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Does high public debt level constrain the interest rate setting behaviour of the South African Reserve Bank?

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Abstract

Constraints exerted on interest rate setting behaviour of central banks by high public debt is well acknowledged in the theoretical literature. Empirical evidence, however, remains limited. The few empirical studies either fail to provide confidence intervals for the threshold estimate (a limitation that raises concerns of precision of such an estimation for the purposes of policy) or are substantially constrained by data unavailability which hampers econometric inference. Yet, establishing the nature of such constraints is important because it highlights the nature of risk of breach of publicly announced inflation targets under inflation targeting regimes and feeds into central bank independence debate. With a complement of an expansive dataset, we account for debt constraint in the interest rate setting behaviour of the South African Reserve Bank using a Taylor rule. We find that the policy response to inflation gap in the high-debt regime is substantially constrained.

Keywords: Monetary policy; public debt; inflation; sample splitting; threshold regressions.

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1. Introduction

Public debt in sub-Saharan Africa has risen precipitously over the years. Between 2009 and 2018, gross debt as a percentage of GDP increased from 24 per cent to 42 per cent (Obeng-Odoom, 2020, p. 163). The recent interest in modern monetary theory (MMT) suggests that such an increase is, perhaps, immaterial because governments (through central banks) could print as much money as possible to settle this debt. The premise of such an argument by the proponents of the MMT is grounded in the thinking that fiscal authorities cannot go bankrupt nor incapacitated to meet their debt obligations in the very currency they supply (Wray, 2015).

However, such printing of money to finance fiscal debt comes with obvious baggage. The effect of rising debt levels on inflation has been acknowledged in the literature (Bayale *et al*, 2021; Mupunga and Le Roux, 2016; and Dornbusch, 1996). For inflation-targeting central banks, therefore, rising public debt levels would necessitate policy restriction (policy rate increase) to curb the inflationary momentum. Such a prudent policy step is, however, not straightforward in practice especially with less independent central banks. Taking a contractionary monetary policy stance in the face of rising public debt heightens the interest service liability of the fiscal authorities, feeding into worsening fiscal deficits and deteriorating the debt stock even further and inflationary momentum eventually. Meanwhile, keeping interest rates low amidst rising inflation is even more ruinous in the context of inflation targeting, as the publicly announced inflation target would not only be missed, but it collapses an important foundation of public trust and endangers the very survival of the inflation-targeting framework on anchoring inflation expectations (Iddrisu and Alagidede, 2020). This represents a serious dilemma for central banks, a phenomenon termed by Mitra (2007) and Dornbusch (1996) as 'debt constraint on monetary policy'.

Although monetary policy rules measuring the nature and extent of monetary policy responses to macroeconomic fundamentals have been widespread in the literature, following the Taylor (1993) interest rate rule, the potential constraint posed by high public debt levels to monetary policy responses have been largely ignored.

The study by Mitra (2007) on the Bank of Canada appears to have been the first, or one of the first, empirical research across the monetary policy rule literature that considered debt constraint on monetary policy (interest rate setting) behaviour. A fundamental drawback of that study, as Mitra (2007) acknowledges, is the

failure to provide confidence interval for the threshold estimate. As the author used sample debt observations to infer about the population, and in particular for policy purposes, the inability to provide confidence interval raises questions of uncertainty about the accuracy and precision of the estimates and could be fundamentally different from the actual population debt threshold. Meanwhile, such empirical exercises are supposed to inform policy. Taking policy decisions on the basis of estimates whose accuracy cannot be ascertained could jeopardise soundness of policy paths and the credibility of the policymakers. The only other study, apart from Mitra (2007), is the recent work by Iddrisu and Alagidede (2020) in the context of Ghana. That study, as its authors acknowledged, was substantially constrained by data unavailability, with a total of 42 observations shared between high and low debt regimes. Indeed, the low debt regime had 9 observations determined by the model. Much as the few (9) observations were model-determined, it inadvertently blights adequate econometric inference.

We make a number of contributions to this strand of literature. To overcome the limitations of the work of Mitra (2007), we make use of the Hansen (2000) sample splitting and threshold estimation technique, similar to Iddrisu and Alagidede (2020), which captures threshold effect of debt and splits the sample to enable us determine the nature of policy responses below and above the threshold and whether or not debt poses a constraint on interest rate setting. In estimating the threshold debt level, our model provides confidence intervals at 95% confidence level on the basis of asymptotic theory.

Unlike Iddrisu and Alagidede (2020) where data unavailability constrained the observations to 42 with baleful consequences on the econometric inference, the current study employs an expansive data by studying the context of South Africa. Whereas Ghana's full-fledged inflation targeting framework was unveiled in 2007 which exacerbated the data unavailability issues and the number of observations that could be used, South Africa launched its inflation targeting framework in 2000, which provides an expansive data span that improves econometric inference. Importantly, the debt-to-GDP ratio of South Africa over the inflation targeting period has witnessed an upward trajectory, reaching as high as 53% in 2017 and an estimated 55.7% in 2018 (IMF, 2019). Given that South Africa is the first country in Africa to embrace a full-fledged inflation targeting framework, these developments and the lessons thereof could present an important model for the rest of Africa.

The results indicate a debt to GDP threshold of 33.7% with debt levels exceeding this threshold in as many as 51 quarters compared to 21 quarters

where debt levels fell below the threshold. We find a considerable inflation accommodation above the debt threshold, an indication of debt constraint on monetary policy. Significantly, we find that on the back of challenging growth trajectory, policy stance has been one of accommodation to provide growth impetus. This is reflected in the rather high weights placed on the output gap below and above the debt threshold. We look at related literature briefly in section 2 and methodology in section 3. Our results are presented in section 4, policy considerations are discussed in section 5 and conclusions made in section 6.

2. Literature review

One of the known theoretical links connecting debt to monetary policy is the concept of seigniorage (Reich, 2017; Keynes, 1953). Fiscal authorities or governments, through the central banks, generate revenues by supplying currencies with face values or purchasing power which outstrip the cost at which the currencies were printed. The difference represents revenues which were used by governments to finance their debts (see Reich, 2017). When debt levels rise and are accompanied by financing through seigniorage revenues or monetisation, higher inflation becomes the natural consequence (Mitra, 2007). The accompanying inflation is normally intended to diminish the burden of the debt in real terms (Dornbusch, 1996). This is particularly the case for debts with longer repayment periods as their real worth could be significantly reduced to nothing by menacing inflation levels (Dornbusch, 1996). However, the value of short tenured debts may not suffer such erosion of the magnitude observed in long tenured debts since investors are rational and would take inflation expectations into consideration when rolling over their debt holdings. Nonetheless, Dornbusch (1996) argues that when inflation is explosive, even the short tenured debt can have its real value significantly diminished.

Another theoretical connection between debt and monetary policy is the interest rate (Mitra, 2007). The debt servicing liability, and the debt stock eventually, can deteriorate when interest rates increase in the face high debt levels. Thus, when debt levels are significantly high, raising the interest rates not only affects the interest cost but also the future budget position and the stock of debt eventually due to additional borrowing to finance such budget positions (Mitra, 2007). Additionally, the rising interest rates also dampens economic activities, thereby shrinking government revenues and worsening the fiscal position. With contraction of the economy and the accompanying high

unemployment rate, the government would perhaps respond by easing fiscal policy in an attempt to chart a recovery path but at a cost of worsening fiscal balances and inflation (Dornbusch, 1996). On the other hand, this liability can be lessened by keeping interest rates low. For central banks that are not independent, this becomes an important link of easing government debt service liability by way of keeping interest rates lower than required. In the context of an inflation targeting central bank, however, this would amount to inflation accommodation when it should be targeted and that has serious ramifications for policy credibility and soundness. Anchoring the inflation expectations of the public then becomes a difficult task going forward and the whole essence of inflation targeting comes collapsing. So, while taking a restrictive policy stance when debt levels rise fuels further cycles of debt and inflation, keeping interest rates low is even more catastrophic particularly for inflation targeting central banks. The dilemma the central banks then face is whether to endure inflation now to avert worsening debt position and inflation eventually or tighten policy stance now to elicit fiscal restraint. Although some central banks could tighten policy stance under the circumstances, the degree of policy restriction could be significantly below the required level (Dornbusch, 1996).

The monetary policy-public debt relationship is also grounded in the active versus passive monetary and fiscal policy debate, with foundations in the fiscal theory of the price level (see Woodford, 1995; Sims, 1994 and Leeper, 1991). According to Leeper (1991), monetary policy is active when the monetary policy stance taken by the monetary policy authorities is independent of fiscal authorities' debt positions. In other words, shock to fiscal debt level is not a determining factor for monetary policy stance when monetary policy is active. On the other hand, where shocks to fiscal debt dictate monetary policy stance, then monetary policy is said to be passive.

The conventional view is that monetary policy is mostly the active one whiles fiscal policy is passive (see Bajo-Rubio *et al*, 2009), implying that it is the changes in the stance of monetary policy that shape the path of price levels. According to Woodford (1995), the conventional view that the quantity theory of money provides the mechanics for price level determination in an economy has largely underpinned the conduct of monetary policy by way of regulation of the quantum of supply of money in the economy. Challenging the appropriateness of this view, Woodford (1995) argues that the quantity-based propositions rely on inadequate preconditions necessary for equilibrium price level determination, particularly because they ignore the substantial role

of fiscal policy in the equilibrium price level determination. Fiscal policy, Woodford (1995) reckons, is an important factor in determining equilibrium price level in an economy as per what has come to be known as the fiscal theory of the price level. The mechanism is that the real private sector net assets as well as the net liabilities of the government reduce (wealth effect) following price level increase, occasioning a weak private sector demand and informing the price level that equates aggregate supply and aggregate demand. Moreover, the variations in the expectations of the future paths of government budgets (in the light of the size of outstanding fiscal debt) exact analogous wealth effects which necessitate changes in price levels that bring aggregate demand and supply to equilibrium (Woodford, 1995). Indeed, some reckon that under fiscal theory of the price level, monetary policy is actually passive whiles fiscal policy is active (see Bajo-Rubio *et al*, 2009). Following initial theoretical contributions by Woodford (1995), Sims (1994) and Leeper (1991), empirical literature on fiscal theory of the price level abound (see Berentsen and Waller, 2018; Bassetto and Cui, 2018; Bajo-Rubio *et al*, 2009; Daniel, 2007, 2001; Tkacevs, 2006 and Kim, 2004).

Monetary policy rule literature that examines the responses of central banks to developments within and outside the economy have greatly mushroomed in the wake of the remarkable success of the Taylor (1993) interest rate rule in the context of the Federal Reserve Bank. The Taylor (1993) rule was subsequently modified to take into account policy response to expectations (Clarida *et al*, 1999; and Woodford, 2001) and the smoothing of interest rate (Blinder and Reis, 2005). A new paradigm of nonlinear monetary policy rule argument then emerged in the literature (Ahmad, 2016; Liu *et al*, 2018; and Caporale *et al*, 2018), questioning the linear policy rule proposition.

Despite these modifications and paradigm shifts in the literature, what is surprisingly ignored empirically is the nature of constraint that rising levels of public debt exert on the interest rate setting behaviour. Mitra (2007) and Iddrisu and Alagidede (2020), as far as we know, are the sole empirical studies that have accounted for such a constraint in a typical policy rule environment. Mitra (2007) considered a threshold model for the Bank of Canada, capturing the nature of policy responses below and above the estimated debt threshold. Mitra (2007) used the GMM estimation approach with data in monthly frequency from November 1991 to the end of 2000. The results indicated that high levels of debt exerted some constraint on monetary policy. In particular, Mitra (2007) observed that policy response to inflation declined by 0.99% when debt exceeded

the estimated threshold compared to what the response was below the threshold. Iddrisu and Alagidede (2020) studied the context of Ghana. They established a debt constraint on the interest rate setting behaviour of the Bank of Ghana.

While the study by Mitra (2007) is a bold step in the literature, the work is primarily limited. The author fails to provide confidence intervals for the threshold estimate, a limitation acknowledged in that study. Without the confidence intervals, determining the precision and accuracy of the threshold estimate is problematic since the author was trying make inference about the population with a sample. Importantly, for the purposes of policy, such confidence intervals could not be more critical. The work of Iddrisu and Alagidede (2020), as indicated earlier, is also constrained by data unavailability. We therefore take the literature further by surmounting the deficiencies of these studies.

3. Methodology

3.1. Data and sources

This study employs data in quarterly frequency from quarter three of 2000 to quarter two of 2018. Starting the data from 2000 is in tandem with the start of the full-fledged inflation targeting. Data on all the variables except inflation and debt to GDP ratio are sourced from Datastream. Inflation data is obtained from the quarterly bulletins released by the South African Reserve Bank (SARB). Data on debt to GDP ratio is taken from the database of IMF in annual frequency. They are then converted to quarterly frequency with the aid of interpolation. The interpolation technique, for every annual observation, delivers a local quadratic polynomial estimation. The resulting polynomials are then used to provide quarterly series that match the observed annual observations. This interpolation method obtains the quadratic polynomial by utilizing adjacent points in sets of three that are taken from the annual series to estimate the quadratic with the result that the sum or the average of the obtained quarterly observations match with the annual series that were originally observed in the economy (IHS Global, 2017).

3.2. Measurement of variables

The variables in our model are the monetary policy variable, inflation and output gaps and debt level in line with Iddrisu and Alagidede (2020). These variables are defined below:

Inflation gap: South Africa's inflation target range for the medium term is 3%-6%. In line with literature, we measure the inflation gap as the difference

between the observed inflation rates and the midpoint of the inflation target range (Naraidoo and Raputsoane, 2011; and Naraidoo and Paya, 2012). Debt constraint is said to exist when the policy response to expected inflation gap above the estimated debt threshold is far lower than required or reduces compared to the response below the debt threshold.

Output gap: Output is represented by real GDP. We measure output gap by the deviation of the real GDP (in logs) from its trend. That is, the calculated trend is deducted from the output series to obtain the output gap. The trend is calculated using a univariate structural time series model which decomposes the output series into the cycle and trend components as per the work of Koopman *et al* (2009). Following Koopman *et al* (2009) and for the purpose of our decomposition, the model is specified as follows:

$$y_t = \mu_t + \omega_t + \epsilon_t \qquad \epsilon_t \sim NID(0, \sigma_\epsilon^2), t = 1 \ldots\ldots T \tag{1}$$

such that the real GDP is represented by y_t, while μ_t and ω_t represent respectively the trend and cycle components. The irregular component is denoted by ϵ_t. The decomposition is done using the Maximum Likelihood technique for estimation, similar to Iddrisu and Alagidede (2020). The trend, one of the decomposed components, is then subtracted from the output series to obtain the output gap as indicated earlier. Previous works such as Ma (2016), Caporale *et al* (2018) and Liu *et al* (2018) had utilized a filter developed by Hodrick and Prescott (1997) called the HP filter to determine the trend. Meanwhile, the HP filter has been argued to be limited in a number of ways. These limitations include the prerequisite of determining the parameter (λ) which penalizes smoothness versus fit, with such determinations done arbitrarily (Alvarez and Gomez-Loscos, 2018), exhibiting poor behaviour in observations that are recent (Caporale *et al*, 2018; and Alvarez and Gomez-Loscos, 2018), delivers spurious cycles in the case of series that have a classic spectral shape (Alvarez and Gomez-Loscos, 2018) and the fact that it is specific to the structure and the data of the United States which is very different from other economies especially small economies (Caporale *et al*, 2018; and Sarikaya *et al*, 2005). Our model-based technique of decomposing trend and cycle has the virtue that because the model implicitly defines the filters, these filters exhibit optimality and are consistent not just with each other but also with our data (Harvey and Trimbur, 2003). Indeed, the said mutual consistency is observed both at the start and end of the output series. Thus, they adapt automatically to the ends of our sample. Importantly, because the model is capable of estimating the parameters, the properties of our output series are consistent with the accompanying filters (Harvey and Trimbur, 2003).

Debt level: We measure this by debt to GDP ratio in line with Mitra (2007).

Monetary policy variable: We use the repo rate as the monetary policy variable. This is the official monetary policy instrument used by the South African Reserve Bank.

On the basis of Augmented Dickey-Fuller (ADF) test by Dickey and Fuller (1981) and the Phillips Perron (PP) test by Phillips and Perron (1988), we find GDP and inflation gaps to be stationary at the levels as shown in Table 1. Monetary policy rate (repo rate) enters the estimation model after first difference.

Table 1: Test for Stationarity

	ADF TEST		PP TEST	
	Level	**First Diff**	**Level**	**First Diff**
π	-3.311*	-4.483***	-2.2905	-4.033**
$y - y^*$	-4.526***		-3.858**	
$\mu - \mu^t$	-4.818***		-4.7719***	

Notes: Trend and intercept are included in both the ADF and the PP Tests. ***, ** and * attached to figures indicate significance at 1%, 5% and 10% respectively.
π signifies monetary policy rate represented by the repo rate. $\mu - \mu^t$ means inflation gap and $y - y^*$ means output gap. The critical values for π under the ADF test at both levels and first difference for 1%, 5% and 10% are -4.089, -3.473 and -3.164 respectively. Under the PP test, the critical values at the levels for 1%, 5% and 10% are respectively -4.087, -3.472 and -3.163. The critical values for the first difference are the same as those observed under the ADF test for π. For $y - y^*$, the critical values under the ADF at the levels are -4.095, -3.475 and -3.165 at 1%, 5% and 10% respectively. For the PP test, the critical values are -4.093, -3.474 and -3.165 at 1%, 5% and 10% respectively. For $\mu - \mu^t$ the critical values under both ADF and PP tests are -4.087, -3.472 and -3.163 at 1%, 5% and 10% respectively.

3.3. Empirical approach

We begin with a basic linear monetary policy rule expressed below:

$$\pi_t = \beta_0 + \beta_1(E_t[\mu_{t+k} - \mu_t^t]) + \beta_2(E_t[y_{t+k} - y_t^*]) + \varepsilon_t \quad (2)$$

where the repo rate is given by π_t, μ_{t+k} denotes inflation rate and μ^t is the publicly announced inflation target. Our inflation gap is then represented by $\mu_{t+k} - \mu^t_t$. The output gap is given by $y_{t+k} - y^*_t$ whiles the error term is given as ε_t. In line with the argument by Woodford (2001), we introduce expectations in our model denoted by E_t. The intuition is that policymakers react to expected inflation and not necessarily the recent inflation. As a result, the output and inflation gaps enter the model as t+1 (one-period lead). Since we are using quarterly data and the Monetary Policy Committee of the South African Reserve Bank sits every two

months to determine the policy rate, then a one-quarter lead is an appropriate approximation.

Since the linear model fails to capture the constraint that high debt levels exert on monetary policy, our study uses a threshold estimation technique to determine the threshold level of debt above which monetary policy is constrained in terms of the setting of policy rate. As the limitation of the only study in this strand of the literature is the failure to provide confidence interval, we resort to the Hansen (2000) sample splitting and threshold estimation technique. This technique gives confidence intervals for the threshold estimate at 95% confidence level with the aid of the asymptotic theory. In doing so, the technique is free from nuisance parameters that plague other threshold models. That is, the technique only incorporates parameters that are of immediate inferential interest as opposed to other threshold techniques which, by construction, require several parameters but may not necessarily have immediate inferential interest in some of these parameters (see Taper and Lele, 2011; and Hansen, 2000).

From equation (2), we represent the repo rate by y with inflation and output gaps represented by x such that the set $\{y_i, x_i, \varphi_i\}^n_{i-1}$ represent our observed sample with x_i signifying an m-vector, and y_i and φ_i being real-valued. Within the observed sample, φ_i stands for the threshold variable given as $\varphi_i = \partial_{t-1}$ and its distribution is continuous. Our threshold variable is the lag of debt to GDP ratio. By using lag of debt to GDP ratio, it helps deal with potential endogeneity problem involving monetary policy rate and the threshold variable. Thus, whiles past debt to GDP values could impact on today's interest rates, current interest rates cannot affect past debt to GDP. Such an approach of using lags to deal with potential endogeneity is not new in the literature (Uprety, 2019; and Boachie *et al*, 2018).

Our threshold model then becomes:

$$\pi_t = (\beta_{11} + \beta_{21}(E_t[\mu_{t+k} - \mu_t^t]) + \beta_{31}(E_t[y_{t+k} - y_t^*]))I_i\{\varphi_i \leq \vartheta_i\} + (\beta_{12} + \beta_{22}(E_t[\mu_{t+k} - \mu_t^t]) + \beta_{32}(E_t[y_{t+k} - y_t^*]))\, I_i\{\varphi_i > \vartheta_i\} + \varepsilon_t \quad (3)$$

with $I_t\{.\}$, an indicator variable, being a dummy that assumes the value 1 when the condition therein is satisfied or otherwise 0. Our threshold value is then denoted by ϑ. The other variables follow the previous definitions.

Before undertaking the threshold estimation, we begin with a test of the linear hypothesis as against the threshold proposition. Thus, we ascertain whether $\beta_{i1} = \beta_{i2}$ or $\beta_{i1} \neq \beta_{i2}$.

By reducing equation (2), we $y_i = \beta' x_i + \omega_i' x_i(\vartheta) + \varepsilon_i$ (4)
such that $\omega_n = \beta_{i2} - \beta_{i1}$ and denotes the threshold effect. Essentially, we get the solution to be $\omega_n \to 0$ when $n \to \infty$. This is by keeping β_{i2} unchanged so that when $n \to \infty$, $\beta_{i1} \to \beta_{i2}$. Importantly, the associated asymptotic distribution of $\hat{\vartheta}$ is free from nuisance parameters that plague other threshold models (Hansen, 2000). By putting equation (4) in a form of matrix with $n \times 1$ vectors of ε_i and y_i when we stack the two and then an $n \times m$ matrices x and x_ϑ by stacking the vectors x_i' and $x_i(\vartheta)'$. The ensuing matrix form is given below:

$$Y = X\beta + X_\vartheta \omega_n + \varepsilon_i \quad (5)$$

With the aid of least squares, we determine the parameters β, ω and ϑ. The Sum of Squared Errors in equation (5) given by:

$$SSE_n(\beta, \omega, \vartheta) = (Y - X\beta + X_\vartheta \omega_n)' (Y - X\beta + X_\vartheta \omega_n) \quad (6)$$

are then minimized by the least squares estimates $\hat{\beta}$, $\hat{\omega}$ and $\hat{\vartheta}$. We essentially restrict the threshold value to a bounded set $[\underline{\vartheta}, \bar{\vartheta}] = \bar{\sigma}$ in the said minimization. We deploy the concentration technique to determine the least square estimates $\hat{\beta}$, $\hat{\omega}$ and $\hat{\vartheta}$ so that $SSE_n(\vartheta)$ is minimized by the value $\hat{\vartheta}$ which is distinctively determined by $\hat{\vartheta} = \underbrace{argmin}_{\vartheta \in \overline{\sigma}} SSE_n(\vartheta)$

where $\overline{\sigma}_n = \overline{\sigma}_n \cap \{\vartheta_1, \vartheta_2, \ldots\ldots\ldots\ldots \vartheta_n\}$ with the slopes determined as

$$\hat{\beta} = \hat{\beta}(\hat{\vartheta}) and\ \hat{\omega} = \hat{\omega}(\hat{\vartheta}).$$

With the aid of the Likelihood Ratio test, we test the hypothesis H_0: $\vartheta = \vartheta_0$ given as $LR_n(\vartheta) = n \frac{SSE_n(\vartheta) - SSE_n(\hat{\vartheta})}{\ldots}$

The null H_0 is rejected for large values of $LR_n(\vartheta)$ We ascertain the reliability of ϑ by determining where it falls in the asymptotic confidence interval for ϑ given the Likelihood Ratio $LR_n(\vartheta)$ defined as $\hat{\bar{\sigma}} = \{\vartheta: LR_n(\vartheta) \leq c\}$ in line with the work of Hansen (2000).

4. Empirical results and analysis

We ascertain whether there is a threshold effect of debt before we proceed with threshold analysis. A test of linearity against that of a threshold is conducted. Table 2 presents the results. In testing the hypothesis, our technique undertakes a bootstrap replication of 5,000 at a 15-percentage trimming. The choice of 5,000 (for the bootstrapping) is to generate sufficient replications to produce robust estimates and to support convergence of the data. The bootstrap p-value representing the statistical significance of the estimated threshold is also given in the table. On the basis of the large Lagrangian Multiplier test statistic and the

bootstrap p-value of 0.0192, we reject the null hypothesis of linearity.

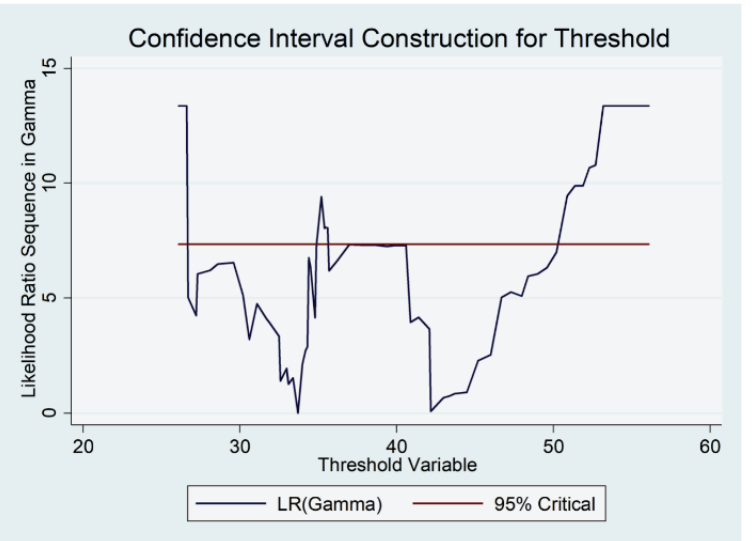
Table 2: Threshold Test

Moderated by	No. of Bootstrap replications	Trimming Percentage	LM-Test of no threshold	Bootstrap p-value
Debt to GDP	5,000	15	10.792	0.0192

Notes: The errors are corrected for heteroscedasticity.

We present the resulting threshold graph along with the confidence intervals of the normalized Likelihood Ratio (ϑ) in Figure 1.

Figure 1: Confidence Interval



The results indicate a threshold debt to GDP ratio of 33.7% with confidence interval of [26.7%, 50.2%] and the Likelihood Ratio (ϑ) crosses the critical line at these points at 95% confidence. Given the threshold debt to GDP ratio of 33.7%, we find that for 21 quarters, the observed debt to GDP ratio fell below the threshold. Meanwhile, for as many as 51 quarters the debt to GDP ratio was above the threshold of 33.7%. This presents a significant consequence to the South African Reserve Bank as high debt levels pose an upside risk to inflation. To ascertain the nature of policy responses to inflation and output gaps in the face of the rising debt, we now turn to Table 3 for the empirical results. Given the rejection of the linearity hypothesis, we present the results on only the threshold model.

Table 3: Results of the Threshold Method

Variables	**Regime 1: [δ≤φ]**		**Regime 2: [δ>φ]**	
Intercept	0.002**	(0.001)	-0.002**	(0.001)
$y_{t+k} - y_t^*$	0.917***	(0.174)	0.849***	(0.278)
$\mu_{t+k} - \mu_t^t$	-0.001**	(0.0004)	0.001***	(0.0003)
Diagnostics				
Threshold estimate	33.7			
95% confidence interval	[26.7, 50.2]			
Observations		21		51
R Squared		0.67		0.34
Sum of Squared Errors		0.0004		0.0014
Residual Variance		0.00002		0.00003
Joint R Squared	0.47			
Heteroscedasticity Test (p-value)	0.71			

Note: *** and ** represent 1% and 5% significance levels respectively. The standard errors in brackets are corrected for heteroscedasticity.

4.1. The Threshold Model

In the threshold model, we look at responses of monetary policy to output and inflation gaps below and above the estimated threshold debt level. Below the estimated debt threshold is designated as low debt regime whereas the high debt regime is where debt levels exceed the estimated threshold.

In the low debt regime, we find that the output gap is positive and statistically significant, implying that a fall (rise) in output gap informs a reduction (increase) in the policy rate by the SARB. Putting this finding into context, we observed that the low debt regime coincides with the period from the last quarter of 2004 to the first quarter of 2010, a period where real economic growth has not been spectacular in South Africa. For instance, while real growth was 4.5% in 2004, it only inched up to 5% in 2005. Growth then dropped to 3.7% in 2008 and the South African economy even contracted by 1.8% in 2009. Over this period, the quantum of policy easing on the aggregate was 6% as against an aggregate tightening of 5%, an indication that the SARB considered output growth as an added priority and thus took policy stance meant to prop up economic activities. Indeed, for 8 quarters out of the 21, policy remained unchanged although there

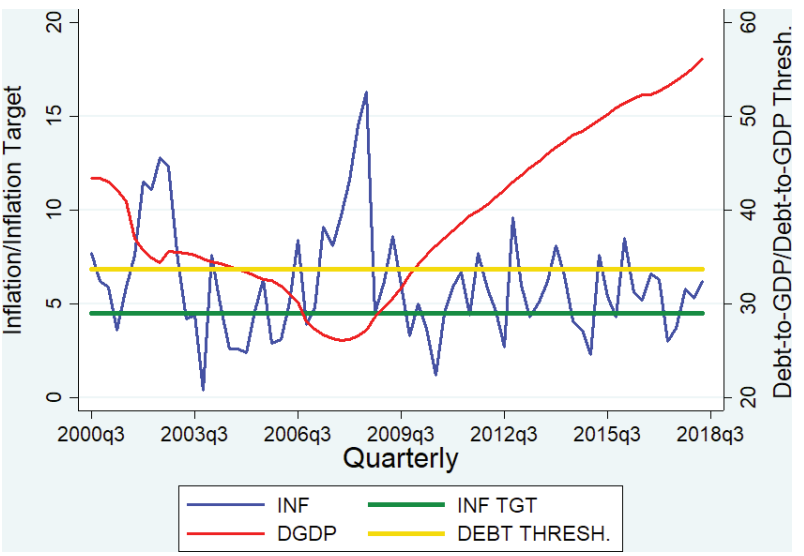
were ample indications of inflationary momentum. Taking policy stance to boost economic activities might be noble but that obviously has ramifications for commitment to inflation targeting which is the primary objective. Indeed, over the sample period, there were ten (10) quarters out of the total twenty-one (21) where inflation was above the upper limit of 6% of the announced inflation target range. There were also four (4) quarters where inflation was between the midpoint target of 4.5% and the upper limit of 6%. Invariably, therefore, there were only seven (7) quarters when inflation fell below the midpoint target. The nature of response of monetary policy under such circumstances where there were clear indications of inflation momentum is therefore telling. Unsurprisingly, we find that the policy response to inflation gap in the low debt regime is negative.

To determine whether high debt levels exert some constraint on the policy responses, we consider the result in the high debt regime. Per the work of Mitra (2007), where the monetary policy response to inflation declines as debt levels surpass the estimated threshold, then the policy behaviour or the setting of interest rate by the central bank is constrained by rising debt. Meanwhile, Dornbusch (1996) posits that constraint of debt on monetary policy is said to exist when a central bank takes a restrictive policy stance but far lower than required in the face of rising debt levels and inflation.

We find that SARB responds positively to output gap. We observe that given the growth challenges of South Africa over the period under consideration, the policy stance has been one of easing. The period of high debt regime coincides with the period prior to the last quarter of 2004 and after the first quarter of 2010, particularly the period after the first quarter of 2010. Over that period, real economic growth stagnated at 3% in the years 2000, 2001, 2002 and 2003. By 2013, real growth had waned to 1.9%, further down to 1.3% and 0.6% in 2015 and 2016 respectively. Although growth picked up to 1.3% in 2017, it was far lower than the average growth rate of 4.7% in emerging economies. Over that same period, the policy rate was eased by as much as 10.5% on the aggregate (at 11 different meetings) compared to an aggregate tightening of 6.25%. Meanwhile, this was a period when inflation exceeded the upper limit of 6% in as many as 22 quarters with some inflation observations being more than twice the upper limit, particularly in almost all the quarters of the year 2002. Additionally, for as many as 13 quarters, inflation was between the mid-point and the upper limit. Clearly, the focus was on stimulating economic growth at the cost of higher inflation. Meanwhile, this is an explicit or full-fledged inflation

targeting central bank. This has dire consequences for the publicly announced inflation targets and erosion of public confidence in the commitment of the central bank to inflation. Looking at the inflation gap, we find that although the response is positive and statistically significant, the extent of response is worryingly small relative to the rise in expected inflation. Specifically, we find that a 1% increase in the expected inflation gap in the high debt regime elicits a policy response of approximately 0.001% which is less than a tenth (10th) of the expected increase in inflation and therefore substantially disproportionate. So, while debt levels are soaring far beyond the threshold, thereby precipitating inflationary momentum, policy restriction is far lower than the rising inflation, a phenomenon akin to the proposition of Dornbusch (1996). This is an indication of debt constraint on policy rate setting. We provide a graphical view of the relationships between inflation and the measure of inflation target as well as the debt and the debt threshold in Figure 2. As depicted in Figure 2, over the 51 quarters when debt levels exceeded the threshold, actual inflation also exceeded the inflation target in most of these quarters (positive inflation gap).

Figure 2: Plots of Inflation, Inflation target, Debt and Debt Threshold



Notes:INF means inflation; INF TGT means inflation target; DGDP is Debt-to-GDP; and DEBT THRESH means Debt-to-GDP threshold.

Given the rising inflation levels above the midpoint target over a period where debt levels exceeded the debt threshold, the nature of policy response is worryingly problematic.

4.2. Robustness checks

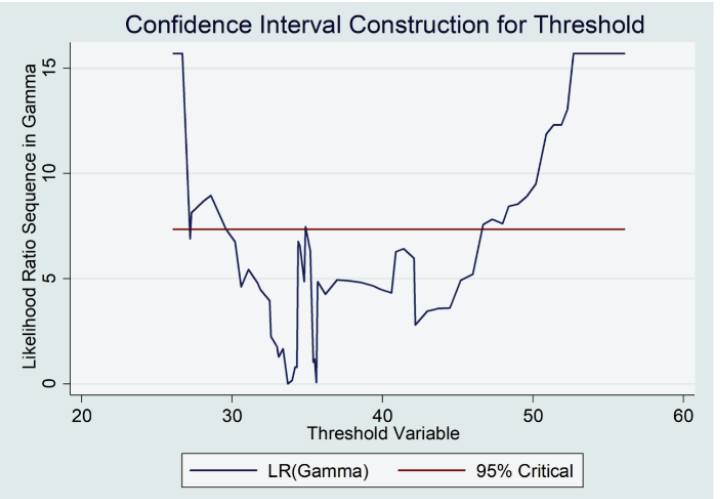
For the purposes of robustness checks, we vary the specifications to include exchange rate in our model. The inclusion of exchange rate follows the argument that in estimating a policy rule of the nature prescribed by Taylor (1993), it is imperative to augment it with exchange rate when dealing with the context of small open economies (Caporale *et al,* 2018; Daude *et al*, 2016; and Ghosh *et al*, 2016) given the important role of exchange rate in these countries. We measure the exchange rate as the Rand against the United States dollar which is the dominantly traded foreign currency in South Africa. The findings, in Table 4, indicate that our earlier results are robust. Indeed, the threshold estimate of debt remains the same at 33.7%. The response of the SARB to inflation gap in the low debt regime remains negative and the response to the output gap is still positive and statistically significant. In the high debt regime, the response of the SARB mirrors the previous findings.

Table 4: Robustness Results - Augmenting with exchange rate of the Rand to US Dollar

Variables	**Regime 1: [δ≤φ]**		**Regime 2: [δ>φ]**	
Intercept	0.001	(0.001)	-0.002**	(0.001)
$y_{t+k} - y_t^*$	0.794***	(0.174)	0.849***	(0.278)
$\mu_{t+k} - \mu_t^t$	-0.0006	(0.0004)	0.001***	(0.0003)
$EXCH_{t+k}$	0.016	(0.016)	-0.014	(0.011)
Diagnostics				
Threshold estimate	33.7			
95% confidence interval	[27.2, 46.0]			
Observations		21		51
R Squared		0.69		0.37
Sum of Squared Errors		0.0004		0.001
Residual Variance		0.00002		0.00003
Joint R Squared	0.49			
Heteroscedasticity Test (p-value)	0.75			

Note: *** and ** represent 1% and 5% significance levels respectively. The standard errors in brackets are corrected

FIGURE 3: CONFIDENCE INTERVAL (THE CASE OF EXCHANGE RATE OF THE RAND TO DOLLAR)



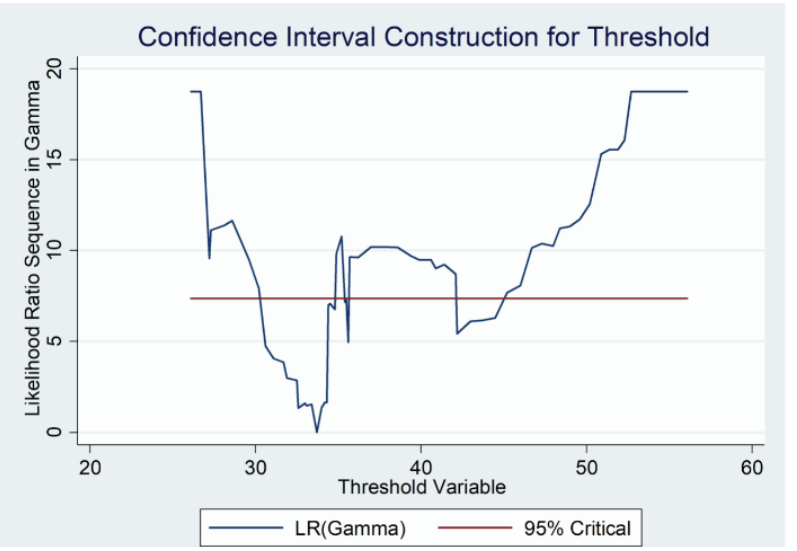
Having measured the exchange rate as the Rand to the United States dollar, we reckon that such a measure may not comprehensively capture the value of the Rand as it also trades against other major international currencies. We therefore resorted to a broader measure of exchange rate to further assess the resilience of our findings. We use the real effective exchange rate (REER) of the Rand against a weighted basket of currencies of major trading partners of South Africa. The results, in Table 5, show that the earlier findings remain robust.

TABLE 5: ROBUSTNESS RESULTS - AUGMENTING WITH REAL EFFECTIVE EXCHANGE RATE

Variables	**Regime 1: [δ≤φ]**		**Regime 2: [δ>φ]**	
Intercept	0.001	(0.001)	-0.002**	(0.001)
$y_{t+k} - y_t^*$	0.829***	(0.181)	0.787***	(0.256)
$\mu_{t+k} - \mu_t^t$	-0.0006	(0.0004)	0.001***	(0.0003)
$REER_{t+k}$	0.0002	(0.0002)	-0.0004***	(0.0002)
Diagnostics				
Threshold estimate	33.7			
95% confidence interval	[30.6, 44.5]			
Observations		21		51
R Squared		0.69		0.43
Sum of Squared Errors		0.0004		0.0012
Residual Variance		0.00002		0.00003
Joint R Squared	0.52			
Heteroscedasticity Test (p-value)	0.65			

Note: *** and ** represent 1% and 5% significance levels respectively. The standard errors in brackets are corrected for heteroscedasticity.

Figure 4: Confidence Intervals (The Case of real effective exchange rate)



5. Policy discussions

The response of the SARB in the high debt regime when upside risk to inflation was glaring and the fact that inflation did rise far above the publicly announced target inflation range in some instances leaves much to be desired. As indicated earlier, this was a period when some inflation outcomes were more than twice the announced upper limit. Meanwhile, inflation targeting framework thrives when the public believes that the central bank is capable of achieving the announced inflation target on sustainable basis and although occasional inflation overshooting may occur, inflationary outcomes that exceed twice the upper limit are certainly detrimental to public confidence building. When such public confidence is lost, inflation targeting would come crashing. The policy conundrum in terms of the monetary policy responses vis-à-vis the rising public debt levels and the associated positive inflation gap may suggest issues of central bank independence from the fiscal authorities. Indeed, such a suggestion may not be farfetched given that the inflation target that the SARB works with is determined by the fiscal authorities. Admittedly, the determination of inflation target by fiscal authorities is not peculiar to South Africa and not necessarily wrong, but its effect on the operational independence of the central bank cannot be underestimated either. An independent central bank desirous of establishing credibility should be seen to adopt appropriate monetary policy stance devoid of direct or indirect fiscal meddling. Fiscal authorities must also show some

responsibility and understand the effect of their fiscal decisions on inflation targets.

While it is the case that when economic growth of an economy is declining (such as the experience of South Africa) monetary policy could be accommodative to spur growth, the sacrificing of inflation which is the primary objective in an explicit or full-fledged inflation targeting framework in South Africa is worrying. Policy response should only be accommodative to the extent that inflation does not exceed the set target. Otherwise, the very purpose for such public announcements is defeated . Indeed, continued policy accommodation in the face of rising inflation above the publicly announced target in the name of propelling growth then leaves the public asking which the primary objective is. At that point confidence is derailed and anchoring inflation expectations in the future becomes even more difficult. The crusade for growth enhancement following the challenges should not be the burden of only the SARB. Indeed, the fiscal authorities should be seen taking a greater responsibility than the central bank to allow the latter focus squarely on inflation target.

6. Conclusion

Central banks that explicitly target inflation usually respond to factors or developments that pose upside and downside inflation risks. Increasing levels of public debt is one such factor that exert upside risk to inflation but response to it may not necessarily be straightforward. A restrictive monetary policy response only exacerbates costs of servicing the debt, fiscal position, debt stock and inflation subsequently. However, easing policy stance or responding less than what the prevailing inflationary momentum requires jeopardizes the prospects of achieving the publicly announced inflation target and the credibility of policymakers in anchoring expectations of inflation.

The concerns and dilemma posed by rising public debt levels to interest rate setting behaviour of central banks are widespread in policy circles and acknowledged in the literature. What is worrying, however, is the paucity of empirical investigation into the nature and extent of such concerns or constraints. Mitra (2007) took a remarkable step as the first empirical study to account for such constraint in the context of the Bank of Canada. The only other study is the recent work by Iddrisu and Alagidede (2020) in the context of Ghana. Mitra's (2007) study, however, suffers a fundamental weakness as it fails to provide confidence intervals for the threshold estimate. Meanwhile, for policy purposes,

such estimations must be amenable to precision checks to engender soundness and credibility of policy. Although Iddrisu and Alagidede (2020) deployed an estimation technique that ameliorates the weakness of the work of Mitra (2007), their work is substantially constrained by data unavailability.

With the benefit of a newly recovered data set, this paper has modified the Taylor rule to take account of debt constraint on monetary policy and relying on the Hansen (2000) sample splitting and threshold estimation technique that delivers confidence intervals for the threshold estimate devoid of nuisance parameters that plague other threshold models. We also use an expansive data relative to the work of Iddrisu and Alagidede (2020). Using debt to GDP ratio to represent public debt levels in line with Mitra (2007) and Iddrisu and Alagidede (2020), we find a debt threshold of 33.7% for South Africa with 21 and 51 observations respectively falling below and above the threshold.

We find that the policy response in the low debt regime to inflation gap is negative on the back of apparent policy easing at a time when inflation outcomes exceeded the upper limit of the publicly announced inflation target band in as many as 10 quarters.

The policy response was much in favour of propelling economic growth as South Africa witnessed challenging growth pattern over the period. This is reflected in the positive and highly significant policy response to the output gap in the low debt regime. Although economic growth can prove to be a major enabler of poverty reduction in South Africa and Sub-Saharan African countries as a whole, it is the distribution of the fruits of economic growth that is more germane. Indeed, the endemic inequality levels in Sub-Saharan African countries and South Africa in particular is a manifestation that economic growth has tended to serve a selected affluent few (see Fosu and Gafa, 2020; and Nwoke, 2020). Nwoke (2020) reckons that to provide meaning to economic strides in Africa, the levers of economic transformation and development should be those that carry the DNA of the continent and ones that are human-focused. Monetary policy can play a role in delivering inclusive growth. As observed by Amaral (2017), monetary policy can exert effect on inequality, although the effect is a function of the nature of the wealth or assets held by households, the distribution of these wealth (or assets) and how long they are held. Much as the primary preoccupation of the SARB should be inflation as it is an inflation targeting central bank, the achievement of inflation target is not an end in itself. It is meant to provide the impetus for economic prosperity. Such an economic

prosperity should be one that is inclusive by taking into consideration the wealth structure of the South African economy. In the high debt regime, we find that the policy response to inflation gap is positive and significant but woefully disproportionate, given the fact that the period saw inflationary outcomes more than twice the upper limit, an indication of debt constraint on monetary policy. Notably, the accommodation of inflation was also on the back of deplorable growth performance as policymakers sought to provide impetus to growth. The response of policy to output gap was therefore significantly large relative to the response to inflation gap. Our findings are robust to different measurement of exchange rate. The use of interpolation to obtain quarterly debt to GDP ratio is a limitation future research may overcome as high frequency data on debt become available.

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