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Fiscal Regime Changes and the Sustainability of Fiscal Imbalance in South Africa; a smooth transition error-correction approach

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Abstract

In addition to the conventional linear cointegration test, this paper tests the asymmetry relationship between revenue and expenditure i.e. making a distinction between the adjustment of positive (budget surplus) and negative (budget deficit) deviations from equilibrium using quarterly data on South Africa. The paper reveals that government authorities in South Africa are more likely to react faster when the budget is in deficit than when in surplus and that the stabilisation measures by government are fairly neutral at low deficit levels, that is, at quarterly deficit levels of 4% of GDP and below. We conclude that the attempt to achieve fiscal sustainability via a reduction in expenditure on sectors conducive to economic growth might be prone to social and politically shocks which could render such fiscal policy unsustainable. In South Africa the main fiscal challenge, therefore, is to find ways through which the recent gains in fiscal solvency can be consolidated. The increasing tension amongst local communities complaining about poor service delivery by the government could be a recipe for fiscal unsustainability.

Keywords: Smooth transition error correction model; Nonlinearity; Government intertemporal budget constraint; and Fiscal sustainability.

JEL classification: C22; C51; H62

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1. Introduction

The issue of sustainable fiscal imbalance has received increasing attention from economists and decision makers alike since the 1980s. From a fiscal perspective, maintaining a stable long-term relation between expenditures and revenues is one of the key requirements for a stable macroeconomic environment and sustainable economy (Buharumshah 2007). Sustainability, in general, concerns current and expected future policies. If economic agents do not expect current and future policies to lead to an intertemporal budget constraint, then the fiscal process would be unsustainable and government insolvency possible.

Several of the empirical studies on fiscal sustainability, however, focus on the time series behaviour of tax revenues and expenditures as well as debt series to investigate whether the behaviour of these series is consistent with the intertemporal budget balance. The empirical results of these studies vary depending on the sample period and the methodology used. In the United States, Cunado, Gil-Alana, and Perez de Gracia (2004); Flavin-Hamilton (1986); Trehan and Walsh (1991); and Ahmed Rogers (1995) failed to reject the intertemporal budget balance whilst Hakkio and Rush, 1991; Wilcox (1989) and others, rejected it. Empirical investigations into government's intertemporal fiscal solvency constraints in East Asia have also been documented (see for example, Baharumshah and Lau 2007). Based on time series analysis and quarterly data over three decades, both Baharumshah and Lau (2007) found evidence of sustainable fiscal finances in Thailand and South Korea, whilst the Philippines and Malaysia demonstrated only ‘weak sustainability’. Baharumshah and Lau (2007) showed that in Singapore, revenue was growing at a faster rate than government spending.

In South Africa, issues of fiscal sustainability received greater attention in the 1980s and 1990s following a growing public debt/GDP ratio. In the earlier and mid-1990s, several researchers argued that fiscal policy was unsustainable in South Africa (Roux 1993:332-3; Van der Merwe 1994; Schoeman 1994; Cronje 1995). Roux (1993) in Burger (2003) argued that the South African government would be able to finance higher social expenditure only if economic growth improved, otherwise, debt financed increases in social expenditure would cause an increase in the public debt-GDP ratio. Van der Merwe (1994) argued that fiscal policy in South Africa is unsustainable due to the large gap between real interest rates and real economic growth as well as the relatively large size of the deficit. Schoeman (1994) also warned that as long as government runs a large deficit in the face of a real interest rate that exceeds the real economic growth, the public debt/GDP ratio would tend to explode.

Consistent with the findings of the various researchers in South Africa, the South African economy embarked on broadly three phases of fiscal reform since 1994.

From 1994 to 1996, following a period of recession and a rapid rise in the budget deficit, Government's Reconstruction and Development Programme was phased into departmental plans and budgets, and a comprehensive reprioritisation of public expenditure was undertaken (Manuel, 2004). The average budget deficit stood at 4.3% of GDP and government debt was approaching 50% of GDP by 1994.

A period of fiscal consolidation from 1997 to 2000 saw the introduction of medium term expenditure planning, substantial investment in tax reform and revenue administration capacity and efficient coordination of fiscal and monetary policy. The budget deficit declined to 3.0% of GDP, and public debt relative to GDP declined from 49.7% in 1994 to 44.4% in 2000 and the average borrowing costs decreased sharply providing room for the government to spend more on social services and infrastructure.

From 2001 to 2008, the government of South Africa adopted a more expansionary fiscal stance in support of its infrastructure investment and social welfare improvement drive. Despite this expansionary stance of government, the main budget revenue increased consistently from 22.5% of GDP in 2002 to 26.6% of GDP in 2007 and slightly declined to 26.3% of GDP in 2008. Expenditure remained around 26% of GDP and slightly increased to 26.9% of GDP in 2008. As a result, budget deficits declined from 2001 to 2005 and thereafter recorded a budget surplus in 2006 and 2007. For 2008, the budget returned to a deficit of 0.6% of GDP (See fig.1).

Although government had achieved a substantial reduction in its budget deficit target from 6.8% of GDP in 2003 to 0.6% in 2008, the scenario has meanwhile changed again (see Budget Review 2010), mainly due to the slowdown in the world economy which also affected the revenue base of the South African economy. However, the policy of fiscal prudence during the period 2003 to 2008 resulted in a substantial decline in real debt service cost while the real growth rate of the economy increased considerably. Nevertheless, the former still exceeds the growth rate resulting in a (r-g) gap[4]. Furthermore, it appears that public debt and budget deficit reductions have been achieved at the expense of a relative reduction in service delivery expenditure, as is evident in the reduction in the

[4] See Burger, Philippe, 2003, Sustainable Fiscal Policy and Economic Stability, Theory and Practice.

expenditure on education to GDP ratio from an average of 6.21% during the period 1990-1999 to an average of 5.6% during the period 2000–2008; and health expenditure to GDP from an average of 2.93% during 1990-1999 to 2.84% during 2000-2008[5].

In most of the studies recorded in the literature on fiscal measures to address the solvency condition, researchers have either tested for linear stationarity in the total government deficit series or tested for linear cointegration between total government spending and total tax revenues. To the best of our understanding, few researchers have used nonlinear techniques to quantify the adjustment process of fiscal and other macroeconomic variables towards the long-run equilibrium (see Van Dijk Dick & Franses and Philip Hans 1997), Hansen and Kim (1996), Kunst (1992, 1995) and Dwyer (1996); Swanson(1996) ; and Cipollini A.(2001). In South Africa in particular, no study has tested whether the error-correction process used in the respective studies is linear. Instead, previous studies have assumed that the adjustment process driving the variables toward equilibrium is linear i.e. adjustment towards equilibrium is always present and of the same strength under all circumstances. In this study the authors want to point out that there are situations however in which the validity of this assumption might be questioned (see Van Dijk D. et.al 1997).

Therefore the authors employ an extension of the linear intertemporal budget constraint rule of fiscal sustainability to a regime-switching framework, where the transition from one regime to the other occurs in a smooth way. The switching between regimes is controlled by the state of the fiscal balance. This feature of the smooth transition model allows us to test the ability of high against low budget deficits or surpluses to best describe the nonlinear dynamics of the fiscal policy in South Africa.

Following the introduction, Section II presents sustainability criteria as obtained from the literature. Section III provides the estimation procedures, both linear and non-linear specifications; Section VI presents the results from the estimations and the last section summarises and concludes.

[5] Although the actual or nominal allocations have increased in the case of social services, like health and education.

2. Sustainability Criteria

The most straight forward way to assess the fiscal sustainability position is to start from a Government's intertemporal budget constraint. The budget constraint looks at the long-run relationship between government revenue and expenditure (that covers the total government spending on goods and services, transfer payments and interest on debts). For simplicity, assume that budget deficits are financed using bonds with a maturity of one period. This implies that the government faces the budget constraint as shown in equation one:

$$G_t + (1 + r_t) B_{t-1} = R_t + B_t \tag{1}$$

Where G is government expenditure, r is the one period real rate of interest, R is government revenue and B is the stock of debt. Iterating equation (1) forward yields the government's intertemporal budget constraint:

$$B_t = \sum_{s=0}^{\infty} \prod_{i=1}^{s} (1 + r_t)^{-1} (R_{t+s} - G_{t+s}) + \lim_{s \to \infty} \prod_{i=1}^{\infty} (1 + r_{t+i})^{-1} B_{t+s} \tag{2}$$

We assume that the real interest rate is stationary with unconditional mean given by r and also that the real supply of bonds does not grow on average, at a rate in excess of the average rate of interest (see Flavin and Hamilton 1986 and Haug 1995**).** With these assumptions, we can have the following expression:

$$\lim_{s \to \infty} (1 + r)^{-s} B_{t+s} = 0 \tag{3}$$

The above equation (3) states that the debt stock, when measured in present value terms, vanishes in the limit. By definition, it excludes Ponzi financing i.e. that is; the government is not 'bubble' financing its expenditure by issuing new debts to finance the deficits. This is equivalent to saying that the deficit is sustainable if and only if the stock of debt held by the public is expected to grow no faster than the mean real rate of interest which is viewed as a proxy for the growth rate of the economy (Baharumshah 2007).

Following equation (3), the inter-temporal budget constraint, equation (2) can be re-written as;

$$G_t - R_t = \sum_{s=0}^{\infty} (1 + r)^{-s+1} (\Delta R_{t+s} - \Delta G_t + r \Delta B_{t+s-1}) \tag{4}$$

The inter-temporal budget constraint, under the no-Ponzi scheme rule, imposes restrictions on the time series properties of government expenditure and revenue given by the right hand side of equation 4. This will be stationary, as long as government expenditure, revenue and the stock of debt are all stationary in first differences. Specifically, if G_t and R_t are I(1), they will be cointegrated implying that there exists an error correction mechanism pushing government finances towards the levels required by the inter temporal budget constraint.

Assuming that the transversality condition for the budget constraint holds and the limit term in Equation (3) is zero, we arrive at the following cointegrating relationship as shown in equation 5 (see Hakkio and Rush 1991);

$$R_t = \alpha + \beta G_t + \varepsilon_t \tag{5}$$

Following Martin (2000), the deficit is 'strongly' sustainable (strong solvency) if and only if the I(1) process of R and G are cointegrated and β=1. The deficit is only 'weakly' sustainable if R and G are cointegrated and 0<β<1 (see Trehan and Walsh, 1988; Quintos, 1995). The linear model estimated in this paper is specified as:

$$\mathrm{drev}_t = \alpha_0 + \alpha_1 \mathrm{dlrev}_{-1} + \alpha_2 \mathrm{dlrev}_{-2} + \alpha_3 \mathrm{dlrev}_{-4} + \alpha_4 \mathrm{dlrev}_{-5} + \alpha_5 \mathrm{dlrev}_{-8} + \alpha_6 \mathrm{dlexp}_t + \alpha_7 \mathrm{dlexp}_{-2} + \alpha_8 \mathrm{dlexp}_{-4} + \alpha_9 \mathrm{dlexp}_{-5} + \alpha_{10} \mathrm{dlexp}_{-8} + \alpha_{11} \mathrm{ecm}_{-1} \tag{6}$$

3. Specification and Estimation Techniques

In this paper, our empirical estimation involves the following steps: i) testing for stationarity of the variables; ii). testing for cointegration and estimation of the cointegrating relation; iii) testing for nonlinearity of the adjustment process; and iv) estimating and evaluating of the Smooth Transition Error Correction model.

3.1 Linear estimation techniques

We carry out three different tests for the order of integration which are: the Augmented Dickey-Fuller (1981), the Kwiatowski, Phillips, Schmidst and Shin (1992) and the Phillips- Perron tests. The Dickey-Fuller and Phillips-Perron (1990) tests have, as their null hypothesis, that the dynamics of the respective series are characterized by a unit root. The KPSS on the other hand is based on the null of stationarity. The use of three tests is justified since Perron (1989, 1997) and Zivot and Andrews (1992) have demonstrated that the augmented Dickey-Fuller test has low power in the presence of a structural break.

We consider those cointegration tests that are most popular among researchers: the residual-based test suggested by Engle and Granger (1987) and the Likelihood ratio test introduced by Johansen (1988). Given a bivariate case (for simplicity) with no deterministic regressors, the residual-based test for cointegration is performed via the two-step procedure of Engle and Granger (1987). That is, we first estimate the cointegration regression as specified in equation (7) using ordinary least square (OLS) and second, test for the presence of a unit root in the regression residuals.

$$y_t = -\beta x_t + u_t \tag{7}$$

Johansen (1988) advocates a test for cointegration by testing the rank r of π by applying likelihood ratio tests to test the significance of the squared partial canonical correlations between Δy_t and y_{t-1}, denoted $\hat{\lambda}_1$ and $\hat{\lambda}_2$ which can be obtained by solving a generalized eigenvalue problem. Given $\hat{\lambda}_1 > \hat{\lambda}_2$ the trace statistics can be used to test $H_0 : r = r_0$ against the alternative hypothesis $H_1 : r \geq r_{0+1}$ for $r_0 = 0,1$. If the trace test points towards cointegration between y_t and x_t, an estimate of the cointegration vector β is given by the eigenvector corresponding to the largest canonical correlation λ_1.

This paper considers both non-parametric and parametric tests for linearity. The non-parametric test follows Brock-Dechert-Scheinkman (BDS) (1987). It tests the null hypothesis of independent and identically distributed (I.I.D.) against an unspecified alternative. BDS test cannot test chaos directly, but only nonlinearity, provided that any linear dependence has been removed from the data (e.g. using traditional ARIMA-type models or taking a first difference of. The BDS statistics is, therefore, different from other non-parametric test statistics since it mainly focuses on either the second- or third-order properties of x_t.The basic idea of the BDS test is to make use of a “correlation integral” popular in chaotic time series analysis. Given a k-dimensional time series and observations $\{X_t\}_{t=1}^{T_K}$, define the correlation integral as[6].

$$C_k(\delta) = \lim_{T_k \to \infty} \frac{2}{T_k(T_k-1)} \sum_{i<j} I_\delta(X_i, X_j) \qquad (8a)$$

Where $I_\delta(u,v)$ is an indicator variable that equals one if $\|u-v\|<\delta$, and zero otherwise, where $\|\cdot\|$ is supnorm. The null hypothesis of the BDS test is that the series is linear; against the alternative that time series is non- linearly dependent if first differences of the natural logarithm have been taken. i.e. H_1: series is nonlinear.

This test statistic has a standard normal limiting distribution.

The parametric test for linearity follows Teräsvirta (1994) who suggests a method of approximating the transition function by a Taylor expansion about the null of linearity $\gamma = 0$. The linearity test involves estimating auxiliary regression by OLS:

$$\Delta y_t = \emptyset' w_t + \emptyset'_1 \widetilde{w_t} z_{t-d} + \emptyset'_2 \widetilde{w_t} z^2_{t-d} + \emptyset'_3 \widetilde{w_t} z^3_{t-d} + \varepsilon_t \qquad (8b)$$

Where

$$W_t = (1, \Delta y_{t-1}, \ldots\ldots\ldots\ldots \Delta y_{t-p}, \Delta x_{t-p}, z_{t-d})'$$

$$w_t^{\sim} = (\Delta y_{t-1} \ldots\ldots\ldots\ldots \Delta y_{t-p}, \Delta x_{t-1} \ldots\ldots\ldots \Delta x_{t-p}, z_{t-d})$$

The original null hypothesis of linearity, H_0: $\gamma = 0$ is equivalent to the hypothesis that all coefficients of the auxiliary regressors $\widetilde{w_t}\, z^j_{t-d}$, j= 1,2,3 are zero i.e. $H'_0,\ \emptyset_1 = \emptyset_2 = \emptyset_3 = 0$. For detail LM-type test for this hypothesis, (see Van Dijk D.et.al 1997). To select the most appropriate lag of z_t to use as transition variable, the test should be carried out for a number of different values of d, say $d = 1, \ldots\ldots D$. If the linearity is rejected for several values of d, the one with the smallest p-value is selected as the transition variable (Van Dijk, D. et.al 1997).

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[6] See Tsay R.S. (2005). Analysis of Financial Times Series, Second edition Page. 210

3.1 Non-linear estimation technique

If the linearity hypothesis is rejected, we can estimate a nonlinear model using non-linear least squares (NLS). In this paper, we apply the smooth transition threshold models (Chan and Tong, 1986; Teräsvirta and Anderson, 1992; Granger and Teräsvirta, 1993; Teräsvirta, 1994) which allow for smooth transition between regimes of behaviour and thus generalise the threshold autoregressive model (TAR). The other strength of the smooth transition model is that it is theoretically more appealing than the simple TAR models that impose an abrupt switch in parameter values because only if all agents act simultaneously will this be the observed outcome. Additionally, the STR model allows different types of market behaviour depending on the nature of transition function. In particular, the logistics function allows differing behaviour depending on whether deviations from equilibrium are positive or negative, whilst the exponential function allows differing behaviour to occur for large and small deviations regardless of sign (see McMillan, D. 2004). Following McMillan, 2004, the STR model is given by equation 9 below:

$$\Delta x_t = \delta_0 + \sum_{i=1}^{p} \Delta x_{t-i} + \rho_1 u_{t-1} + \left(\theta_i + \sum_{i=1}^{p} \theta_i \Delta x_{t-i} + \rho_2 u_{t-1}\right) F(u_{t-d}) + \varepsilon_t \quad (9)$$

Where $F(u_{t-d})$ is the transition function and u_{t-d} the transition variable. The logistic function is given as follows, with the full model thus referred to as a logistic STR (or LSTR) model:

$$f(U_{t-1}) = \{1 + \exp[-\gamma(u_{t-1} - \tau)]\}^{-1} \quad \gamma > 0 \quad (10)$$

Which allows a smooth transition between the differing dynamics of positive and negative deviations, where γ is the smoothing parameter and τ the transition parameter. This function allows the parameters to change monotonically with u_{t-1}. As $\gamma \rightarrow \infty$, $F(u_{t-1})$ becomes a Heaviside function, $F(u_{t-1}) = 0, (u_{t-1}) \leq \tau, F(u_{t-1}) = 1, (u_{t-1}) \geq \tau$, and equation 9 reduces to a TAR model. As $\gamma \rightarrow 0$, equation 9 becomes a linear model of order *p*.

The second type of asymmetry, which distinguishes between small and large equilibrium errors, is obtained when $f(u_{t-d})$ is taken to be the exponential, with the resulting model referred to as the exponential STR (or ESTR) model and ESTECM for a bivariate model:

$$f(u_{t-1}) = 1 \quad \exp [\quad \gamma(u_{t-1} \quad \tau)^2 \qquad (11)$$

Equation 9 results in gradual changing strength of adjustment for larger (both positive and negative) deviations from equilibrium. It implies that the dynamics of the middle ground differ from those of the larger deviations. This model is therefore only able to capture non-linear symmetric adjustment. A possible drawback of this choice for the transition function is that both if $\gamma \rightarrow 0$ or $\gamma \rightarrow \infty$, the model becomes linear. This can be avoided by using the 'quadratic logistic function' as proposed by Jansen and Teräsvirta (1995).

$$f(u_{t-1}) = (1 + \exp \{-\gamma(u_{t-1} - \tau_1)(u_{t-1} - \tau_2)\})^{-1} \qquad (12)$$

In this case, if $\gamma \rightarrow 0$, the model becomes linear, whilst if $\gamma \rightarrow \infty$, the function F(.) is equal to 1 for $u_{t-1} < c_1$ and $u_{t-1} > c_2$, and equal to in between.

The STR model is estimated using the non-linear least squares; however in the LSTR model, a large γ results in a steep slope of the transition function at τ, thus a large number of observations in the neighbourhood of is required to estimate γ accurately. Furthermore, convergence of γ may be slow, with relatively large changes in γ having only a minor effect upon the shape of the transition function. To go around this problem, Teräsvirta and Anderson (1992), Granger and Teräsvirta (1993) and Teräsvirta (1994) proffer scaling the smoothing parameter γ by the standard deviation of the transition variable, and by the variance of the transition variable in the case of ESTR (see MCMillan D. G. 2004).

4. Data Discussion

The data used to estimate the model suggested in this paper consists of the South African central government receipts and expenditures ratios to GDP. The data, obtained from the Quarterly Bulletin published by the South African Reserve Bank, are quarterly, from 1960:1 to 2008:4. All variables have been expressed as a percentage of GDP and converted into their natural logarithmic form. We use revenue and expenditure ratios to GDP since government authorities are mainly concerned with the dynamics of the different budget items relative to the overall size of the economy (see Hakkio and Rush, 1991; Cipollini,A. 2001)

5. Empirical results

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests as well as the Kwiatkowski –Phillips-Schmidt-Shin (KPSS) stationarity tests for both series are reported in Table1. We note that the null of a unit root cannot be rejected on the basis of ADF and PP for both series. This result is supported by the KPSS test as this test rejects the null of stationarity for both series. There is no ambiguity in the order of integration; therefore we use the first differences of the series in our study. A residual-based test of cointegration as suggested by Engle and Granger (1987) and the likelihood ratio test introduced by Johansen S. (1991) shows evidence of a long -run relation between the two variables of interest (See fig. 6). We test the hypothesis that the co-integrating vector is (1,-1). Since the ρ-value is not significant at the conventional levels we cannot reject the null hypothesis that the restrictions are binding (see Table 2), implying that during the sample period, fiscal policy in South Africa, consistent with the intertemporal condition of sustainability, was sustainable.

The fitted linear conditional error-correction model for revenue/GDP is shown in Table 5b column 1. The linear model seems quite satisfactory, with the post estimation residual tests indicating normality but with evidence of heteroscedasticity. The LM-tests reject the null of no serial correlation. It may be that these significant test values are caused by neglected nonlinearity (Van Dijk , D. et. al 2001).

5.1 Linearity testing and model selection

We carry out the BDS test on a series of estimated residuals to check whether the residuals are independent and identically distributed (iid) i.e. whether the residuals from our linear model has any non-linear dependence in the series after the linear model has been fitted. Table 3 indicates that all the test statistics are greater than the critical values significantly. Thus, we should reject the null hypothesis of I.D.D. The results strongly suggest that the time series in our model are non-linearly dependent, which is one of the indications of chaotic behavior.

We also consider a parametric test, the Escribano and Jorda (EJ hereafter) (2001) linearity LM test. The null hypothesis in this test H_0 is that the series follow a stationary linear process. The computation of the test is carried out using the F- version which is an asymptotic Wald test.

Computing the LM-type test statistics, and setting d equal to 1 through 8 it is seen that linearity is rejected for d=1,2,6 and 8 at 5 percent level of significance. But given that d=6 has the smallest ρ-value we select it as the delay variable (see Table 4). This implies that in South Africa it takes 6 quarters or one and a half years for fiscal policy changes to be effective. This is not uncommon as fiscal policy issues require legislature procedures which normally take much longer. Deciding between the transition functions can be done by short sequence of tests nested within H_0. This testing is motivated by the observation that if a logistics alternative is appropriate, the second order derivative in the Taylor expansion (8b) is zero (see Van Dijk D. 1997). The null hypothesis to be tested is as follows:

$$H_{03}: \emptyset_3 = 0; H_{02}: \emptyset_2 = 0 | \emptyset_3 = 0; H_{01}: \emptyset_1 = 0 | \emptyset_3 = \emptyset_2 = 0$$

Granger and Teräsvirta (1993) suggest carrying out all three tests, independent of rejection or acceptance of the first or second test, and using the outcomes to select the appropriate transition function. The decision rule is to select an exponential STR function only if the p-value corresponding to H_{02} is the smallest, and select the logistic function in all other cases.

Table 4 shows that at d=6, the logistic representation of the data is the most preferred.

5.2 LSTECM estimation

Having established a non-linear relationship we now estimate the parameters of the LSTECM by using the non-linear least squares (NLS) technique. Two LSTECM models are fitted, one is general and the other is fitted after parameter reduction (see Table 4b col. 3 and 4) (which is obtained by removing the insignificant coefficients). The model estimated is specified as:

$$\begin{aligned} Dlrev_t = {} & \alpha_0 + \alpha_1 dlrev_{-1} + \alpha_2 dlrev_{-2} + \alpha_3 dlrev_{-4} + \alpha_4 dlrev_{-5} + \alpha_5 dlrev_{-8} + \alpha_6 dlexp_t + \\ & \alpha_7 dlexp_{-2} + \alpha_8 dlexp_{-4} + \alpha_9 dlexp_{-5} + \alpha_{10} dlexp_{-8} + \alpha_{11} ecm_{-1} + (1 - F)(\beta_0 + \beta_1 dlrev_{-1} + \\ & \beta_2 dlrev_{-2} + \beta_3 dlrev_{-4} + \beta_4 dlrev_{-5} + \beta_5 dlrev_{-8} + \beta_6 dlexp_t + \beta_7 dlexp_{-2} + \beta_8 dlexp_{-4} + \\ & \beta_9 dlexp_{-5} + \beta_{10} dlexp_{-8} + \beta_{11} ecm_{-1}) \end{aligned}$$

(13)

Where the weight F is modelled as follows:

$$F(ecm_{t-d}) \equiv F(ecm_{t-d}; \gamma, c) = \{ 1 + \exp[-\gamma(ecm_{t-d} - c)]\}^{-1} \qquad \gamma > 0$$

The parameter γ which determines the smoothness of the transition regime is set at 10; and the threshold is computed to be at 0.04. As stated earlier, the delay variable (d) is computed to be at 6 quarters i.e. one and a half years. We also follow Granger and Teräsvirta (1993) and Teräsvirta (1994) in making γ dimension-free by dividing it by the standard deviation of σecm_{t-d}. As the surplus grows larger, $ecm_{t-d} \rightarrow \infty$, $F \rightarrow 1$ and as the budget deficit grows increasingly larger, $ecm_{t-d} \rightarrow -\infty$, $F \rightarrow 0$. When $F \rightarrow 0$ implying $(1- F) = 1$ i.e. budget deficit, the relevant parameters are a summation over α and β.

The results from estimating model equation (13) are presented in Table 5b. Table 5b columns 3 and 4 report the nonlinear least square estimates of our models. Tests of the residuals show no residual autocorrelation; no serial correlation; no non-normality of residuals; and finally no heteroscedasticity. The Akaike info criterion shows that the non-linear model (i.e. model 3) is a better-fit than the linear model. The error correction terms are of the expected signs and statistically significant and shows that the adjustment process to equilibrium is faster when the government budget is in deficit than in surplus. The threshold is estimated as 4% of deficit-GDP. That is, since the state-dependent speed of the adjustment coefficient is only significant for the outer regimes, the error-correcting dynamics are present only for large shocks (i.e. only for absolute value of (ecm_{-6}). In short, government authorities are likely to react faster when the budget deficit exceeds 4% of GDP on a quarterly basis since it will create concern for the achievement of the solvency target. The one and a half years period reaction delay (i.e. d = 6) combined with a relatively smooth switch from one regime to the other γ =10, can be explained in terms of the political-institutional processes (see Cipollini 2001). Fiscal laws and regulations are drafted, through a budget document and tabled to parliament for approval before implementation, a process that could be time demanding. The empirical result shows that a 1% increase in government budget deficit (the transition variable) implies variation in the transition function larger (i.e. a stronger policy maker reaction) than the corresponding 1% increase in a budget surplus[7], showing that in this phase the South Africa government becomes more concerned about solvency or fiscal sustainability. However, it appears that fiscal sustainability in South Africa has been

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[7] Figures 7 and 8 shows the state dependent speed of adjustment over time

attained at the expense of a reduction in the expenditure to GDP on education and a relatively constant expenditure to GDP on health, during the deficit and surplus fiscal regimes (see figures 2 and 4); whilst the ratio of expenditure to GDP on these sectors were declining both during the budget deficit and surplus regimes, expenditure to GDP on social protection and public order and safety increased in both regimes (see figures 3 and 5). This result is supported by the negative correlation between the thresholds (i.e. budget deficit and surplus regimes) and the trend of education and health expenditure to GDP (see Tables 6a and b). A priori one would expect that such a decline in the allocations to sectors which could stimulate growth and which in turn could generate future revenue, may pose a threat to the accumulated fiscal space.

6. Summary and Conclusion

This paper has tested the asymmetry relationship between revenue and expenditure i.e. made a distinction between adjustment of positive (budget surplus) and negative (budget deficit) deviations from equilibrium using quarterly data on South Africa. Our findings suggest that fiscal policy over the sampled period has been sustainable since the historical processes in South Africa are consistent with the intertemporal government budget constraint. Of more importance, our findings show that the assumption that adjustment towards equilibrium is always present and of the same strength under all circumstances is not valid in the case of fiscal data on South Africa.

Results from the study also reveal that government authorities are likely to react faster when the budget is in deficit than when in surplus implying that the South African government then becomes more concerned about solvency or fiscal sustainability; although such achievement could be prone to social shock as trend expenditure on education and health to GDP has been on a decline over this period of fiscal solvency. The increasing tensions in different communities about poor service delivery by the government in the recent years could be a recipe for fiscal unsustainability in South Africa. The paper therefore, supports the view that sustainability is more than fiscal accounting to include social and political context especially for emerging economies like South Africa where the role of government is socially and politically important[8]. It concludes that the attempt to achieve fiscal sustainability via a reduction in the expenditure/GDP ratios on sectors which could be potentially growth enhancing and therefore expand the revenue base, may be socially, politically and economically unsustainable.

[8] See Adelzadeh (199:2); Burger and Fourie (2004).

7. Future Research

Future research which leads to the second paper requires estimating the revenue gap in the South African economy to ascertain whether there is potential for revenue to grow further to reduce the backlog in service provision which is identified as a potential threat to the current fiscal stability enjoyed by the country.

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Table 1: Unit Roots Tests

Panel A	ADF	PP	KPSS
Revenue-GDP	1.42	-0.598	1.599***
Expenditure-GDP	0.906	-0.300	1.307***
Panel B			
ΔRevenue-GDP	-9.665***	-9.998**	0.095
ΔExpenditure-GDP	-10.132***	-7.528***	0.092

Note *(**)(***) denotes significance at 10, 5, and 1% levels respectively.

Table 2: Binding Restrictions

	B(1,1)=1, B(1,2) =-1			
Hypothesied no. of Cointegration	Restricted Likelihood	LR Statistics	Degree of freedom	Probability value
1	452.0105	0.219771	1	0.639215

Table 3: BDS Test

ε/σ	Embedding Dimensions(m)	BDS Statistics
2	2	0.014***(0.0045)
2	3	0.024***(0.0071)
2	4	0.040***(0.0085)
2	5	0.046***(0.0087)
2	6	0.046***(0.0085)

Note: *(**)(***) denotes significance at 10, 5 and 1% respectively

Table 4: LM-Type for non-linearity and model selection

Transition Variable	LM	H_{01}	H_{02}	H_{03}
Ecm_{-1}	0.018	0.018	0.043	0.025
Ecm_{-2}	0.706	0.706	0.240	0.558
Ecm_{-3}	0.448	0.448	0.140	0.680
Ecm_{-4}	0.113	0.113	0.205	0.446
Ecm_{-5}	0.144	0.144	0.068	0.090
Ecm_{-6}	0.000	0.000	0.001	0.0012
Ecm_{-7}	0.421	0.421	0.507	0.957
Ecm_{-8}	0.001	0.0011	0.0010	0.124

Note: ρ-values of F variants of the LM-type tests used in the specification procedure of Escribano and Jorda(2001).

Table 5a :In-sample estimates of linear and nonlinear models

$$
\begin{aligned}
Dlrev_t = {} & \alpha_0 + \alpha_1 dlrev_{-1} + \alpha_2 dlrev_{-2} + \alpha_3 dlrev_{-4} + \alpha_4 dlrev_{-5} + \alpha_5 dlrev_{-8} + \alpha_6 dlexp_t + \alpha_7 dlexp_{-2} + \alpha_8 dlexp_{-4} \\
& + \alpha_9 dlexp_{-5} + \alpha_{10} dlexp_{-8} + \alpha_{11} ecm_{-1} + (1 - F)(\beta_0 + \beta_1 dlrev_{-1} + \beta_2 dlrev_{-2} + \beta_3 dlrev_{-4} \\
& + \beta_4 dlrev_{-5} + \beta_5 dlrev_{-8} + \beta_6 dlexp_t + \beta_7 dlexp_{-2} + \beta_8 dlexp_{-4} + \beta_9 dlexp_{-5} + \beta_{10} dlexp_{-8} \\
& + \beta_{11} ecm_{-1})
\end{aligned}
$$

Table 5b: Model estimâtes, 1960: Q1- 2008: Q4

Parameter	Linear model	Non-linear (General)	Non-linear (Specific)
α_0	0.002 (0.005)	0.009 (0.008)	0.005 (0.008)
α_1	-0.28***(0.081)	-0.424*** (0.109)	-0.469*** (0.081)
α_2	0.102** (0.047)	0.100* (0.058)	
α_3	0.478***(0.068)	0.507*** (0.088)	0.510*** (0.069)
α_4	0.227***(0.062)	0.334*** (0.089)	0.284*** (0.067)
α_5	0.199** (0.060)	0.154** (0.075)	0.173 *** (0.059)
α_6	0.153** (0.059)	0.136* (0.078)	0.093** (0.046)

α_7	-0.082** (0.041)	-0.132** (0.056)	-0.108** (0.054)
α_8	-0.145** (0.070)	-0.1534* (0.087)	
α_9	-0.213***(0.054)	-0.253*** (0.079)	-0.127* (0.066)
α_{10}	0.008 (0.054)	0.023 (0.075)	
α_{11}	-0.214***(0.061)	-0.165** (0.077)	-0.121* (0.072)
β_0		-0.058*** (0.021)	-0.058*** (0.019)
β_1		0.399** (0.171)	0.326*** (0.019)
β_2		-0.085 (0.106)	
β_3		-0.073 (0.151)	
β_4		-0.111 (0.142)	
β_5		0.126 (0.131)	
β_6		0.103 (0.135)	
β_7		0.148* (0.089)	0.138* (0.078)
β_8		-0.184 (0.160)	-0.220** (0.094)
β_9		-0.131 (0.144)	-0.269** (0.125)
β_{10}		0.018 (0.112)	
β_{11}		-0.342 ** (0.144)	-0.332*** (0.124)
$\alpha_6 + \beta_6$		0.239*** (0.012)	
$\alpha_{11} + \beta_{11}$		-0.507*** (0.0147)	-0.453*** (0.011)
Adjusted R^2	0.90	0.91	0.92
T	184	184	184
AIC	-2.35	-2.34	-2.37
ARCH	[0.0066]	[0.52]	[0.30]
LM	[0.001]	[0.108]	[0.402]
DW	2.10	2.09	2.06

Note: *(**)(***) denotes significance at 10, 5 and 1% respectively; T- No. of observations, ARCH- Autoregressive conditional heteroscedasticity, AIC- Akaike info criterion ,DW- Durbin Watson stat. [ ] are probability values. The Delta method is used to calculate the standard errors of $(\alpha_6 + \beta_6)$ and $(\alpha_{11} + \beta_{11})$.

Table 6a: Correlation between expenditure Items GDP and Deficit Regime

	Deficit	Defence	Education	Health	Social protection	Public order & Safety	Housing
Deficit	1.0000	-0.1398	-0.475	-0.2373	0.1149	-0.0564	-0.2423
Defence	-0.1398	1.0000	-0.5009	-0.5387	-0.9051	-0.9047	0.7138
Education	-0.475	-0.5009	1.0000	0.7637	-0.4592	0.6585	-0.3971
Health	-0.237	-0.5387	0.7637	1.0000	0.5580	0.6582	-0.2009
Social Protection	0.1149	-0.9051	-0.4592	0.5580	1.0000	0.8987	-0.5650
Public order &safety	-0.0564	-0.9047	0.6585	0.6582	0.8987	1.0000	-0.5861
Housing	-0.242	0.7138	-0.3971	-0.20092	-0.5650	-0.5861	1.0000

Table 6b: Correlation between expenditure Items GDP and Surplus Regime

	Surplus	Defence	Education	Health	Social protection	Public order & Safety	Housing
Surplus	1.0000	-0.4803	-0.2655	-0.0099	0.4964	0.4303	-0.1847
Defence	-0.4803	1.0000	-0.5009	-0.5387	-0.9051	-0.9047	0.7138
Education	-0.2655	-0.5009	1.0000	0.7634	-0.4592	0.6585	-0.3971
Health	-0.0099	-0.5387	0.7634	1.0000	0.5580	0.6582	-0.2009
Social Protection	0.4964	-0.9051	-0.4592	0.5580	1.0000	0.8987	-0.5650
Public order &safety	0.43030	-0.9047	0.658	0.6582	0.8987	1.0000	-58615
Housing	-0.1847	0.7138	-0.3971	-0.2009	-0.5650	-0.5861	1.0000

Appendix 1: Description of the variables and sources

Variables	Description
Revenue	National government revenue as a percentage of gross domestic product

Expenditure	National government expenditure as a percentage of gross domestic product
Education	National government expenditure on education as a percentage of gross domestic product
Health	National government expenditure on health as a percentage of gross domestic product
Socialprotection	National government expenditure on social protection as percentage of gross domestic product
Public order and safety	National government expenditure on public order and safety as percentage of gross product product
Housing	National government expenditure on housing as a percentage of gross domestic product
Deficit	Expenditure greater tha revenue as a percentage of gross domestic product

Source: South African Reserve Bank (http://www.reservebank.co.za)

Figure 1: Selected macroeconomic variables of South Africa

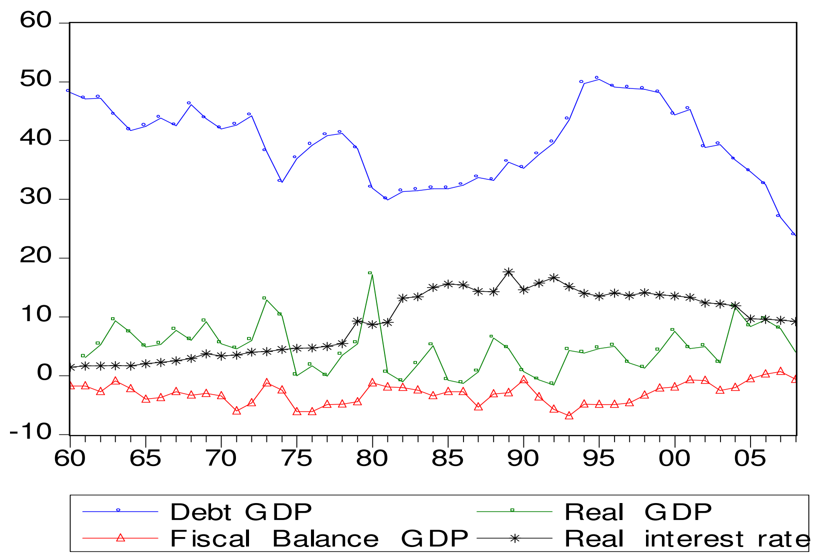

Figure 2: Expenditure on growth enhancing sectors during deficit regime

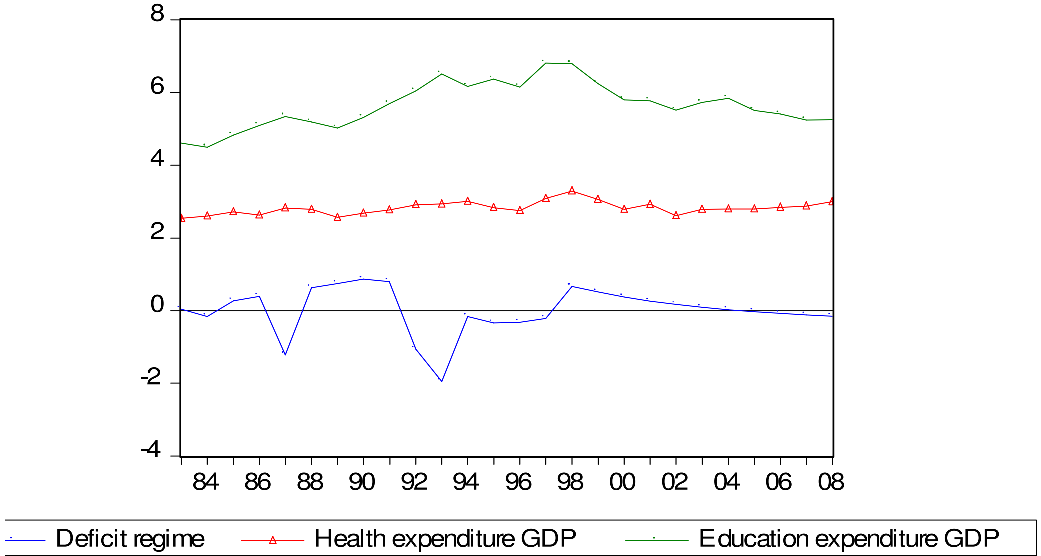

Figure 3: Deficit vs some non-productive sectors

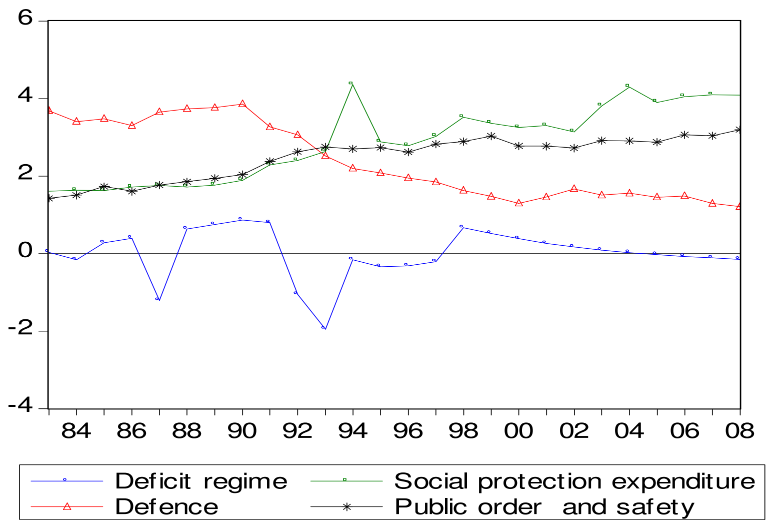

Figure 4: Surplus regime vs growth enhancing sectors

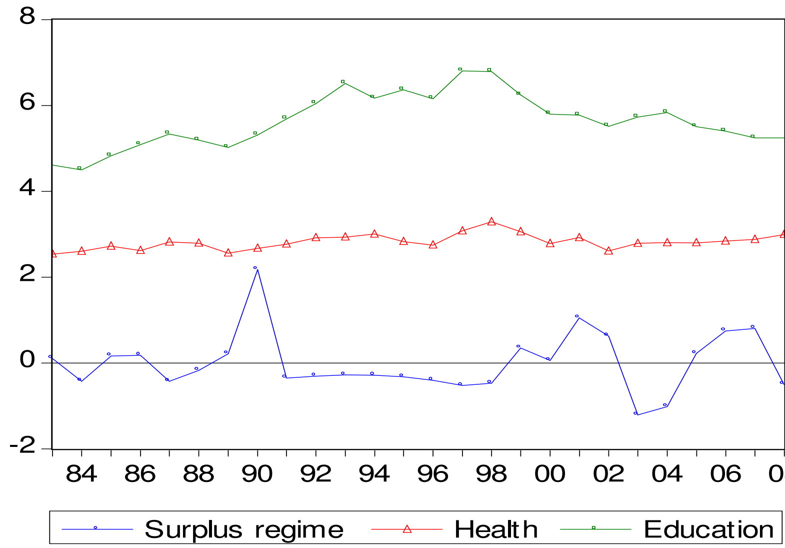

Figure 5: Surplus regime vs non productive sectors

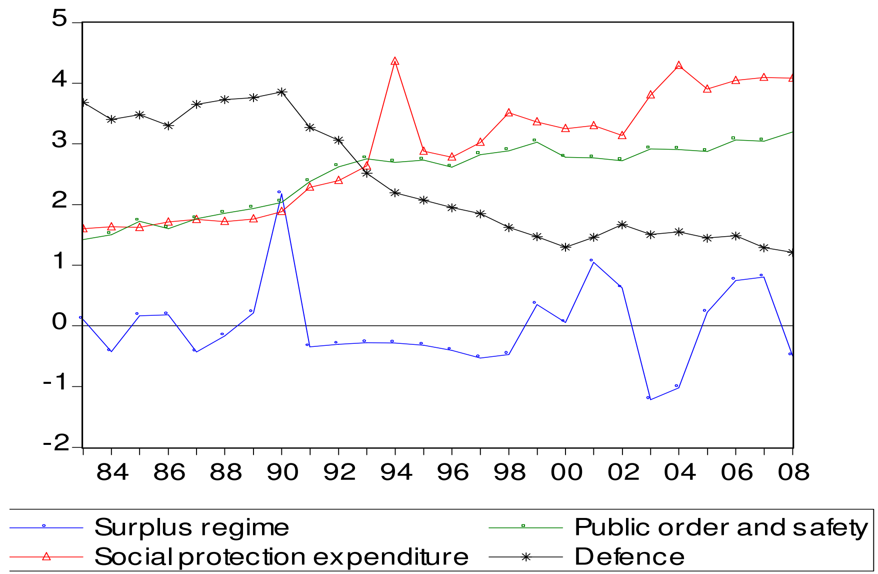

Figure 6: Cointegrating relationship between series

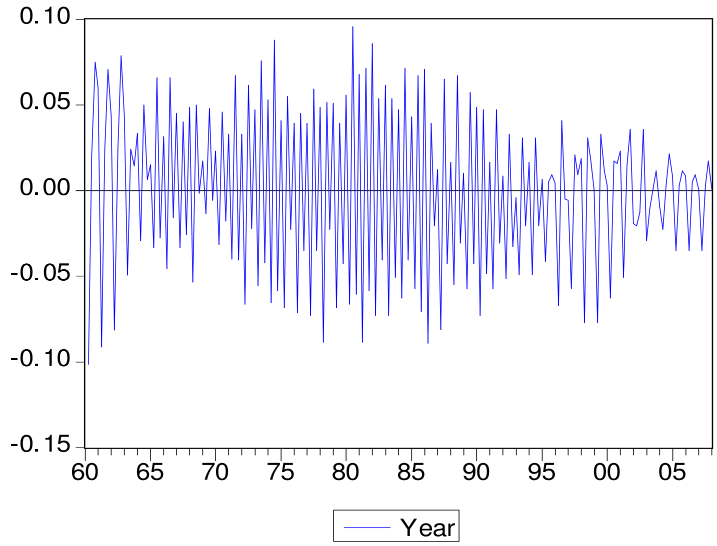

Figure 7: Transition function over time with budget deficit regime

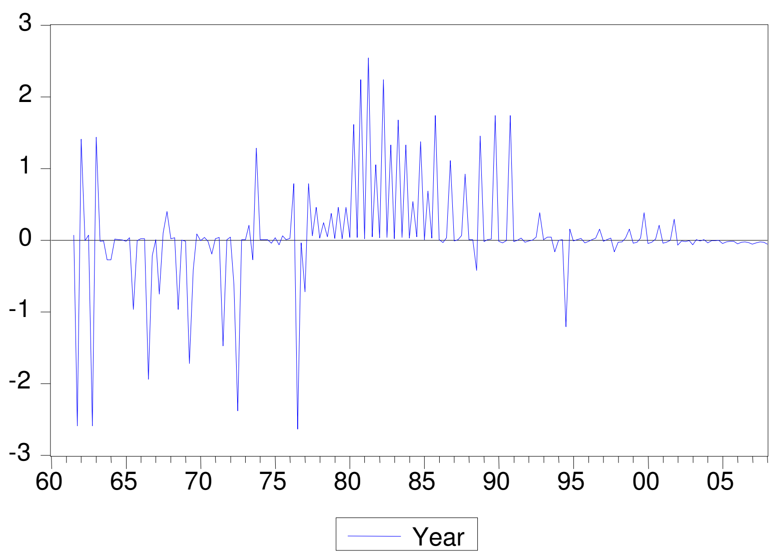

Figure 8: Transition function over time in surplus regime