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Central Banks' Response to Inflation, Output Gap, and Exchange Rate in Nigeria and South Africa

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Abstract: In Africa, a number of countries like South Africa have adopted inflation targeting. In Nigeria, different monetary policy regimes have been adopted over the years with rather unsatisfactory success. This study examines inflation targeting in Nigeria and South Africa, using fully modified least square to estimate a modified Taylor rule for the period 1970 to 2016. The study unravels evidence of a significant response of inflation and squared inflation to policy interest rates in South Africa, but not in Nigeria. Overall, South Africa's central bank places much emphasis on inflation targeting in setting interest rates, which Nigeria does not. Further, for South Africa, output gap is significant, while it is not significant for Nigeria. The study also reveals that exchange rate, openness to trade and international reserves play significant roles in central bank policy in both countries. In other words, there is need for central banks to adopt an eclectic approach, setting the monetary policy rule to adjust to any observed disequilibrium between output gap, inflation, exchange rate, foreign reserves and openness to trade.

Subjects: Macroeconomics; Econometrics; International Economics

Keywords: Central bank; Exchange rate; FM-OLS; Inflation; Inflation targeting; Monetary policy; Output gap; Taylor rule
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PUBLIC INTEREST STATEMENT

Considering the mixed success of inflation targeting in Africa, this study examines inflation targeting in Nigeria and South Africa, using fully modified least square to estimate a modified Taylor rule for the period 1970 to 2016. The study unravels evidence of a significant response of inflation and squared inflation to policy interest rates in South Africa but not in Nigeria. South Africa's central bank emphasizes inflation targeting in setting interest rates which Nigeria does not. Further, for South Africa, output gap is significant, while it is insignificant for Nigeria. The study also reveals that exchange rate, openness to trade and international reserves play significant roles in central bank policy in both countries. In other words, there is need for the central banks to adopt an eclectic approach, setting the monetary policy rule to adjust to any observed disequilibrium between output gap, inflation, exchange rate, foreign reserves and openness to trade.

1. Introduction

In any economy, long-term economic growth can be achieved by maintaining price stability, and price stability is achieved via control of inflation using inflation targeting. Inflation targeting (IT) is a central banking policy whereby an inflation objective is announced and a clear commitment to this objective is specified; this helps shape public expectations, consequently helping in planning and also providing an anchor for expectations of future inflation to shape price and wage setting decisions (Naraidoo & Gupta, 2010). IT has become a normal operating procedure in central banks globally (Aizenman et al., 2008; Bernanke et al., 2018; Bordo & Levin, 2017; Katusiime & Agbola, 2018). In Africa, a number of countries like South Africa have adopted IT and they did so mainly as a result of its apparent success in rendering low stable inflation in countries such as Canada, New Zealand, and the United Kingdom. Between 1960 and 1998, South Africa's monetary policy strategy included monetary-aggregate targeting, exchange-rate targeting, discretionary monetary policy, and an eclectic approach. These periods involve instituting some pre-announced M3 and other intermediate targets (such as exchange rates). Formal IT was introduced in 2000 (Jonsson, 2001; Van der Merwe, 2004).

In Nigeria, different monetary policy regimes have been adopted over the years with rather unsatisfactory success. These policies ranged from direct monetary controls, exchange rate targeting, to monetary targeting (Adeniji, Obansa and Okoroafor, 2018; Akinyemi et al., 2018; Bassey & Essien, 2014). At first, the main monetary policy instrument in Nigeria was the minimum rediscount rate (MRR) (Agu, 2007). In recent years, the monetary policy rate (MPR) has become the main monetary policy instrument. The other intervention instruments included open market operations, discount window operations, cash reserve ratio and foreign exchange net open position. However, monetary policy instruments are supposed to be grounded on recognized formulations of their relationships with macroeconomic aggregates.

Certainly, the controversy in monetary policymaking does not revolve around only the monetary policy rule but more so around what determines how central banks vary the rule over time (Agu, 2007). For instance, the central bank could set the interest rate to adjust to any disequilibrium between output gap, inflation, exchange rate, foreign reserves and openness to trade. Surprisingly, the nature of central banks response in Nigeria and South Africa is not ascertained in the literature. The goal of this study therefore is to model central bank's response to output gap, inflation, exchange rate, foreign reserves and openness to trade in Nigeria and South Africa consistent with recent developments in formulation and estimation of the monetary policy reaction function.

Despite the popularity of inflation targeting, the literature is replete with mixed empirical evidence and substantial controversy in the analysis of the IT framework. There are two main strands in the literature. The first-strand addresses the macroeconomic outcomes of IT regimes vis-à-vis non-IT countries. The second strand evaluates central bank behavior under IT and non-IT environment (Aizenman et al., 2008; Clardia et al., 1998). In this second strand, there are mixed evidences over whether IT adoption changes central banks' behavior, and particularly their responses to output gap and inflation. Within the latter strand, this study examines the central bank operating behavior in Africa using the Taylor rule. The study focuses particularly on Nigeria and South Africa's central banks' responses to exchange rates, output gaps and inflation, using the Taylor rule. There are motivations for the choice of South Africa and Nigeria. Whereas in South Africa, a few studies exist on the subject of inflation targeting and central bank reaction to economic variables in their decision-making process, there is sparsely any literature on inflation targeting and the reaction function for Nigeria. Secondly, South Africa is an inflation targeting country, while Nigeria is not. There is a need to compare the two biggest countries in Africa to compare their central banks' response to key variables, such as inflation, output gap, exchange rate, international reserves and openness to trade.

There are many motivations for this study. Firstly, majority of the studies in the literature are focused on IT in developed countries and quite few address IT in African countries. There is a need

to fill this gap in the literature considering the fact that IT in African countries may differ from industrial countries largely because of challenges associated with limited credibility, weak institutions, and large external shocks (Adaramola & Wale-Awe, 2017; Aghion et al., 2006; Fraga et al., 2003; Olusoji & Odeleye, 2018). In addition, the outcome of this level of analysis could assist economists and financial markets in predicting the future path of monetary policy as well as the monetary policy stance of central banks in the two countries, as well as other emerging markets. As encouraged by Torres (2002), policymakers will have clear and quantifiable reaction functions identifying a set of variables that forms the monetary policy rule and provides a decent approximation to the interest rates setting practice.

The rest of the study is laid out as follows: Section 2 examines prior literature on inflation targeting and central bank's reaction function. Section 3 discusses the data and the empirical methods. The empirical results are provided and discussed in Section 4, while Section 5 concludes the paper and makes some policy recommendations based on findings.

Woodford (2001) The Taylor rule and optimal monetary policy. *American Economic Review, 91*(2), 232–237.

Gerlach and Schnabel (2000) The Taylor rule and interest rates in the EMU area. *Economics Letters, 67*(2), 165–171.

Smets (2002). Output gap uncertainty: does it matter for the Taylor rule? *Empirical Economics, 27* (1), 113–129.

2. Literature review

2.1. Theoretical framework

The Taylor rule, proposed by Taylor (1993), and Henderson and McKibbin (1993), is a reduced form approximation of the responses of policy interest rate to changes in output, inflation, or other economic variables. Particularly, the rule describes how the central bank raises the policy interest rate by more than one-percentage point, for every one-percentage point rise in inflation. The goal of the rule is to encourage price stability by decreasing uncertainty and growing the credibility of the central bank's future actions (Gerlach & Schnabel, 2000; Smets, 2002; Woodford, 2001). It avoids the inefficiencies of time non-consistency in the exercise of discretionary monetary policy (Taylor, 2012).

According to Taylor's original rule, interest rate responds to the difference between actual and potential GDP, and also to the difference between actual and targeted inflation rates:

$$i_t = \rho i_{t-1} + \alpha(y_t - y^*) + \beta(\pi_t - \pi^*) \tag{1}$$

where i_t is the policy interest rate; i_{t-1} is the lagged policy interest rate; $y_t - y^*$ is the output gap; $\pi_t - \pi^*$ is the inflation gap.

The rule is therefore based on three factors: actual versus targeted inflation levels; actual and potential GDP; and the short-run interest rate consistent with potential GDP. Taylor's rule is therefore a guideline for central banks on how to adjust interest rates in order to change economic conditions. Notwithstanding its limitations and critics, Taylor's rule has become established in central banking for adjusting and setting cautious rates for economic stabilization, while sustaining long-run growth (Akinkunmi, 2017; Branch, 2014; Froyen & Guender, 2018; Jung, 2017; Scott & Barari, 2017).

2.2. Empirical literature

There is a large body of empirical literature investigating inflation targeting in both advanced industrial economies (Bernanke et al., 2018; Bordo & Levin, 2017; Conçalves & Eduardo, 2008; Johnson, 2002; Mishkin & Schmidt-Hebbel, 2007; Rose, 2007) and developing countries (Mohanty & Klau, 2004; De

Mello and Moccero, 2008; Aizenman et al., 2008; Iklaga, 2008; Kim & Mehrotra, 2017; Buffie et al., 2018; Valera et al., 2018). However, not much has been done with respect to emerging markets such as Nigeria and South Africa, compared to the number of studies done for developed countries.

There are two main strands in the literature. The first strand addressed the macroeconomic outcomes (e.g., the effects on inflation and inflation volatility) of IT regimes vis-à-vis non-IT countries. These studies employed both individual country time-series and multi-country panels and largely found mixed evidence on IT effects on inflation and other key variables (e.g., Anand et al., 2015; Baxa et al., 2015; Bernanke et al., 2018; Mishkin & Schmidt-Hebbel, 2007).

For example, in a significant study, Johnson (2002) undertook a panel study of five IT and six non-IT developed countries and found that the announcement of inflation targets depresses expected inflation. Also, Mishkin and Schmidt-Hebbel (2007) showed that IT helps advanced industrial countries to achieve low inflation in the long run and that there are lower responses of inflation to oil and exchange rate shocks. Rose (2007) argued that IT is a long-run regime in contrast to other monetary rules, and that IT countries have low exchange rate volatility. However, Ball and Sheridan (2005) found no long-run differences between advanced industrial IT and non-IT countries. For developing countries, Mishkin and Schmidt-Hebbel (2007) found that IT did not perform well compared to similar studies on advanced countries. The International Monetary Fund (2005) found that IT is connected with a 4.8 percentage-point fall in inflation relative to other monetary regimes. Conçalves and Eduardo (2008) found that the adoption of IT leads to lower inflation and reduced growth volatility relative to non-IT countries.

The second strand of the literature evaluates central bank behavior under IT and non-IT settings. In this strand, there are mixed empirical evidence over whether IT regime changes central banks' behavior, and particularly their responses to inflation and output gap. These studies also employ both individual country time-series and multi-country panels, investigating differences in IT and non-IT regimes using the Taylor rule and focusing on advanced industrial countries (e.g., Mohanty and Klau, 2005; Schorfheide, 2007); Lubik and Schorfheide (2007) found significant response of interest rates to exchange rate movements in Australia and New Zealand, but not in Canada and the UK. Ravenna (2008), estimating a DSG model for Canada, found that the low average inflation is associated with the credibility of policy under the IT regime. In contrast, Dueker and Fischer (2006) found there is no significant difference in monetary policy rules between IT countries and non-IT countries.

For developing countries, Schmidt-Hebbel and Werner (2002) found that Brazil, Chile and Mexico respond to exchange rate changes in the short-term with inflation targeting. Mohanty and Klau (2004) found that the response of policy to exchange rate is often greater than the response to the output gap and inflation, supporting the "fear of floating" hypothesis. De Mello and Moccero (2008) estimated an interest rate policy function using a New Keynesian structural model for Latin America and found that IT, in a post-1999 regime, is connected with significant responses to expected inflation in Chile and Brazil, while for Mexico, exchange rates fluctuations during the IT period were significant in the central bank's reaction function.

Additionally, Aizenman et al. (2008) examined the role of exchange rate in the IT experiences of emerging market economies, distinguishing between commodity and non-commodity exporting nations. The authors found a significant response from inflation to policy interest rates in IT countries. However, in non-IT regimes, the central banks react less to inflation. The response to real exchange rates was found to be stronger in non-IT regimes, meaning that more constrained policymaking in the IT regime simultaneously target both inflation and exchange rates. For countries embracing IT, the authors found that the strongest response to exchange rates is relatively intensive for countries exporting basic commodities.

For South Africa, Naraidoo and Gupta (2010) found an inflation learning rule for future inflation rates is appropriate for examining the central bank's decision process in its interest rate setting policy. The main findings from Naraidoo and Gupta (2010) are: "(1) that the adoption of inflation targeting led to significant changes in monetary policy; (2) post-2000 monetary policy is asymmetric as policymakers respond more to downward deviation of inflation away from the target; (3) post-2000 policymakers may be attempting to keep inflation within the 4.5%–6.9% range rather than pursuing a target zone of 3–6%, as generally pre-announced, and; (4) the response of monetary policy to inflation is nonlinear as interest rates respond more when inflation is further from the target".

For Nigeria, Agu (2007) specified two models, the first grounded on the historical development of the Central Bank while the second grounded on the Taylor rule with the aim of unfolding the Central Bank**'s** reaction function. The author found the primacy of inflation in monetary policy reaction in Nigeria. However, interest rate smoothening behaviour could not be confirmed. Kelikume and Olaniyi (2015), using Granger Causality test and impulse response functions, investigated inflation targeting as a potential monetary framework for Nigeria. The authors showed that inflation respond significantly to exchange rate and interest rate while economic growth responds significantly to exchange rate and inflation.

In another study for Nigeria, Olaniyi (2018) showed the non-linear relationship between money, inflation and output with respect to the Friedman and Schwartz hypotheses that monetary policy affects prices in the long-run but not in the short-run, and influences output in the short-run but not in the long-run. Iklaga (2008) found that a Taylor-rule framework is an appropriate tool to summarize the key elements of the central bank's monetary policy stance. The study also, found that inflationary pressures and output play significant roles in the Bank's decisions during the review period.

An exhaustive review of the literature shows that, despite the popularity of IT, the literature is replete with mixed empirical evidence and substantial controversy in the analysis of the IT framework. Particularly, there are mixed evidences over whether IT adoption changes central banks' behavior, as well as their responses to output gap and inflation. The majority of the studies in the literature are focused on IT in developed countries and quite few address IT in African countries. There is a need to fill this gap in the literature considering the fact that IT in African countries may differ from industrial countries largely because of the differing institutions (Aghion et al., 2006; Fraga et al., 2003). To fill this gap therefore, this study examines the central bank operating behavior in Africa, particularly Nigeria and South Africa's central banks' responses to exchange rates, output gaps and inflation, using the Taylor rule. Comparison of the two biggest countries in Africa will demonstrate their central banks' response to key variables, such as inflation, output gap, and exchange rate.

3. Data and methodology

3.1. Data description and sources
This study uses annual data between 1970 and 2016. The data on interest rate, exchange rate, GDP, inflation, trade openness and foreign reserves data are sourced from World Bank's (2018) World Development Indicators.

3.2. Model specification
Following a broad literature originating from Taylor (1993), and Henderson and McKibbin (1993), this study adopts a monetary policy reaction function given by:

$$i_t = \rho i_{t-1} + \alpha(y_t - y^*) + \beta(\pi_t - \pi^*) + \gamma X_t \tag{2}$$

where X_t is a set of possible explanatory variables, which may be part of the policy reaction function. As standard in the literature, central banks, in setting interest rates, react to both inflation gap and output gap (Aizenman et al., 2008). In addition, consistent with English et al. (2003), the policy smoothing goal is assumed to manifest in the lagged interest rate on the right-hand side.

In this study, consistent with Aizenman et al. (2008) and Odior and Arinze (2017), exchange rate, trade openness and international reserves are included as possible explanatory variables that may also be part of the policy reaction function. It is additionally assumed that the relationship between inflation and interest rate is non-linear (Naraidoo & Gupta, 2010). Thus, for comparable analysis, the estimated equation for Nigeria and South Africa is:

$$+ \theta_5 Exchrate_t + \theta_6 Trade_t + \theta_7 Reserves_t + \xi_t \tag{3}$$

where *Interest* represents the lending interest rate; *Gdpgap* represents the output gap; *Inflation* stands for the consumer price index; *Exchange* represents the exchange rate; *Trade* represents openness to trade; and *Reserves* stands for international reserves.

3.3. Estimation technique

The estimation techniques used in this study is the fully modified least squares (FM-OLS). FM-OLS is a semi-parametric estimation technique; it provides optimal estimates of cointegrating regressions. In contrast to the Johansen and ARDL approach, FM-OLS is more robust to endogeneity and serial correlation. Hence, the estimates are more robust and more consistent. Additionally, it is applicable irrespective of the order of integration of the variables (whether I(0) or I(1)) (Phillips & Hansen, 1990; Hansen and Kim, 1995). As developed by Phillips and Hansen (1990), Phillips and Moon (1999) and Pedroni (1995, 2000), the FM-OLS estimator uses the initial estimates of the symmetric and one-sided long run covariance matrices of the residuals.

Consider the n + one dimensional series vector process (y, X), with the cointegrating equation,

$$y_t = \acute{X}_t \beta + \tilde{D}_{1t} \gamma_1 + \hat{\mu}_{1t} \tag{4}$$

Where $\acute{X}_t$ are n stochastic regressors; $D_t = (\tilde{D}_{1t}, \tilde{D}_{2t})$ are the deterministic trend regressors; and $\hat{\mu}_{1t}$ are the residuals.

The $\hat{\mu}_{2t}$ is obtainable as $\hat{\mu}_{2t} = \Delta\hat{\varepsilon}_{2t}$ from the levels regressions

$$X_t = \hat{\Gamma}_1 + \hat{\tilde{\Gamma}}_2 D_{2t} + \hat{\varepsilon}_{2t} \tag{5}$$

Or from the difference regressions

$$\Delta X_t = \hat{\Gamma}_1 \Delta D_{1t} + \hat{\tilde{\Gamma}}_2 D_{2t} + \hat{\mu}_{2t} \tag{6}$$

Let λ and Ω be the long run covariance matrices obtainable from the residuals, $\hat{\mu}_{2t} = (\hat{\mu}_{1t}, \tilde{\hat{\mu}}_{2t})$.

Thus, the modified data is given as

$$y_t^+ = y_t - \hat{\omega}_{12} \Omega_{22}^{-1} \hat{\mu}_2 \tag{7}$$

And the estimated bias correction terms as

$$\lambda_t^+ = \hat{\lambda}_{12} - \hat{\omega}_{12} \Omega_{22}^{-1} \hat{\lambda}_{22} \tag{8}$$

The FMOLS estimator is thus given by

$$\theta = \begin{bmatrix} \beta \\ \hat{\gamma}_1 \end{bmatrix} = \left(\sum_{t=2}^{T} Z_t \acute{Z}_t \right)^{-1} \left(\sum_{t=2}^{T} Z_t y_t^+ - T \begin{bmatrix} \hat{\lambda}_1 \\ 0 \end{bmatrix} \right) \tag{9}$$

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Table 1. Elliott-Rothenberg-Stock Unit Root Test

	Nigeria		South Africa	
	I(0)	**I(1)**	**I(0)**	**I(1)**
Interest	11.11	1.06*	3.38***	0.51*
Inflation	1.64*	0.46*	1.78*	0.51*
Gdpgap	2.18**	3.65***	0.62*	0.50*
Trade	6.42	1.29*	5.22	1.06*
Reserves	26.72	0.88*	37.42	1.77*
Exchrate	63.17	3.12***	58.82	1.88*
Test critical values:	1% level	1.87		
	5% level	2.97		
	10% level	3.91		

*Note: * significant at 1%; ** significant at 5%; *** significant at 10%. Lag length is selected using Spectral OLS AR based on SIC, maxlag = 9.*

Where $Z_t = \left(X_t, \tilde{D_t}\right).$

4. Empirical results and discussion

Since most macroeconomic series have unit root (Nelson & Plosser, 1982), checking the order of integration of the variables is appropriate. The variables are therefore tested for unit root, using the Elliot, Rothenberg and Stock Point Optimal unit root test (ERS) which is more computationally robust than the traditional unit root tests such as P. C. Phillips and Perron (1988) and Augmented Dickey and Fuller (1979) tests. Critical values for the ERS test statistic is computed by interpolating the simulation results from ERS (1996, Table 1, p. 825) for T = (50, 100, 200). The results of the ERS unit root test in Table 1 indicate stationarity of some variables at I(0) and some at I(1), meaning that the variables are a mix of $I(0)$ and $I(1)$ which is valid for the FM-OLS approach.

To apply FMOLS for estimation, a cointegrating relationship must first be established among the set of variables. For that reason, the presence of a cointegrating relation is tested using Hansen Parameter Instability co-integration test. Table 2 shows that the null hypothesis of no co-integration can be rejected for both Nigeria and South Africa. In other words, a long run relationship exists among the variables in the two countries.

Having established the presence of long-run relationships among the set of variables, the FMOLS is now implemented. To better assess the robustness of the parameter estimates to different specifications in the two countries, the model is estimated, using 1970–2016 (the full sample) and 1985–2016 as sample periods. The results are the same for both countries. The results in Table 3 show estimates for the Taylor rule regressions employing FM-OLS. The model explains much of the fluctuations in interest rates, the monetary policy variable, in both countries.

Table 2. Hansen Parameter Instability Cointegration Test

	Cointegrating equation deterministics: C	
	Lc statistic	**Prob.[a]**
South Africa	1037.310**	< 0.01
Nigeria	5398.758**	< 0.01

*Note: ** significant at 5%. [a]Hansen (1992b) Lc(m2 = 4, k = 0) p-values, where m2 = m-p2 is the number of stochastic trends in the asymptotic distribution. [a]Hansen (1992b) Lc(m2 = 4, k = 0) p-values, where m2 = m-p2 is the number of stochastic trends in the asymptotic distribution.*

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Table 3. Central Banks' Responses to Inflation, Output Gaps, and Exchange Rate in Nigeria and South Africa. Dependent Variable: *Interest*

	South Africa				Nigeria		
	Full Sample (1970–2016)						
Variable	**Coeff.**	**t-Stat**	**Prob.**		**Coeff.**	**t-Stat**	**Prob.**
Interest (−1)	0.95*	12.32	0.00		0.73*	8.92	0.00
Gdpgap	13.81*	5.26	0.00		0.21	0.11	0.91
Inflation	1.11*	4.06	0.00		0.19	0.02	0.98
Inflation^2	−0.05*	−3.63	0.00		−0.07	−0.61	0.55
Exchrate	0.86*	4.97	0.00		0.02**	2.11	0.04
Trade	0.18*	3.14	0.00		0.07**	2.58	0.01
Reserves	−3.00*	−4.53	0.00		−0.85**	−2.13	0.03
C	50.08*	3.81	0.00		18.20	1.48	0.15
1985–2016							
Variable	Coeff.	t-Stat	Prob.		Coeff.	t-Stat	Prob.
Interest (−1)	0.84*	10.32	0.00		0.46*	4.43	0.00
Gdpgap	11.62*	4.13	0.00		1.40	0.65	0.52
Inflation	1.21*	6.33	0.00		0.12	1.15	0.26
Inflation^2	−0.05*	−5.78	0.00		−0.10	−0.67	0.51
Exchrate	0.72*	3.64	0.00		0.03***	2.11	0.05
Trade	0.17*	4.03	0.00		0.10*	3.59	0.00
Reserves	−3.02*	−6.09	0.00		−1.40***	−1.89	0.07
C	52.93*	5.55	0.00		32.94***	2.04	0.05

* significant at 1%; ** significant at 5%; *** significant at 10%

Consistent with studies such as Aizenman et al. (2008), the degree of persistence of the monetary policy rule, proxied by the coefficient of the lagged interest rate, is rather high. The persistence for South Africa (an IT country) is marginally higher than for Nigeria (a non-IT country). The coefficients of inflation and squared inflation are highly significant for South Africa but not significant for Nigeria. Considering the effects and persistence, the long-run response for South Africa is to increase interest rates when inflation increases. In Nigeria, policymakers may not respond to inflation in the pronounced way of their South African counterparts: because the coefficients of inflation and squared inflation are not significant for Nigeria. This finding is incon-sistent with Agu (2007) and Iklaga (2008) who found that inflationary pressures play significant roles in the Central Bank of Nigeria's decisions.

For South Africa, output gap is significant, while it is not significant for Nigeria. In contrast, Iklaga (2008) found that output play significant roles in the Central Bank of Nigeria's decisions. The coefficients of exchange rates are highly statistically significant for both countries, meaning that both IT and non-IT African central banks respond to exchange rates when setting policy interest rates. However, the response to exchange rate is much higher in South Africa (0.86) than Nigeria (0.02). This is comparable with Kelikume and Olaniyi (2015) who showed that inflation responds to exchange rate and interest rate in Nigeria. Buffie et al. (2018) showed that sound management of exchange rate enhances the effectiveness of IT.

Additionally, both countries' central banks ought to consider openness to trade and international reserves in setting their interest rates given their level of significance. While a rise in trade open-ness leads to higher interest rates, increased reserves lead to lower interest rates. This empirical

evidence is consistent with Aizenman et al. (2008) who argued that when countries are open to trade, they are also likelier to be receptive to international capital movements. In that regard, they may have reduced control over domestic interest rates and reduced ability to respond to exchange rate changes. This effect may tower above their aspiration to stabilize the economy by more determinedly responding to exchange rate changes.

One of the most astonishing and unanticipated finding of this study is that while inflation is positively related to interest rate, squared inflation is negatively related. This suggests that interest rate increases with the increase in inflation but after a certain level of inflation which is the turning point, interest rate starts to decrease. It can be argued that as inflation rises, it becomes more unstable and uncertain. The maturity of debt instruments reduces as the uncertainty rises. Consequently, interest rates are rendered worthless, as the maturity reduces to months or even days. During periods of hyperinflation, the future ceases to exist and cash becomes the only means of exchange as assets with a maturity over a few days is fully wiped out.

5. Conclusion and policy implications

This study has examined inflation targeting in Nigeria and South Africa using FM-OLS to estimate a modified Taylor rule. The findings have unraveled evidence of a significant response from inflation and squared inflation to policy interest rates in South Africa but not in Nigeria. Overall, South Africa's central bank place much emphasis on inflation targeting in setting interest rates, which Nigeria does not. Further, for South Africa, output gap is significant, while it is not significant for Nigeria. The study also reveals that exchange rate, openness to trade and international reserves play significant roles in central bank policy in both countries.

The findings of this study have key policy implications for both central banks in Nigeria and South Africa. First, different monetary policy frameworks have been adopted in both South Africa (e.g., monetary policy strategy included monetary-aggregate targeting, exchange-rate targeting, and discretionary monetary policy) and Nigeria (e.g., direct monetary controls, exchange rate targeting, and monetary targeting). In recent years, South Africa has adopted formal IT while the main monetary policy instrument in Nigeria has become the monetary policy rate. However, as illustrated in this study, monetary policy instruments should be grounded on recognized formulations of their relationships with macroeconomic aggregates. Policymakers in the two countries should have clear and quantifiable reaction functions identifying the set of variables that forms the monetary policy rule and therefore provide good approximations to the interest rates setting practice.

At the time of this inquiry, inflation (16%) and interest rate (25%) are very high in Nigeria, and certainly incongruous with the country's macroeconomic stability aspirations. The Central Bank of Nigeria should stabilize fluctuations in money supply, inflation and interest rate in the country. Lending interest rates should be made flexible. Also, appropriate measures should be adopted to raise the value of the naira so as to reduce the inflation rate in the country.

Like South Africa, monetary authorities in Nigeria should make conscious efforts to achieve low and stable inflation rates, also using inflation targeting. In fact, the monetary policy framework of the Central Bank of Nigeria should include implementation of inflation targeting. In line with the literature, for the inflation targeting framework to be most successful in the country, certain prerequisites must be met: "central bank independence, adopting price stability as the sole objective of monetary policy and the existence of a well-developed technical infrastructure.

In addition, the impact of fiscal dominance as well as financial, structural and external sector dominance should be kept at the barest minimum. The independence of a central bank is guaranteed when its monetary policy decisions are not subjected to review by any governmental authority. Such a level of independence allows central banks to always have the free will to deploy their policy instruments to target inflation in order to keep it within the agreed band or on the

specific target" (Akuns et al., 2016). The key merit therefore is better accountability of the central bank in achieving its inflation objectives, built around increased communication with the public, leading to improved market expectations.

However, developing countries' central banks, such as in Nigeria and South Africa, often have weak financial, fiscal and monetary institutions, thus rendering the application of inflation target-ing considerably difficult. In this regard, the degree of the triumph of inflation targeting signifi-cantly depends on executive capacity, and the political will and commitment on the part of the central banks. The central banks should therefore be flexible about inflation objectives/targets when confronted with more pressing macroeconomic problems that could be remedied using existing policy instruments.

On the basis of the findings of this study, there is a need to adopt an eclectic approach to setting the monetary policy rule. It is important to set the interest rate to adjust to any observed disequilibrium between output gap, inflation, exchange rate, foreign reserves and openness to trade. In fact, strict inflation targeting may not be an appropriate framework to solve the key macroeconomic problems challenging these African economies, such as price instability, exchange rate stability and inclusive economic growth. Still, inflation targeting remains a relevant policy approach but may not be adequate in its capacity to deal with economic and financial crisis if deployed only.

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