Government expenditure and economic growth: Testing for nonlinear effect among SADC countries, 1993-2017

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Abstract

The relationship between government spending and growth in 10 SADC countries, over the period 1994 to 2017, using BARS theories, have been examined. The PSTR model is used to determine the threshold and transition function at which the excessive government expenditure deteriorates economic growth. The results show that there is a non-linear relationship between government spending and growth. The estimated threshold level of government expenditure is found to be 25.40 % of the GDP. The findings confirm the existence of the BARS inverted U-shape. This study proposes that policymakers ought to formulate prudent fiscal policies that encourage government expenditure, which would improve growth for those countries which are below the estimated threshold point. Those countries approaching the threshold point need to monitor their government spending so that it does not surpass the threshold.

Keywords words: Economic growth; government expenditure; PSTR model, SADC.

1. Introduction

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The effect of government expenditure on economic growth has been an issue that has been debated over the past decade, especially when considering the efficacy of fiscal policy. Up to date, both the empirical results and theoretical predictions are controversial in identifying the role of government spending on economic life. Previous studies examining the impact of government spending on economic growth, primarily employed a linear estimation technique, while others estimated a nonlinear model. Some studies (Chen and Lee, 2005; Abounoori and Nademi, 2010; Chiou-Wei *et al.*, 2010; Aydin *et al.*, 2016) employed a nonlinear model, in different counties, using different time spans. Their findings revealed that a nonlinear effect of government expenditure on economic growth indeed exists. While some studies that employed a linear model found that government expenditure tends to improve economic growth (Ram, 1986; Schaltegger and Torgler, 2006; Bose, Haque *et al.*, 2007; Esen and Bayrak, 2015). Other studies found that government spending affects economic growth negatively (Guseh, 1997; Dar and AmirKhalkhali, 2002; Roy, 2009; Afonso and Furceri, 2010).

The argument behind those studies that found that government expenditure reduces economic growth, is that high government spending cuts the rate of economic growth, by reducing the level of national investment. Barro (1990) argued that the impact of public expenditure on economic growth depends on the level of development, which means that as the economy expands, the effect of government spending on economic growth changes. It also depends on the distinction between the non-productive and productive government expenditure. Production of public services or goods, which is an input in the private sector production process, promoting physical and human capital investments and having economic externalities, may affect economic growth positively. Moreover, eliminating market failures and ensuring political-stability by government intervention in the economies have been seen as one of the main determinants of economic growth (Barro, 1991). Karras (1997) pointed that an increase in government expenditure results in a decline in economic growth, since the diminishing returns to scale comes into action, if the size of the government is larger than the optimal level. Goel and Nelson (1998) and Graeff and Mehlkop (2003) argued that an expansion on the scope or size of government leads to corruption, and may open room for further regulations that encourage individuals to find illegal ways to evade these rules and boundaries.

The aim of this paper is to investigate the relationship between government expenditure and economic growth, in the case of SADC region, by testing the BARS inverted U-curve. The paper also aimed to find the threshold level of government expenditure that adversely affects economic growth. To investigate the existence of threshold, the study makes use of the Panel Smooth Transition Regression (PSTR) model. The following SADC countries are selected due to the availability of data: Botswana, Comoros, DRC, Swaziland, Mauritius, Mozambique, Namibia, South Africa, Tanzania and Zimbabwe.

The theoretical model of this study is based on the analysis carried out by Barro (1989), Armey (1995), Armey and Armey (1995), Rahn and Fox (1996) and Scully (1994; 1995). This theory is commonly known as the BARS inverted U-curve. The BARS curve measures the relationship between the size of the government and the economic growth. The inverted U-shape of the BARS curve simply means that government expenditure is good for economic growth up to a certain point beyond which government expenditure depresses economic growth (Aleksandrivich and Upadhyaya, 2015). The logic underlying the BARS curve is based on the theory of government failure and markets failure. Mathematically, the BARS curve can be expressed as the following:

$$GROWTH = \alpha + \beta GEXP - \gamma GEXP^2 \qquad (1)$$

The equation above states that economic growth, measured by real GDP (GROWTH), is dependent on the size of the government expenditure (GEXP). The negative coefficient of $GEXP^2$ shows the negative effect of government size on economic growth (Tabassum, 2015), while the positive sign of the coefficient EG indicates the beneficial effect of government expenditure on economic growth (Carter *et al*., 2013).

There are many factors that might lead government spending to depressed economic growth, for instance government intervention with taxation discourages productive behaviour like hard work and investment (Vedder and Gallaway, 1998), as noted by Peden (1991), government activities that reduces economic activities, such as transfer payments. Transfer payments discourage people for taking employment, and this, therefore, declines output. The existence of the public sector also creates the opportunity of earning economic rent from unproductive activities, like having access to official foreign exchange and selling on the black market, thereby earning economic rent (Peden, 1991). This discourages some talented individuals from engaging in productive activities. In contrast, there are certain aspects of government expenditure that account for a positive effect on economic growth. One may argue that an intervention of the state to remedy the market's failure and to stimulate economic activities is the provision of public goods in order to promote economic growth. If the private sector may be left alone to provide public goods, the quantity of public goods provided will be inadequate (education, roads, sanitation, etc.) (Di Matteo, 2013).

1.1 Empirical literature

After scrutinising the literature, it can be seen that the relationship between government spending and economic-growth is classified into three different strands, namely nonlinear (quadratic), negative and positive. However, the main argument of this paper, drawn on the first strand, hypothesises that the relationship between government spending and economic growth is in a non-linear form.

The *first strand* follows the BARS curve, arguing that there is a non-linear relationship between government expenditure and economic growth (Vedder and Gallaway, 1998; Pevcin, 2004; Chen and Lee, 2005; Abounoori and Nademi, 2010; Chiou-Wei *et al.*, 2010; Aydin *et al.*, 2016).

The argument behind this nonlinearity relationship, is that below the threshold regime, low government-spending gradually declines economic growth. However, after the threshold point, high government spending positively stimulates the economy. Therefore, in the first strand, the argument behind the nonlinear relationship between government expenditure and economic growth combines both positive and negative relationships in explaining the nature of the relations between the two variables. Hence, the quadratic relations between government-expenditure and economic-growth are questioned and allied with the level of economic growth.

The *second strand* contained studies that believe that government spending and economic growth are linear in nature and that they are negatively related (Bader and Qarn, 2003; Mitchell, 2005; Roy, 2009; Afonso and Furceri, 2010).

The study by Afonso and Furceri (2010) found that economic growth is negative related with government spending. The authors further stated that an increase in government spending will negatively affect interest rates, which will negatively affect public investment. The crowding out effect is likely to incur in such a situation.

The study by Mitchell (2005) investigated the government expenditure and economic growth trend by looking at two and three decades in 15 countries within the European Union and United States. The author found that an increase in government expenditure is bad for economic growth. Hence, after scrutinising all studies in the second strand, the argument behind the negative relationship between government expenditure and economic growth is an injection on government-spending which contributes to the increase in interest rates. Thus, high interest rates lead to the crowding out effect on private-investment. Therefore, the government expenditure are subject to the law of diminishing-returns, believing that an additional expenditure which results into a decline on economic-growth. Consequently, economic fragile would be expected, if the country is facing such process, which will automatically lower investment, then disturb the competent distribution of resources.

High government expenditure automatically contributes to high budgets deficits, which would have a bad consequences on the tax payer, because in order for the state to get additional burden to finance the budget deficit, taxation would need to increase. The measure problem is that due to anti-elitist concerns it is not an easy task to finance the budget deficit, but it would be restrained through borrowings. Hence, borrowing will contribute to current account deficits. Therefore, having budget deficits will eventual lead to the emergence of twin deficits which burdens the country to financial fragility.

Apart from that this will contribute high inflation. All in all these studies believe that an increase in government spending is not a good tool in boosting the economy, due to that it has many negative consequences to the economy as whole, apart from that even to citizen.

The *third strand* follows the *Wagner's Law*, which hypothesises that there is a positive relationship between government expenditure and economic growth (Ghali, 1998; Haque and Osborn, 2007; Wu *et al.*, 2010; Loto 2011; Akpan and Abang, 2013; Carter *et al.*, 2013; Ghose and Das, 2013; Esen and Bayrak, 2015).

The study by Loto (2011) examined the impact of government expenditure on economic growth using the error correction model in Nigeria over the time span 1980-2008. The author found that there is a positive relationship between government spending (health) and economic growth. The study also showed that an increase in government spending (agriculture) declined the level of economic growth in Nigeria.

Carter *et al.* (2013) examined the relationship between government expenditure and economic growth focusing on a small economy in Barbados, using dynamic-ordinary least squares, as well as the unrestricted error correction model, using a time series-data over the period 1976-2011. The empirical results supported the positive relationship between government spending and economic growth.

Ghose and Das (2013) conducted a study concerning 19 developing countries, using a panel co-integration approach finding the relationship between the size of the government and economic growth. The empirical findings supported the third strand of a positive relationship between the two variables.

The argument behind these studies is that increasing government expenditure is a tool that can help the government in stimulating the economy. These studies take government spending as a form of insurance, assuming that the economy would be stabilized when the private property rights properly performs their functions.

The argument behind this would be based on the assumption that development would be driven by an increase in government spending through health care, infrastructure and education, which also play a vital role in improving private investment, therefore, high investment leads to an expansion of economic growth.

By including property rights, it becomes possible for society to meet a higher productivity trading relationship and to enjoy the benefits of voluntary exchange (Grossman, 1988). The view is that government, which is assigned a critical role to a reconciliation of conflicts between private and social interests, provides socially optimal direction to economic growth, while development becomes a focus consideration. Moreover, there are points of view arguing that in countries that are based on a monopoly market, and do not have capital-insurance-information markets, government investments will further increase the efficiency of factor and commodity markets and reveal the effects of externality for the private sector.

2. Analytical Model

This study aimed to examine the nonlinear effect of government expenditure on economic growth in SADC region over the period 1994-2017. The study further aimed to find the threshold below which the relationship is positive and above which the relationship is negative. These aims were accomplished by using the PSTR model due to its advantage of addressing the nonlinear problems.

2.1. Panel Smooth Transition Regression (PSTR) Model

To evaluate the nonlinear relationship between government expenditure and economic growth, the PSTR model, developed by González *et al.* (2005) was used. The simplest case of the PSTR model is with two extreme regimes or one threshold in single transition function in illustrating the threshold effect of government expenditure (G_{it},) on economic growth (y_{it}):

$$y_{it} = \mu_i + \lambda_t + \beta_0' x_{it} + \beta_1' x_{it} g(G_{it}, \gamma, C) + \varepsilon_{it} \qquad [1]$$

Where y_{it} is a dependent variable which is a scalar, then $i = 1, \dots, N,$ and $t = 1, \dots, T$ indicate cross-section and the time dimensions of the panel respectively. Moving forward, the dependent variable is simply denoted by y_{it} , which is a scalar. Whereas, λ_t and μ_i signifies the time-effect and fixed individual effect correspondingly and ε_{it} denotes the errors' term. Hence, a k-dimensional vector of time-varying exogenous-variables (Government expenditure) are denoted by x_{it} and thus the transition function $g(G_{it};\gamma,c)$ is a continuous function and depends on the threshold variable G_{it} and normalized to be bounded between 0 and 1. These extreme values are associated with regression coefficients $\beta 0$ and $\beta 0+\beta 1$.

More generally, the value of the transition variable G_{it} determines the value of $g(G_{it};\gamma,c)$ and thus the effective regression coefficients $g(G_{it};\gamma,c)$ for individual i at time t, as with Teräsvirta (1994, 1998) and Jansen and Teräsvirta (1996), also in Teräsvirta *et al.* (2010, Chapter 3), by using the logistic specification:

$$(G_{it};\gamma,c)=\left(1+\exp\left(-\gamma\prod_{j=1}^{m}(G_{it}-cj)\right)\right)^{-1} \textit{with}\ \gamma>0\ \textit{and}\ c_1\leq c_2\leq\cdots c_m \quad [2]$$

In equation two, $c_j=(c_1,\ldots,c_m)$', which is m dimensional vector of parameters location, the slope parameter denoted by γ controls the smoothness of the transitions. Moreover, $\gamma>0\ \textit{and}\ c_1<\cdots<c_m$ are restrictions imposed for identification purposes. In practice, $m=1\ \textit{or}\ m=2$ is usually considered as values that allow the commonly-encountered types of variation in the parameters. The model suggests that both extreme regimes are related, with high and low values of G_{it} for $m=1$, from $\beta_0+\beta_0+\beta_1$ is a monotonic transition of the coefficient, when G_{it} is increasing, where the alteration is fixed around c_1.

When $g(G_{it};\gamma,c)$ becomes a pointer function $I[G_{it}>c_1]$, $\gamma\rightarrow\infty$, as demarcated by $I[A]=1$ when A takes place and 0 otherwise. In this case, the STAR proposed by Hansen (1999) is reduced in the PSTR model by the two regime panel threshold in equation 1. The model falls into a homogenous or linear panel-regression model with fixed-effects. The PSTR model will then be generalised in order to allow more than two different regimes at the additive model:

$$y_{it}=\mu_i+\lambda_t+\beta 0x_{it}+\sum_{j=1}^{r}\beta_j'\,x_{it}g_j(G_{it}^{(j)};\gamma_j,c_j)+\varepsilon_{it} \qquad [3]$$

The transformation $g_j(G_{it}^{(j)};\gamma_j,c_j),j=1,\ldots r$ are simply defined by equation 2 with a polynomial degrees m_j. When $m_j=1, G_{it}^{(j)}=G_{it}$ and $\gamma_j\rightarrow\infty$ when $j=1,\ldots r$ then equation 3 falls to PSTR model with $r+1$ regimes. This become helpful for the test of no remaining nonlinearity and time varying.

2.2 Model Specification Test: Testing Homogeneity

In the PSTR model, the specification stage in the modelling cycle consists of testing the homogeneity against the PSTR. The homogeneity test is helpful in identifying the appropriate transition variable G_{it} in a set of candidate's transition variables that strongly reject H_0 of the linearity. The sequence for selecting the order m of the transition function under the null hypothesis, $H_0^*: \beta_3^* = \beta_2^* = \beta_1^* = 0$ for selecting $m = 3$, if it is rejected, it will continue to test $H_{03}^*: \beta_3^* = 0, H_{02}^*: \beta_2^* = 0 | \beta_3^* = 0$ and $H_{01}^*: \beta_1^* = 0 | \beta_3^* = \beta_2^* = 0$, in selection $m = 2$, if it still fails, $m = 1$ will be selected a default [2] (Granger and Teräsvirta, 1993; Teräsvirta, 1994; Teräsvirta *et al.*, 2010).

Testing homogeneity against the PSTR is important for two reasons. Firstly, if there is statistical-issue, specifically, the PSTR model does not identify if the data-generating process is homogeneous, and to evade the estimation of unidentified models, homogeneity has to be tested in the first stage. Secondly, a homogeneity test may be useful for testing propositions from economic theory. By imposing either $H_0: \gamma = 0$ or $H_0' : \beta_1 = 0$, the PSTR model in equation 1 and equation 2 is reduced to a homogeneous model. In testing the homogeneity, $H_0: \gamma = 0$ is used, where $g(G_{it}; \gamma, c)$, is imposed in avoiding the identification problem in equation 1 by its first-order Taylor development around $\gamma = 0$. After reparameterisation, this leads to the auxiliary-regression:

$$y_{it} = \mu_i + \beta_0'^* x_{it} + \beta_1'^* x_{it} G_{it} + \cdots + \beta_m'^* x_{it} G_{it}^m + u_{it}^* \qquad [4]$$

Where $(\beta_1^*, \dots, \beta_m^*)$ are the parameter-vectors that are multiples of γ and $u_{it}^* = u_{it}^* + R_m \beta_1' x_{it}$, where R_m is the remainder of Taylor-expansion. Thus, testing the $H_0^*: \beta_1^* = \cdots, = \beta_m^* = 0$ in (3), is equivalent to testing H_0 in equation 1. The H_0 will be tested using the Lagrange Multiplier-Wald test and the Lagrange Multiplier-Fischer test, since both are for testing the linearity within the PSTR model. Hence, the Taylor series estimate does not touch the asymptotic-distribution theory when the null-hypothesis is verified by an LM-test, because note that under the null hypothesis $\{u_{it}^*\} = \{u_{it}^*\}$. The LM-type statistic can be defined by writing (3) in a matrix-notation as follows:

$$y = D_\mu \mu + X\beta + W\beta^* + u^* \qquad [5]$$

Where $y = (y_1', .., y_N')$ with $y_i = (y_{i1}', .., y_{iT}')$, $i = 1, \dots, N, D_\mu = (I_N \otimes i_T)$ where I_N is the $(N \times N)$ identity-matrix, i_T a $(T \times 1)$ vector of ones, and $\mu = (\mu_1, \dots, \mu_N)$. Besides $X = (X_1', \dots, X_N')$ where $X_i =$

[2] The reasoning behind this simple rule is explained in Teräsvirta (1994).

$(x_{i1}, \ldots, x_{iT})$, where $W = (W_1', \ldots, W_N')$ with $W_i = (w_{i1}, \ldots, w_{iT})$, and $w_{it} = (x_{it}' G_{i1}, \ldots, x_{it}' G_{it}^m), \beta = \beta_0^*$ and $\beta^* = (\beta_1^{*\prime}, \ldots, \beta_m^{*\prime})$. Lastly $u^* = (u_1'^*, \ldots, u_N'^*)$.

The LM test-statistic takes the form:

$$LM_\chi = \hat{u}^{0\prime} \breve{W} \Sigma^{-1} \breve{W} \hat{u}^0 \qquad [6]$$

Estimating the model under the null-hypothesis, where $\hat{u}^0 = (\widehat{u_1}^{0\prime}, \ldots, \widehat{u_N}^{0\prime})$, it yield the vector of residuals and the standard within the transformation-matrix becomes $M_\mu = I_{NT} - D_\mu (D_\mu D_\mu)^{-1} D_\mu$ where $\overline{W} = M_\mu W$. In addition, $\hat{\Sigma}$ is a reliable estimator of the covariance-matric $\Sigma = (\hat{\beta}^* - \beta^*)(\hat{\beta}^* - \beta^*)$, when the errors are identically distributed across time-individuals and homoscedastic, the standard covariance-matrix estimator takes this form:

$$\hat{\Sigma}^{HAC} = \left[-\widetilde{W}' \check{X} \left(\widetilde{X'} \widetilde{X'}\right)^{-1} : I_{km}\right] \hat{\Delta} \left[-\widetilde{W}' \check{X} \left(\widetilde{X'} \widetilde{X'}\right)^{-1} : I_{km}\right]' \qquad [7]$$

Where I_{km} is $(km \times km)$ identity-matrix, and $\widehat{\Delta} = \sum_{i=1}^{N} \widetilde{Z_\iota}' \widehat{u_1}^{0\prime} \widehat{u_N}^{0\prime} \widetilde{Z_\iota}$. With $\widetilde{Z_\iota} = I_T - i_T (i_T' i_T)^{-1} i_T') Z_i$, where $Z_i = [W_i, W_i], i = 1, \ldots, N$ the estimator in equation 8 become consistent for a fixed T as $N \to \infty$, as it is clarified in Arellano (1987) and Hansen (2007). For an analysis of the remaining-cases, in which T as $N, T \to \infty$, with a fixed N. LM_χ, becomes asymptotically-distributed as $\chi^2(mk)$, under the null-hypothesis, where the F-version $LM_F = LM_\chi (TN - N - l - mk)/(TNmk)$ has an estimated $F(mk, TN - N - k - mk)$ distribution.

2.3 Model Evaluation

Model evaluation in the panel smooth transition regression is an important part of the model building procedure. In this paper, two misspecification test were considered. The first one is that of the parameter of constancy over time and of no remaining linearity in the model, as developed by Eitrheim and Teräsvirta (1996), for univariate STAR models to fit the present panel framework.

2.4 Testing Parameter Constancy

Equation 1 is set for parameter constancy in sense that variables change smooth over time, therefore, the alternative model may be called a time-varying panel smooth transition regression (TV-PSTR) model as follow:

$$y_{it} = \mu_i + (\beta_{10}' x_{it} + \beta_{11}' x_{it} g(G_{it}; \gamma_1, c_1)) + f(t/T\,; \gamma_2, c_2)(\beta_{20}' x_{it} + \beta_{21}' x_{it} g(G_{it}; \gamma_1, c_1)) + u_{it} \quad [8]$$

The TV-PSTR model accommodates various alternatives to parameter constancy, depending on the definition of $f(t/T\,;\gamma_2,c_2)$. This function is assumed to have the form:

$$f(t/T\,;\gamma_2,c_2)=\left(1+exp\left(-\gamma_2\prod_{j=1}^{h}(t/T-c_{2j})\right)\right)^{-1} \qquad [9]$$

Where $c_2=(c_{21},\dots,c_{2h})'$ is a $h-dimensional$ vector of location parameters, with $c_{21}<\ c_{22}<\cdots<c_{2h}$, and $\gamma_2\ >0$ is the slope parameter. This collapse to Eq.10 is in order to be able to use LM-type test for parameter constancy,

$$\begin{aligned}y_{it}&=\mu_i+\beta_{10}^{*'}x_{it}+\beta_1^{*'}x_{it}(t/T)'+\beta_2^{*'}x_{it}(t/T)^2+\cdots+\beta_h^{*'}x_{it}(t/T)^h\\&\quad+\left(\beta_{11}^{*'}x_{it}+\beta_{h+1}^{*'}x_{it}(t/T)^2+\cdots+\beta_{2h}^{*'}x_{it}(t/T)^h\right)g(G_{it};\gamma_1,c_1)+u_{it}\ [10]\end{aligned}$$

Where $u_{it}^*=u_{it}+R_h(t/T\,;\gamma_2,c_2)$ and $R_h(t/T\,;\gamma_2,c_2)$ is the remainder term. In (15), the parameter vectors β_j^* for $j=1.2,\dots,h,h+1,\dots 2h$ are multiples of γ_2, such that the null hypothesis in (12) can be reformulated as $H_0^*{:}\,\beta_j^*=0$ for $j=1.2,\dots,h,h+1,\dots 2h$ in the auxiliary regression. Under H_0^* $\{u_{it}^*\}=\{u_{it}\}$, the Taylor series approximation does not affect the asymptotic distribution theory. The χ^2- and F-versions of the LM-type test can be computed as in (6) defining $w_{it}'=\left(\,x_{it}'\,x_{it}'\,g(G_{it};\gamma_1,c_1)\right)\otimes s_t'\ with\ s_t=(\,(t/T),\dots,(t/T\,))^h)'$ and replacing $\bar{X}$ in (7) and (8) by $\bar{V}=M_\mu V$, where $V=V_1',\dots,V_N'$ where $u_{it}=(\,x_{it}'\,x_{it}'\,g(G_{it};\gamma_1,c_1),(\partial\,\hat{g}/\partial\gamma_1)\,x_{it}'\hat{\beta}_2,(\partial\,\hat{g}c_1/\partial)\,x_{it}'\hat{\beta}_2)',$. Under the null hypothesis, LM_χ is asymptotically distributed as $\chi^2(2hk,)$and $LM_F=\ LM_\chi/2hk$ is approximately distributed as $F(2hk,TN-N-2K(h+1)-(m+1))$.

2.5 Test of the Hypothesis of No Remaining Heterogeneity and Time Varying

The assumption that a two-regime PSTR model (1) with (2) adequately captures the heterogeneity in a panel data set can be tested in various ways. In the PSTR framework, it is a natural idea to consider an additive PSTR model with two transitions ($r=2$) as an alternative. Thus,

$$y_{it}=\mu_i+\beta_0'^{*}x_{it}+\beta_1'^{*}x_{it}g_1(G_{it}^{(1)};\gamma_1,c_1)+\beta_2'^{*}x_{it}g_2(G_{it}^{(2)};\gamma_2,c_2)+u_{it}^* \qquad [11]$$

Where the transition variables $G_{it}^{(1)}$ it and $G_{it}^{(2)}$ it can be, but need not be, the same. Then H_0 of no remaining heterogeneity in an estimated two-regime PSTR model will be formulated as $H_0{:}\,\gamma_2=0$ in (7).

This testing procedure has its own problems due to the presence of unidentified nuisance parameters under H_0. The identification problem would be terminated by replacing $g_2(G_{it}^{(2)}; \gamma_2, c_2)$ by a Taylor expansion around $\gamma_2 = 2$. This leads to the auxiliary regression

$$y_{it} = \mu_i + \beta_0^{*\prime} x_{it} + \beta_1^{*\prime} x_{it} g_1\left(G_{it}^{(1)}; \hat{y}_1, \hat{c}_1\right) + \beta_2^{\prime *} x_{it} G_{it}^{(2)} + \cdots + \beta_{2m}^{*\prime} x_{it} G_{it}^{(2)m} + u_{it}^* \quad [12]$$

Where $\hat{y}_1$ and $\hat{c}$ are estimates under H_0 . Thus $\beta_{21}^*, \dots, \beta_{2m}^*$ are multiples of γ_2 the hypothesis of no remaining heterogeneity can be restated as $H_0^*: \beta_{21}^*, \dots, \beta_{2m}^* = 0$. If $\beta_1 \equiv 0$ in (17), and the resulting test collapses into the homogeneity test. In order to compute the LM test statistic defined in (7) and its F-version, by setting $w_{it} = x_{it}' G_{it}^{(2)} + \cdots + x_{it}' G_{it}^{(2)m\prime}$ and again replace $\bar{X}$ in (7) and (8) by $\bar{V}$, where in this case $u_{it} = (\, x_{it}' \, x_{it}' \, g, (G_{it}^{(1)}; \hat{y}_1, \hat{c}_1)(\partial\, \hat{g}/\partial\gamma)\, x_{it}'\hat{\beta}_1, (\partial\, \hat{g} c_1/\partial)\, x_{it}'\hat{\beta}_1)',$. When H_0^* holds, the LM_χ statistic has an asymptotic $\chi^2(mk,)$ distribution, whereas LMF has an approximate $F(2hk, TN - N - 2K(h+1) - (m+1))$ distribution.

2.6 Variable Used in this Study

This study, adopted variables which were suggested in theory, as well as in the empirical literature, as the variables that explain the relationship between government expenditure and economic growth. The data used in this paper includes $GROWTH$ measured by GDP at constant prices (2010) as a dependent variable and $GEXP$ measured by government final consumption expenditure (% of GDP) as an independent variable. With a set of control variable, $OPEN$ which is openness measured by export plus import divided by GDP, investment $GFCF$ as share of GDP measured by gross fixed capital formation (as % of GDP) and consumption ($CONS$) measure by final consumption expenditure (% of GDP). Finally, labour force **(**L) is captured by population growth according to Moral-Benito (2012).

The Solow and Swan model denotes that at the equilibrium steady-state, economic-growth is generated by exogenous population-growth and technical advancement, but in the long run, high population growth strains the economic growth by lowering the GDP per capita, leads into decline in the standards of living and increasing income inequality. Therefore, a positive sign is a priori expected. All these variable were downloaded from the World Bank website. Note that among all the variable used in this study, it is only GDP that would be transformed into logs.

3. Empirical Analysis and Interpretation of Results

The previous section outlined the analytical framework of this paper by identifying whether there is a nonlinear relationship between government expenditure and economic growth as it is hypothesised in BARS inverted U-curve. This study will be helpful to policy-makers because they would understand the nature of the relationship between these two variables. It will also help them to quantify the optimal size of government spending because excessive government spending may deteriorate economic-growth in SADC region. Hence, the test of the unit root in the nonlinear case is not important because the PSTR model does not deal with cointegration or order of variables.

3.1 Testing for the Appropriate Transition Variable in the PSTR Model

The linearity test was used in identifying the appropriate transition variable among the set of variables used in this study as candidates (González *et al.*, 2017). Table 1 presents LM-type tests of homogeneity and the corresponding $p - values$ in the panel regression of economic growth on the size of the government and other explanatory variable.

Table 1: Result of Selecting the Transition Variable

m	LM_χ		LM_F		HAC_χ		HAC_F		WB	WCB
	$test$	$p\ val$	$test$	$p\ val$	$test$	$p\ val$	$test$	p val	$p\ val$	$p\ val$
Transition variable: Government expenditure (GEXP*)										
1	**90.05**	**3.062e-17**	**9.98**	**3.044e-11**	**6.33**	**0.27**	**1.08**	**0.36**	**0.00**	**0.00**
2	24.68	2.264e-05	4.16	2.469e-04	9.61	0.47	0.80	0.62	0.00	0.75
3	2.37	1.100e-01	4.59	1.738e-07	13.24	0.58	0.72	0.72	0.00	0.50
Transition variable: Consumption (CONS)										
1	53.47	2.363e-10	9.22	6.099e-08	9.051	0.10	1.55	0.17	0.00	0.20
2	63.95	6.447e-10	5.35	5.247e-07	10.48	0.39	0.87	0.55	0.00	0.25
3	86.40	4.640e-12	4.70	1.052e-07	13.63	0.55	0.74	0.73	0.00	0.00
Transition variable: Investment (GFCF)										
1	32.40	4.955e-06	5.56	7.902e-05	9.16	0.10	1.57	0.16	0.00	0.25
2	36.60	6.648e-05	3.06	1.208e-03	11.25	0.33	0.94	0.49	0.00	0.50
3	48.31	2.263e-05	2.63	1.218e-03	15.93	0.38	0.86	0.60	0.00	0.50
Transition variable: Trade openness (OPEN)										
1	29.02	2.297e-05	4.98	2.496e-04	6.44	0.26	1.10	0.35	0.00	0.50
2	50.29	2.356e-07	4.21	2.552e-05	9.00	0.53	0.75	0.67	0.00	0.75
3	30.90	0.000000	6.25	1.017e-10	13.99	0.52	0.74	0.71	0.00	0.25
Transition variable: Labour (L)										
1	52.64	3.994e-10	6.03	8.792e-08	6.19	0.28	1.06	0.38	0.00	0.25
2	88.73	9.548e-15	7.74	5.161e-10	8.16	0.61	0.68	0.73	0.00	0.25
3	40.30	3.109e-15	3.76	1.680e-09	10.16	0.80	0.55	0.90	0.00	0.25

*Notes to Table 1: * denotes significance and the variable selected by the LM test to be a transition variable.*

Source: Estimation results of the study (Rstudio software).

The LM type test based on the asymptotic χ^2 distributions, and their F versions for both the Lagrange Multiplier- Wald test and Lagrange Multiplier-Fischer test, confirmed government expenditure (GEXP) as a transition variable for this study, due to the $p - value$ which is smaller than all other sets of variables included in this test as candidates. This smaller $P - value$ signifies that GEXP is the most suitable choice of the transition variable for this study. After identifying the right transition variable among a set of variables, the null hypothesis of the linearity will be tested using the government expenditure.

3.2 Linearity Result Against the PSTR Model

One of the aims of this study was to find the nonlinearity between government spending and economic growth in SADC countries as it is hypothesised in the BARS curve theory. The nonlinearity was tested, as explained in the methodology section. Moreover, linearity test is important for two reasons, which are statistical and economic reasons. Looking at the statistical stand point, if the data generating process is linear, the PSTR model does become not identified, hence the linearity test is necessary to avoid the estimation of the unidentified models. While in the economics stand point, linearity-test account for economic-theory suggestion, such as the BARS curve in this paper.

This study used the Lagrange Multiplier-Wald test and Lagrange Multiplier-Fischer test in equation 4 to test the null hypothesis of linearity effect between the government expenditure and economic growth in SADC countries.

Table 2: Results of the Linearity (homogeneity) Tests

```
---------------------------------------------------------------------------
LM tests based on transition variable 'GEXP'
 m LM_X PV LM_F PV HAC_X PV HAC_F PV WB_PV WCB_PV
 1 90.05 3.062e-17 4.987 3.044e-11 6.338 0.2747 1.088 0.3681 0.00 0.00
***************************************************************************
Sequence of homogeneity tests for selecting number of switches 'm':
---------------------------------------------------------------------------
LM tests based on transition variable 'GEXP'
 m LM_X PV LM_F PV HAC_X PV HAC_F PV WB_PV WCB_PV
 1 90.05 3.062e-17 4.987 3.044e-11 6.338 0.2747 1.088 0.3681 0.00 0.00
***************************************************************************
```

H_0: Linear Model: H_1 PSTR model with at least one threshold.

Source: Estimation results of the study (Rstudio software).

Table 2 shows the linearity (homogeneity) tests between government expenditure and economic growth. The test confirmed that indeed there is a nonlinearity between the two variables, therefore, this simply shows the rejection of the null hypothesis of the linearity. These results are in line with the literature (Chen and Lee, 2005; Abounoori and Nademi, 2010; Chiou-Wei *et al.*, 2010; Aydin *et al.*, 2016; Asghari and Heidari, 2016).

According to the result of this test, the $p-value$s of both LM_{χ} and LM_F are formative since there are less than zero. Both $p-values$ are 3.062e-17 and 3.044e-11 respectively. Hence, after finding that there is nonlinearity between government expenditure and economic growth, the estimation of the PSTR model proceeds to the third step of finding the sequence of selecting the order m of the transition variable ($GEXP$) as is presented.

3.3 Sequence for Selecting the Order m of the Transition Function

The linearity test was also used as a sequence for choosing between $m=1$, $m=2$ and $m=3$. The sequence of linearity test for determining the order m was proposed by Granger and Teräsvirta (1993) and Teräsvirta (1994). Therefore, in this study, testing for the sequence of selecting the appropriate order m, the auxiliary regression in equation 4 is applied with $m=3$ testing the null-hypothesis $H_0^*: \beta_3^* = \beta_2^* = \beta_1^* = 0$. Thus, if the null hypothesis is rejected, the test goes to $H_{03}^*: \beta_3^* = 0, H_{02}^*: \beta_2^* = 0 | \beta_3^* = 0$ and $H_{01}^*: \beta_1^* = 0 | \beta_3^* = \beta_2^* = 0$, selection $m=2$. Again, the test rejected the null hypothesis of H_{02}^*. The author selected $m=1$ as it shown in table 3 the reason behind this simple rule is explained in Teräsvirta (1994).

The results of the specification test sequence for all five candidate transition variables are reported in table 3.

Table 3: Sequence of Homogeneity Tests for Selecting Order m of Transition

m	LM_{χ}		LM_F		HAC_{χ}		HAC_F		WB	WCB
	test	*p val*	*test*	*p val*	*test*	*p val*	*test*	p *val*	*p val*	*p val*
Transition variable: Government expenditure (GEXP)										
H_{01}^*	**90.05**	**3.062e-17**	**4.98**	**3.044e-11**	**6.33**	**0.27**	**1.08**	**0.36**	**0.00**	**0.00**
H_{02}^*	24.68	2.264e-05	4.16	3.469e-04	9.61	0.47	0.80	0.62	0.00	0.75
H_{03}^*	2.37	1.100e-01	4.59	1.738e-07	13.24	0.58	0.72	0.72	0.00	0.50
Transition variable: Consumption (CONS)										
H_{01}^*	53.47	2.363e-10	9.22	6.099e-08	9.051	0.10	1.55	0.17	0.00	0.00
H_{02}^*	63.95	6.447e-10	5.35	5.247e-07	10.48	0.39	0.87	0.55	0.00	0.25
H_{03}^*	86.40	4.640e-12	4.70	1.052e-07	13.63	0.55	0.74	0.73	0.00	0.00

Transition variable: Investment (GFCF)										
H_{01}^{*}	32.40	4.955e-06	5.56	7.902e-05	9.16	0.10	1.57	0.16	0.00	0.25
H_{02}^{*}	36.60	6.648e-05	3.06	1.208e-03	11.25	0.33	0.94	0.49	0.00	0.50
H_{03}^{*}	48.31	2.263e-05	2.63	1.218e-03	15.93	0.38	0.86	0.60	0.00	0.50
Transition variable: Trade openness (OPEN)										
H_{01}^{*}	29.02	2.297e-05	4.98	2.496e-04	6.44	0.26	1.10	0.35	0.00	0.50
H_{02}^{*}	50.29	2.356e-07	4.21	2.552e-05	9.00	0.53	0.75	0.67	0.00	0.75
H_{03}^{*}	30.90	0.000000	6.25	1.017e-10	13.99	0.52	0.74	0.71	0.00	0.25
Transition variable: Labour (L)										
H_{01}^{*}	52.64	3.994e-10	9.03	8.792e-08	6.19	0.28	1.06	0.38	0.00	0.25
H_{02}^{*}	88.73	9.548e-15	7.74	5.161e-10	8.16	0.61	0.68	0.73	0.00	0.25
H_{03}^{*}	40.30	3.109e-15	3.76	1.680e-09	10.16	0.80	0.55	0.90	0.00	0.25

*Notes to Table 3: * denotes significance and the variable selected by the LM test to be a transition variable*.

Source: Estimation results of the study (Rstudio software).

The results confirmed that $m = 1$ is the best choice when $GEXP$ will be used as the transition variable looking at the HAC test, while the wild bootstrap tests are not informative as their $p - values$ equal to zero. Then, after passing all of the tests of the PSTR, it can continue with the estimation of PSTR model using equation 13 which is equivalent to equation 4.

3.4 Empirical Results of the PSTR

After finding the sequence order, the PSTR model is estimated as follows:

$$\begin{aligned}\mathrm{Growth}_{it} = \mu_i + \lambda_i + \beta_{01}\mathrm{GEXP}_{it} + \beta_{02}\mathrm{OPEN}_{it} + \beta_{03}\mathrm{GFCF}_{it} + \beta_{04}\mathrm{CONS}_{it} + \beta_{05}L_{it} \\ + (\beta_{11}\mathrm{GEXP}_{it} + \beta_{12}\mathrm{OPEN}_{it} + \beta_{13}\mathrm{GFCF}_{it} + \beta_{14}\mathrm{CONS}_{it} + \beta_{15}\mathrm{L}_{it})\, g(\mathrm{GEXP}_{it}; \gamma, c) + u_{it}\end{aligned} \quad [13]$$

Where the time fixed effect is denoted by λ_i

$$(GEXP_{it}; \gamma, c) = \Big(1 + \exp\big(-\gamma((GEXP_{it} - cj))\big)\Big)^{-1} \; with\, \gamma > 0 \qquad [14]$$

Table 5 presents the estimated results of the PSTR model based on equation 13, which is equivalent to equation 4 defined in this study. In facilitating the interpretation, the estimates of $\beta_{0j}\ and\ \beta_{0j} + \beta_{1j}$, for $j = 1, \dots 4$, corresponding to regression coefficient in the regimes associated with $g(\mathrm{GEXP}_{it}; \gamma, c)$ bounded by zero and one respectively. Hence, the coefficients $\beta_{0j}\ and\ \beta_{0j} + \beta_{1j}$, simply represent low and the high regime. The estimated slope of the transition γ which determines the smoothness of the transition from the low regime associated with the value of $GEXP$ to the high regime, where C is an M-dimensional vector of the location parameters.

The estimated threshold level of government expenditure is found to be 25% of real GDP in which government spending stifles economic growth in SADC region. Moreover, the estimated slope parameter (13.13), simply supports the smoothness of government spending from a low regime to a high regime. The estimated threshold of this study is similar to the threshold reported by Chobanov and Mladenova (2009), who investigated the optimum size of the government using a panel study of 28 EU countries over the period 1970-2009. Their results showed that the optimum size of the government is 25% of real GDP. Their results showed that the optimum size of the government is 25% of real GDP. Moreover, Farris (2013) investigated the optimum government size in New-Zealand over the time period 1890 to 2012. It was established that the optimum size of the government is 25.3%.

Examining the calculated mean of government expenditure as share of GDP, all the selected SADC countries in region are below the threshold point. Countries like Comoros, DRC, Mauritius and Tanzania have the calculated mean of government expenditure of 10.77, 7.87, 14.12, and 14.24, respectively, while countries like Zimbabwe, Botswana, Swaziland, Mozambique, Namibia, and South Africa are close to the threshold point. These countries have the calculated mean of 16.11, 22.18, 18.54, 19.40, 23.73 and 19.40 respectively.

The logic behind those countries that are below the threshold is that more government spending is needed due to the fact that their level of government spending is still good for economic growth. For instance, the DRC is known as one of the poorest countries in Africa, therefore, this shows that if the DRC may make the fiscal policy effective, with an aim of increasing government spending, that would improve economic growth.

Those countries with high mean of government expenditure are those countries that are better off. However, these countries should look at their fiscal policy closely because the more they increase government expenditure above the threshold point, it might lead into a decline of economic growth. Table 4 provides the estimated results of the PSTR model and the estimated optimum size of government expenditure in SADC countries.

Table 4: Panel Smooth Transition Regression Model Estimation

Dependent Variable: Economic growth		
Explanatory variables	**Low regime** $\beta_{0j} \times 100$	**High regime** $(\beta_{0j} + \beta_{1j}) \times 100$
Government-expenditure-share GDP (GEXP)	**3.98**** (1.47)	**-15.76*** (8.52)
Trade openness ($OPEN$)	**0.27** (0.62)	**3.90***** (1.73)

Investment share of GDP (GFCF)	**0.57** (1.16)	**-5.21*** (3.05)
Consumption share of GDP (CONS)	**-5.54*** (1.64)	**-7.32**** (2.40)
Labour (L)	**0.24***** (0.01)	**1.75**** (0.76)
Transition Parameters		
Threshold (c)		**25.40*** (0.11)
Slope (γ)		**13.13**** (5.06)
# of obs.		**240**
# of countries		**10**

Notes to Table 4: *: The t statistics in parentheses are based on Corrected Standard Errors. The values in brackets are standard errors, c and γ denote the estimated location parameter and slope parameter, respectively. Moreover, */**/*** denotes the level of significance at 1%, 5% and 10%, respectively. Values in parentheses are t-statistics based on standard errors corrected for heteroscedasticity.*

Source: Estimation results of the study (Rstudio software).

Government expenditure (GEXP), possess with a statistical significant impact in both regimes, showing that when the level of government expenditure is low in the lower regime it has a positive impact on economic growth. Hence, when the level of government expenditure is high, it converges to negative, showing that it reduces the level of economic growth. Therefore, the findings of this study support the BARS inverted U-curve theory, as also confirmed by literature (Pevcin, 2004; Chen and Lee, 2005; Abounoori and Nademi, 2010; Chiou-Wei., 2010; Aydin *et al.*, 2016).

High government expenditure also automatically contributes to high budgets deficits, which would result in bad consequences for the tax payer, because in order for the state to get additional burdens to finance the budget deficit, it would need to increase taxation. The measure problem in that due to anti-elitist concerns it not an easy task to finance the budget deficit, but it would be restrained through borrowings. Hence, borrowing will contribute to current account deficits. Therefore, having budget deficits will eventual lead to the emergence of twin deficits which would cause the country to experience financial fragility. Apart from that, it will also contribute to high inflation as well.

The positive impact of government expenditure on economic growth before the threshold is due to the fact that increasing government spending is one of the tools that can help the government to stimulate the economy. Therefore, government spending is taken as a form of insurance, assuming that the economy would be stabilised when the private property rights properly perform their functions. The argument behind this would be based on the assumption that development would be driven by an increase in government spending through health care, infrastructure and education, which also plays a vital role in improving private investment, and therefore, high investment leads to an expansion of economic growth. By including property rights, it becomes possible for society to meet a higher productivity trading relationship and to enjoy the benefits of voluntary exchange (Grossman, 1988).

Government is assigned a critical role in the reconciliation of conflicts between private and social interests, and provides socially optimal direction to economic growth, while development becomes a focus consideration. Moreover, there are points of view arguing that, in countries that are based on a monopoly market do not have capital insurance information markets, government investments will further increase the efficiency factors and commodity markets, and reveal the effects of externality for the private sector. These findings are theoretically plausible and consistent with several economic studies, which include Asghari and Heidari (2016), by examining the impact of government expenditure and economic growth in the case of OECD-NEA countries.

Heath (2012) tested the validity of the Armey curve over the time period 1959-2009, in the case of Sri Lanka, using a polynomial regression. The author expounded that the Armey curve in reality is not for developed countries, but it holds for developing countries.

Makhoba *et al.* (2019) examined physical policy and economic growth using South African data. The finding showed that in South Africa, government expenditure declined the level of growth in the long-run. Moreover, looking closer at the magnitude of the coefficient, in the low regime, the magnitude is far smaller compared to that of the high regime. This shows that after government expenditure is beyond the threshold point of 25%, it become detrimental to economic growth with a massive magnitude.

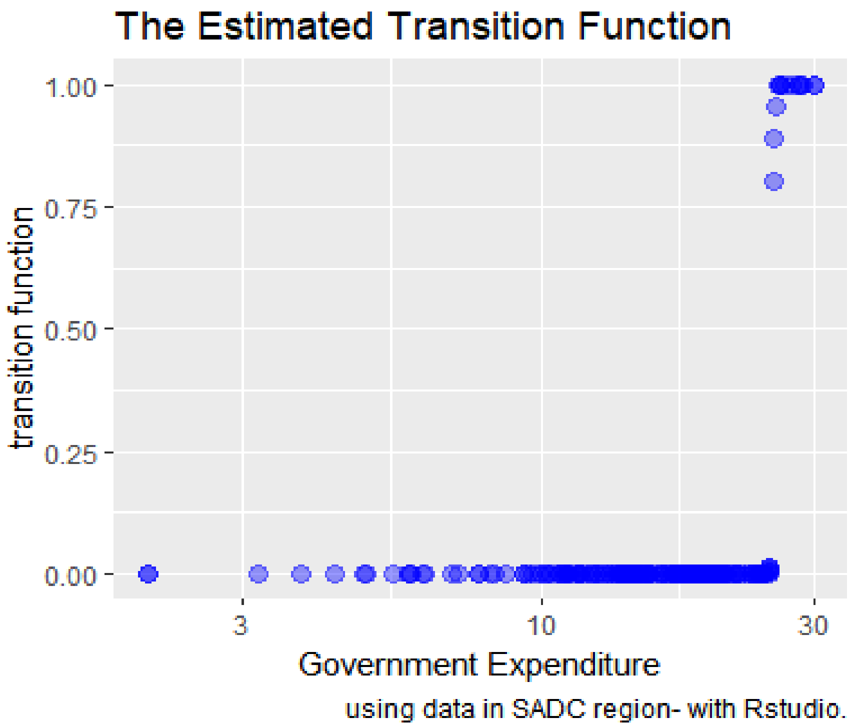
Looking at the control variables of trade openness ($OPEN$) posses with a positive impact with a massive magnitude on economic growth when the level of expenditure is high. While when the level of expenditure is low, it has no economic impact to economic growth. This shows that the impact of trade openness on economic growth is not clear in the low regime. The findings were supported by Heath (2012).

Moreover, Moyo and Khobai (2018), in the case of 11 selected SADC countries over the time 1990-2016, found that trade openness declined the level of economic growth in the long run. Investment possess with an unexpected sign on economic growth, shows that it reduces economic growth due to a number of reasons, while when there is high, investment has no economic sense to economic growth.

The possible reason behind the insignificant impact of investment on economic growth in the SADC region could be that SADC is a group of developing countries. Again, the possible reason behind the negative impact of when the level investment is high on the economic growth in the SADC region could be that large government intervention results in 'crowding out' effect, which was referred to Keynes as 'diversion', where public spending crowds out private spending and investment. Similar result where reported by Grossman (1988), who employed a time-series data in the case of US over the period 1929-1976.

Consumption (CONS), have a negative and statistical significant in both regimes. In the high regime, consumption declines the level of economic growth with a massive impact on economic growth, while in the high region even in the low regime consumption decline the level of economic growth. As were prior expectations, labour (L) have a positive and statistical significant impact on economic growth in both regimes. Labour force participation rate measures the human capital in an economy. This simply shows that when the level of human capital is low, it increases the level of economic growth. However, when the level of human capital is high, it contributes to economic growth with massive magnitude. This finding is theoretically plausible and consistent with several economic studies, which including the hypothesis made by the neo-classical theory. Moreover, Moyo and Khobai (2018) examined trade openness and economic growth in 11 selected SADC countries over the time 1990-2016. Their findings showed that in the case of SADC countries, human capital (labour) improves economic growth.

Figure 2: Transition Function Plotted Against Government Expenditure



Note: Estimated transition function of the PSTR model. Each circle represents an observation.

Source: Estimation results of the study (Rstudio software).

As seen in the plot in figure 2, it is obvious that the change from low government expenditure to high expenditure, that the high regime smooth comparatively quickly. The high transition parameter of 13.13 simply supports the smoothness of government expenditure from a low to a high regime. The high transition-parameter proposes that an action is needed with an immediate effect once the level of government expenditure is near or above the 25% of GDP, of which is the threshold point estimated in this study. Lastly, it can be seen that this study contained 240 observations, in a panel of 10 selected SADC countries, due to data availability.

3.5 Results of Parameter Constancy and No Remaining Nonlinearity

After estimating the PSTR model, it is very important to apply the misspecification test of the parameter constancy, and no remaining heterogeneity, by examining the adequacy of a two regime model. Therefore, results from the WB and WCB tests that takes both heteroskedasticity, and possible within-cluster dependence into account, suggest that the estimated model with one transition is adequate.

Table 5: Tests of Parameter Constancy and No Remaining Non-Linearity

```
*********************************************************************
Results of the evaluation tests:
---------------------------------------------------------------------
Parameter constancy test
```

```
 m LM_X PV LM_F PV HAC_X PV HAC_F PV
 1 6.486 0.7729 0.5297 0.8679 7.913 0.6374 0.6462 0.7729
----------------------------------------------------------------------------
No remaining nonliearity (heterogeneity) test
 m LM_X PV LM_F PV HAC_X PV HAC_F PV
 1 54.39 4.103e-08 4.442 1.207e-05 15.02 0.1312 1.227 0.2758
----------------------------------------------------------------------------
WB and WCB no remaining nonliearity (heterogeneity) test
 m WB_PV WCB_PV
 1 1 1
****************************************************************************
```

H_0: *Linear Model:* H_1 *PSTR Model with at least one threshold*.

Source: Estimation results.

Table 6 presents the test for parameter constancy and of no remaining non-linearity after assuming a two regime model. The results confirm the rejection of the null hypothesis because both their P- values of the WB and WCB equals to 1, which signifies that the model has only one threshold or two regimes. Thus, this implies that in the SADC region, there is one threshold point which separates low government expenditure regime with high government expenditure regime.

4. Conclusion and Policy Recommendations

Adopting the hypothesis made in the BARS curve, low regime government expenditure improves economic growth, up until it reaches a certain threshold level, then after the threshold it converges to a negative, which means that once the level of government expenditure is high, it declines the level of economic growth. The study aimed to test three hypothesis related with government expenditure and economic growth in the case of SADC countries: (i) to test the existence of the nonlinearity and find after which threshold point between government expenditure is detrimental, or neither good for economic growth, and (ii) to test the validity of the BARS inverted U-curve in the SADC region.

After testing the present of a nonlinearity relationship between government expenditure and economic growth, the results are consistent with those studies who find the existence of nonlinearity between the two variables. Thus, the nonlinearity found the threshold point where it separate low and the high regime which is approximately 25.40%. Hence, the findings are in agreement with the BARS hypothesis.

Figure 1 demonstrates the graphical plot of the estimated transition of this study that shows how the inverted U-curve looks like in the case of SADC countries. In answering the last hypothesis, since the result are in line with the BARS curve, it simply shows that when government expenditure is low, it is positively related with economic growth, and hence once the level of government expenditure is high, it converges to negative.

Comparing the estimated threshold with the calculated government expenditure mean of the SADC countries, it may be found that other countries in the SADC region are still with the threshold point, except for DRC which is way below the optimal level of government expenditure.

Countries such as Democratic republic of Congo need to adjust government spending by 17.53% of GDP, following by Maulthus, which must adjust by 11.28% of GDP. Moreover, Namibia needs to increase government spending by 2% of its GDP, while South Africa needs to spend about 6% of GDP in order to reach the threshold point. Mozambique, Zimbabwe, Botswana, Comoros, Tanzania and Swaziland need to decrease their level of government expenditure by 6%, 9.29%, 3.21%, 14.63%, 11.16% and 6.86% of GDP, respectively.

This study proposes that policymakers ought to formulate prudent fiscal policies that encourage government-expenditure which would improve growth for those countries which are below the estimated threshold point. Again a strong monitoring system is needed since Graeff and Mehlkop (2003) argued that an expansion on the scope or size of government leads to corruption, and may open further regulations that encourage individuals to find illegal ways to evade these rules and boundaries. Again, for those countries closely the threshold point, government spending needs to be discouraged because it is no longer good for economic growth.

5. Limitations of the study

The assumptions of this study is that xit are all exogenous-variables. This study did not test the exogeneity of the xit variables as González et al (2017) stated that in some application this assumption might seem unnecessary restrictive. However, the authors lets exogeneity test in this specific application for future research purpose. Regardless of the exogeneity assumption, the PSTR model remains the most recently and robust model in dealing with a nonlinear problem a panel data context.

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