models. With respect to productive spending, the positive coefficient of 0.91 percent indicates by how much TFP will increase as a result of a 1 percentage point rise in decision skewed towards increases in expenditure on education, R&D and infrastructure development. These results are similar to

Gonzalez and Pazo (2008) and Dhont and Heylen (2008), who also reached the same conclusion. Table 7 also indicates that the selected independent variables contribute 89 percent variation in TFP growth in the tertiary sector.

Table 7: Long run model estimation results for the impact of fiscal policy on the tertiary sector TFP growth in Botswana

ARDL (1,1,0,0,1,1,1,0) selected based on AIC. **Dependent variable is lter_tfp**				
Independent Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
LMT	-0.418061	0.086909	-4.810355	0.0003***
LSACU	0.244509	0.137720	1.775403	0.0976*
LNMIT	-0.624472	0.058347	-10.702811	0.0000***
LVAT	-0.320376	0.046369	-6.909251	0.0000***
LOTR	-0.576128	0.134780	-4.274571	0.0008***
LSS	-0.494286	0.081347	-6.076255	0.0000***
LPRO	0.910593	0.107239	8.491261	0.0000***
C	2.046126	0.695886	2.940317	0.0107**
R-squared = 0.942719				
Adj R-squared = 0.893620				

Source: Author's Computation
*Note: The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

The results of the short-run dynamic coefficients are given in Table 8. They indicate that productive spending, non-mineral income tax and SACU revenue are significant in the short run. The coefficient of ECT shows that only 63 percent of the disequilibrium that occurred due to an economic shock will be corrected. This speed of adjustment suggest that it will take about 1 year and 7 months (or 19 months) for the TFP growth in the tertiary sector will revert to equilibrium.

Table 8: Short run model estimation results for the impact of fiscal policy on the tertiary sector TFP growth in Botswana

ARDL (1,1,0,0,1,1,1,0) selected based on AIC.

Dependent Variable is Dlter_tfp

Independent Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P-Value**
D(LMT)	-0.008202	0.037619	-0.218034	0.8305
D(LSACU)	0.194152	0.070845	2.740519	0.0159*
D(LNMIT)	0.403518	0.098896	4.080243	0.0011***
D(LVAT)	0.041712	0.072524	0.575149	0.5743
D(LOTR)	-0.029996	0.106180	-0.282503	0.7817
D(LSS)	-0.063798	0.057813	-1.103533	0.2884
D(LPRO)	0.590468	0.166030	3.556388	0.0032***
ECT(-1)	-0.625316	0.087911	-7.113023	0.0000***

*Ecm = lter_tfp+0.4181*lmt-*

*0.2445*lsacu+0.6245*lnmit+0.3204*lvat+0.5761*ltor+0.4943*lss-0.9106*lpro-2.0461*c*

Source: Author's Computation

*Note: The asterisks ****, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

The diagnostic test results for the tertiary sector TFP model are reported in Table 9. The results show that there are no traces of serial correlation and heteroscedasticity as depicted by the respective P-values of the Breusch-Godfrey Serial Correlation LM Test and the Heteroskedasticity Test, which are all greater than 0.05.In addition, the Jarque-Bera statistics suggest that the residuals are normally distributed.

Table 9: Diagnostics Tests for the ARDL model of the impact of fiscal policy on the primary sector TFP growth in Botswana

Durbin-Watson = 2.377703	*Jarque-Bera = [0.629001] (0.730154)*
*Wald Test =[31185730] (0.0000)****	*Breusch-Godfrey Serial Correlation LM Test = [2.814696] (0.0995)*
	Heteroskedasticity Test: Breusch-Pagan-Godfrey = [1.782028] (0.1507)

Source: Author's Computation

*Note: Values in brackets are F-statistics while values in parentheses are p-values.The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively.*

6. Conclusion and Policy Implications

The study analysed the impact of fiscal policy on TFP growth in Botswana using annual data between 1984 and 2016. To do this analysis, three models of primary, secondary and tertiary sectors using ARDL econometric methodology were estimated. Variables included in the study are mineral tax, SACU revenue, non-mineral income tax, VAT, other taxes revenue and productive spending as well as government expenditure on social services. The study also calculated TFP for each of the sectors using the Cobb-Douglas Production function.

The results show that in the long run, changes in mineral taxes have negative significant impact on TFP growth in both the secondary and tertiary sectors. The impact of changes on the primary sector was found to be positive. The results of the mineral tax on the sectoral TFP growth are worrying as they suggest that TFP growth will be severely affected in the post mineral production era. The results also showed that SACU revenue have positive significant impact on TFP growth in the primary and tertiary sectors only and do not have any impact on TFP growth in the secondary sector. The results of the SACU revenue also send a signal that post the SACU revenue reduction era, TFP growth in the primary and tertiary sectors will be affected.

The impact of non-mineral income tax on sectoral TFP growth produced some mixed results. For instance, the impact is seen to be significant and negative in the primary sector TFP growth model while it is insignificant in the secondary sector TFP growth model. However, much of this impact is more pronounced in the primary sector.

The results also support the literature that associates the increase in VAT with a negative TFP growth. However, in Botswana, this impact is much felt in the primary sector. With respect to the other tax revenue, in the long run, it has a negative significant impact on TFP growth in the secondary and tertiary sectors and a positive significant impact on TFP growth in the primary sector.

The findings also revealed that that productive spending has positive significant impact on TFP growth in all sectors. This is encouraging as this suggests that current policies on productive spending are bearing fruits. The results also revealed that expenditure on social services reduces TFP growth in the secondary and tertiary sectors but improves it in the primary sector.

With respect to the speed of adjustment, the results showed that the only sector that recorded a faster speed of adjustment to equilibrium is the primary sector. This suggests that, overall, fiscal policy decisions will have a greater detrimental impact on TFP growth in the secondary and tertiary sectors.

These results suggest some interesting policy implications for Botswana. Overall, they offer authorities (not only in Botswana), with a much clear understanding of how their fiscal policy decisions affect sectoral TFP. Specifically, the results of productive spending on TFP growth provide an opportunity to diversify the economy from a resource driven one to a knowledge based economy. In light of this, authorities should therefore, design an enforceable fiscal rule that focuses on productive spending. However, to ensure sustainability, this rule should be financed through non-mineral non SACU revenue. This will be sustainable in the long run, especially after the collapse of these two revenue sources. The result also suggest that there might be room to improve TFP in the primary sector by adopting a policy that increases in other tax revenue and expenditure on social services. However, the impact that these policy options may have on TFP growth of other sectors must be taken into consideration. The results also suggests that there may be need to re-evaluate policies relating to mineral tax and VAT as they seem to have negative impact on TFP growth across all sectors. The results of SACU revenue suggest that there may be room to boost TFP growth in the primary and tertiary sectors by implementing policies that promote and enhance collection. The negative impact on sectoral TFP growth arising from adjusting non-mineral income tax upwards should also be taken into consideration during policy design stage as it has the potential to deter benefits associated with foreign direct investment and weigh on TFP growth in the long run.

Lastly, to achieve sustainable long term growth, there is need to raise the TFP across all three sectors. In order to do this, the development and implementation of fiscal policy should be mindful of the varying impacts on productivity of each sector. For this to occur, government policies towards improving TFP growth needs to be sector specific. This is because focusing on the impact of fiscal policy on the overall TFP growth will lead to wrong policy formulation and implementation which may be not yield the intended results. Furthermore, care must be taken when dealing with policies that have significant impact on secondary and tertiary sectors as they have a potential to drive the economy post the mineral led economy era.

For these policies to work, commitment from all stakeholders will be vital to ensure that burden on economic agents is minimised. Policy dialogue between sectoral players during the policy design stage will therefore play a key role in ensuring that the intended policy outcome is realised.

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7. Appendix A

Table A1. Variable Description, Data Sources and Expected Signs

Variable	Description	Source	Expected sign
lpr_tfp	Log of primary sector TFP	Statistics Botswana	Positive
lsec_tfp	Log of secondary sector TFP	Statistics Botswana	Positive
Lter_tfp	Log of tertiary sector T	Statistics Botswana	Positive
Lmr	Log of mineral revenue	Statistics Botswana	Ambiguous
lsacu	Log of SACU revenue	MFED	Ambiguous
lmnit	Log of non-mineral income tax revenue	MFED	Negative
lvat	Log of value added tax revenue	MFED	Negative
lotr	Log of other taxes revenue	MFED	Negative
lpro	Log of productive spending	MFED	Positive
lss	Log of expenditure on social services	MFED	Ambiguous

Source: Author's Computation

Table A2. Unit Root Test (Trend and Intercept)

	Level		**First Difference**		**Conclusion**
Variable	ADF	PP	ADF	PP	
	P-Value	P-Value	P-Value	P-Value	
lpr_tfp	-3.133780	-2.688491	-5.849809	-5.840449	*I(1)*
	(0.1159)	(0.2476)	(0.0002)***	(0.0002)***	
lsec_tfp	-1.841239	-2.164130	-4.970460	-4.963643	*I(1)*
	(0.6609)	(0.4924)	(0.0019)***	(0.0019)***	
Lter_tfp	-1.130428	-1.338715	-5.202972	- 5.203667	*I(1)*
	(0.9077)	(0.8595)	(0.0011)***	(0.0011)***	
Lmt	-0.863042	-3.109991	-4.891857	-6.579372	*I(1)*
	(0.9461)	(0.1217)	(0.0028)***	(0.0000)***	
lsacu	-4.209436	-2.588405	-3.990117	-4.781920	*I(0)*
	(0.0122)**	(0.2876)	(0.0202)**	(0.0031)***	
lmnit	-2.809559	-2.867715	-4.681651	-5.118492	*I(1)*
	(0.2046)	(0.1860)	(0.0040)***	(0.0014)***	
lvat	-0.509164	-0.342704	-5.584238	-8.708942	*I(1)*
	(0.9776)	(0.9854)	(0.0004)	(0.0000)	
lotr	-1.215609	-1.659359	-5.070298	-5.092180	*I(1)*
	(0.8896)	(0.7450)	(0.0016)***	(0.0015)***	
lpro	-3.184990	-1.590678	-3.797180	-4.645727	*I(1)*
	(0.1059)	(0.7743)	(0.0355)**	(0.0042)***	
lss	-3.151117	-2.406963	-4.599128	-6.301896	*I(1)*
	(0.1128)	(0.3692)	(0.0049)***	(0.0001)***	

Source: Author's Computation

*Note: The asterisks ***, ** and * denote significance level at 1 per cent, 5 per cent and 10 per cent, respectively. Values in in parentheses are p-values*

Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	16.37210	NA	7.90e-11	-0.558140	-0.184488	-0.438606
1	194.3218	249.1295*	4.62e-14	-8.154784	-4.791910*	-7.078972
2	286.8645	80.20370	1.99e-14*	-10.05763*	-3.705538	-8.025543*

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

Bounds Test

Critical Value bounds of the F statistic: restricted intercept and no trend

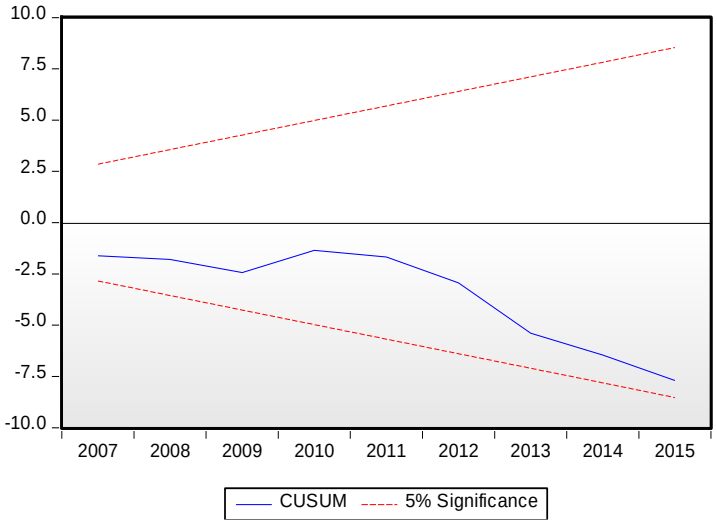
90 percent level		95 percent level		99 percent level	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.277	3.469	2.730	4.163	3.864	5.614

F- Statistic: **11.36752**

Sample Size: 30

Number of regressors: 7

Cusum Stability Test



Cusum of Squares - Stability Test

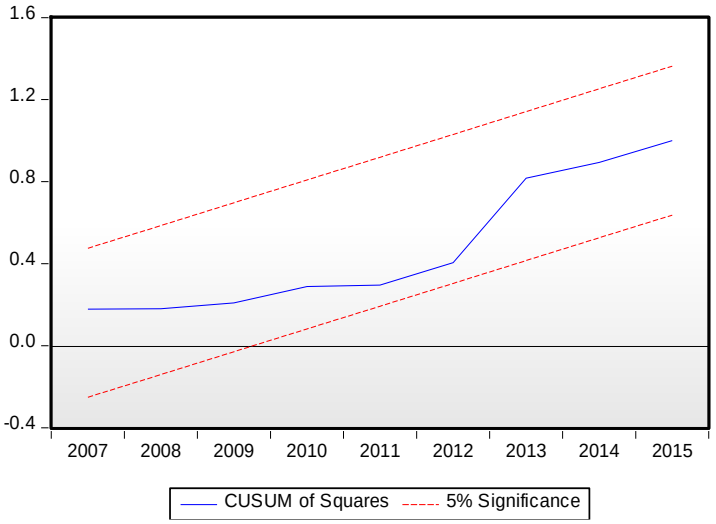


Figure A3. Lag Length Selection Criteria, Bounds test and Stability Test for the Primary Sector TFP Model
Source: Author's Computation

Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	28.95406	NA	3.42e-11	-1.396937	-1.023285	-1.277403
1	210.2778	253.8532*	1.60e-14	-9.218518	-5.855644*	-8.142706
2	303.1487	80.48812	6.74e-15*	-11.14324*	-4.791150	-9.111155*

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

Bounds Test

Critical Value bounds of the F statistic: restricted intercept and no trend

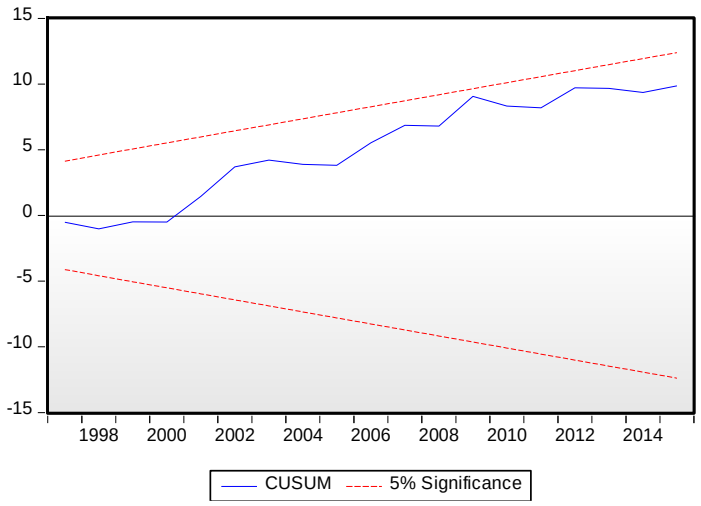
90 percent level		95 percent level		99 percent level	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.277	3.469	2.730	4.163	3.864	5.614

F- Statistic: **5. 695841**

Sample Size: 32

Number of regressors: 7

Cusum Stability Test



Cusum of Squares - Stability Test

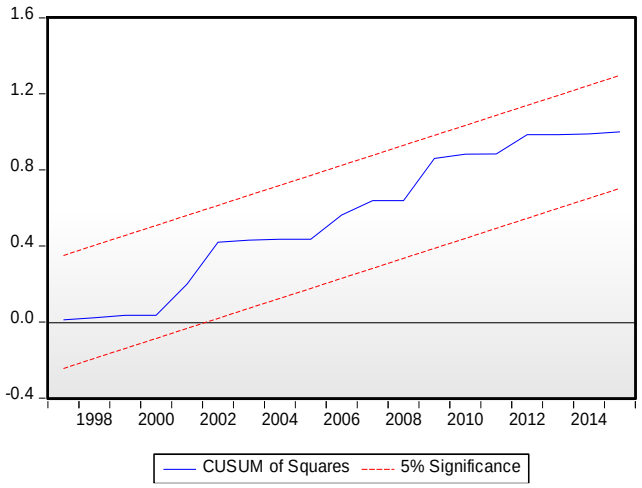


Figure A4. Lag Length Selection Criteria, Bounds test and Stability Test for the Secondary Sector TFP Model
Source: Author's Computation

Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	28.10946	NA	3.61e-11	-1.340631	-0.966978	-1.221096
1	207.5934	251.2776	1.91e-14	-9.039562	-5.676689*	-7.963750
2	305.8547	85.15977*	5.62e-15*	-11.32365*	-4.971553	-9.291558*

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

Bounds Test

Critical Value bounds of the F statistic: restricted intercept and no trend

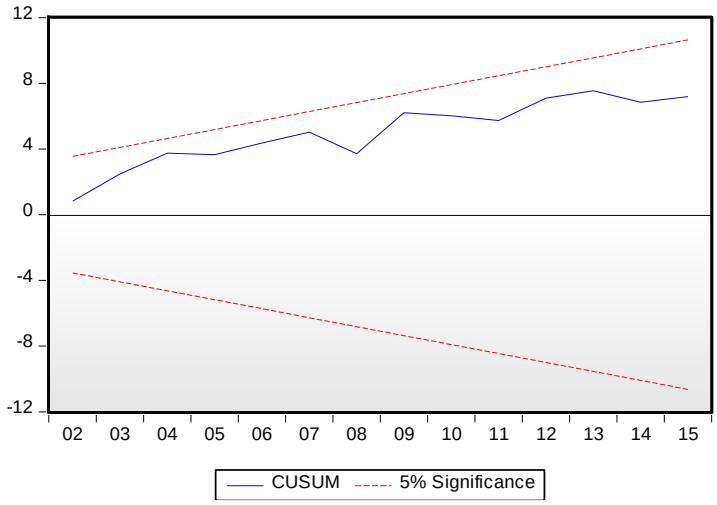
90 percent level		95 percent level		99 percent level	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.277	3.469	2.730	4.163	3.864	5.614

F- Statistic: **5. 624215**

Sample Size: 30

Number of regressors: 7

Cusum Stability Test



Cusum of Squares - Stability Test

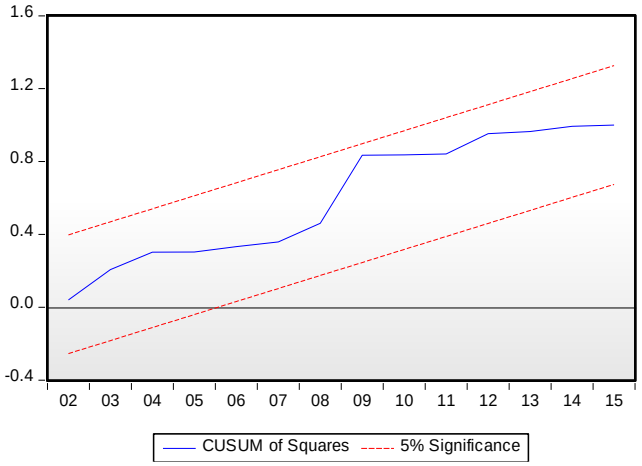


Figure A5. Lag Length Selection Criteria, Bounds test and Stability Test for the Tertiary Sector TFP Model
Source: Author's Computation