Modeling Monetary Policy In South Africa: Focus On Inflation Targeting Era Using A Simple Learning Rule

Ruthira Naraidoo, University of Pretoria, South Africa
Rangan Gupta, University of Pretoria, South Africa

ABSTRACT

A simple empirical nonlinear framework is used to analyze monetary policy between 1983 and 2007 in South Africa, focusing on the policy of inflation targeting introduced in Feb 2000, more precisely when the South African Reserve Bank (SARB) announced that an inflation zone targeting regime of 3-6% would be in place. We find that a model specification embodying a simple 'inflation learning rule' for the future inflation rate seems to provide a better understanding of the decision process made by the SARB in its interest rate setting policy. The main findings 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.

Keywords: Monetary policy; inflation targeting; inflation learning rule; nonlinear smooth transition model

INTRODUCTION

$\mathscr{S}$ ince the 1990s, a growing number of central banks have adopted inflation targeting as a preferred framework for monetary policy. This has replaced frameworks involving targets for the exchange rate or monetary aggregates. South Africa has pursued a monetary policy strategy that included setting some pre-announced M3 and other intermediate targets (such as the exchange rates) from 1986 until 2000 (Jonsson 2001) when formal inflation targeting was introduced. In February 2000, the Ministry of Finance announced in the Budget speech that the government had decided to set an inflation target range of 3-6% (van der Merwe 2004). Before this announcement, "informal inflation targeting" was already applied by the South African Reserve Bank (SARB). Inflation target provides what is known as nominal anchor for monetary policy. In such a framework, an inflation objective is announced and a clear commitment to achieve this objective is spelled out. This helps shape the public's expectations, consequently helping planning and also providing an anchor for expectations of future inflation to influence price and wage setting decisions. The verdict on inflation targets has thus far been positive (see Bernanke *et al.* 1999; Mishkin and Schmidt-Hebbel 2001; Corbo *et al.* 2001; Vega and Winkelreid 2005) and it has also been stressed that the way in which monetary policy is implemented can be a key factor to the macroeconomic stability of the country (see Clarida *et al.* 2000).

This paper considers a number of important research questions related to inflation targeting. First, has inflation targeting affected the conduct of monetary policy? We might expect an increased emphasis to be placed on inflation and a correspondingly lower weight to be placed on output. We would like to test this hypothesis. Woglom (2003), using a linear specification, tries to address the issue of the legacy of inflation targeting. However, given the very short sample size, the results would have been too tentative to draw sound policy conclusions. Second, is the policy symmetric in the sense that policymakers might attempt to have different interest rate adjustments depending on whether deviations of inflation are above or below the target? The literature has often argued for cases of 'hawk'

type or 'dove' type Central Bankers. Third, do policymakers attempt to hit the inflation target precisely in which case we would argue for point inflation target, or do they aim to keep inflation within a target range as announced in February 2000 (see Mishkin and Posen 1997; Bernanke *et al*. 1999)? Fourth, is monetary policy more responsive to inflation when it is further from the target, or is the policy response always linear?

In this paper, we make use of a simple nonlinear structural Taylor rule-type framework to analyze South African monetary policy between 1983 and 2007, focusing on the policy of inflation targeting introduced in 2000. In this forward-looking framework, we posit that the private sector inflation expectations follow a simple rule; that is, a linear function of the inflation target and the lagged inflation rate as originally posited by King (1996). Our main conclusions are:

1. The simple 'inflation learning rule' seems to capture the dynamics of the policy instrument better compared to alternative specifications of how agents form their expectations of future inflation.
2. The adoption of the inflation target has led to significant changes in monetary policy. Between 1983 and 1999 - the period prior to inflation - targeting the influence of output was stronger than inflation. However, from 2000 onward, we find that the influence of inflation has greatly increased, while output has had no effect in shaping interest rate decisions of the monetary authority.
3. Since 2000, monetary policy has been asymmetric as policymakers now respond more to a downward deviation of inflation - away from the target - than to upward deviations.
4. Since 2000, policymakers may be attempting to slightly overshoot their pre-announced target zone (4.5%-6.9% v/s 3%-6%)
5. Monetary policy is more responsive to inflation when it is further from the target, therefore implying nonlinear adjustment of the interest rate. To the best of our knowledge, this is the first attempt to model and compare the South African monetary policy across regimes using a non-linear model of interest rate rule.

MODELING MONETARY POLICY

Monetary Policy in SA since 2000

Target ranges of 1-5% for core inflation were informally announced since 1998. With the institution of an inflation targeting regime, an explicit target of 3-6% (average) for a new CPI measure, CPIX[1], was announced in the Budget Speech of February 2000. Therefore, policy appears to be evolving towards greater transparency, aiming to improve credibility and to achieve a more pronounced effect on inflationary expectations.

Empirical models of monetary policy are widely used to investigate the objectives of policymakers. The great majority of studies use the Taylor rule model and its extensions (e.g., Taylor, 1993; Clarida *et al*., 2000), where interest rates relate linearly to the gap between actual and desired values of inflation and output. More controversially, Taylor rules have also been used to analyze optimal monetary policy; that is, the values of monetary policy instruments that would best allow policymakers to attain their policy goals. Taylor rules are an example of what Svensson (2002, 2003) refers to as 'instrument reaction functions' for monetary policy. Svensson contrasts instrument reaction functions with 'targeting rules' that analyze the implications of equality between the marginal rate of transformation and the marginal rate of substitution in the policymaker's loss function and argues that targeting rules are superior.

Recently, researchers have questioned the original linear specification of the Taylor rule. A nonlinear framework applies if, for instance, the central bank has non-quadratic preferences (Nobay and Peel, 2003), a nonlinear Phillips curve (Dolado *et al*. 2005; Schaling 2004), or if it follows the opportunistic approach to disinflation (Aksoy *et al*., 2007). According to the OAD approach, interest rates should respond to inflation outside a zone of discretion and behave opportunistically inside by accommodating shocks that tend to move inflation towards the target, but not otherwise responding to shocks until inflation reverts to the zone of discretion. These suggestions are particularly relevant for the SARB, which aims to keep inflation within the 3-6% target. Our work is much in the tradition of investigating the objectives of the SARB in the light of a nonlinear specification which will best reflect these objectives.

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[1]CPIX is defined as CPI excluding interest rates on mortgage bonds

We employ a framework which has similarities with Smooth Transition Auto-Regressive (STAR) models (Granger and Terasvirta 1993; van Dijk *et al.* 2002) in that the endogenous variable is determined by a weighted average of regimes with endogenous regime weights. We will consider a nonlinear policy rule of the form:

$$r_t = \overline{r} + \lambda_t(E_t\pi_{t+p};\gamma,\pi^L,\pi^U)R_{It} + (1 - \lambda_t(E_t\pi_{t+p};\gamma,\pi^L,\pi^U))R_{Ot} + \varepsilon_t \qquad (1)$$

where $R_{It} = \alpha_{Ii}(L)r_t + \alpha_{I\pi}E_t(\pi_{t+p} - \pi^*) + \alpha_{Iy}E_t(y_{t+p} - y^*) + \alpha_{Ie}E_t(e_{t+p} - e^*)$ and

$R_{Ot} = \alpha_{Oi}(L)r_t + \alpha_{O\pi}E_t(\pi_{t+p} - \pi^*) + \alpha_{Oy}E_t(y_{t+p} - y^*) + \alpha_{Oe}E_t(e_{t+p} - e^*)$ and $\lambda_t(E_t\pi_{t+p};\gamma,\pi^L,\pi^U)$ is a

nonlinear function. $\overline{r}$ is the natural interest rate, $\alpha_i(L) = \alpha_{i1}L + ... + \alpha_{in}L^n$ is the lag polynomial in interest rate,

showing interest rate persistence and smoothing (Woodford 2003)[2], $E_t\pi_{t+p}$ is the inflation rate expected at time (

$t + p$), π^* is the inflation target, $(y_{t+p} - y^*)$ is the output gap expected at time ($t + p$), α_π is the weight on

inflation, and α_y is the weight on output gap. We also consider especially relevant the issue of whether the interest

rate setting by the Central Bank depends on asset prices (see Bernanke and Gertler 2001) and α_e represents the weight on the gap of other potential variables, such as exchange rates and other financial variables; for instance, house prices, stock prices and commodity prices. (For our purpose, we shall use the growth rate in the nominal effective exchange rates following Ortiz and Sturzenegger, 2007, and ε_t is an error term.) The response of interest rates to lagged interest rates, inflation, the output gap and the exchange rate is allowed to differ between inflation regimes. R_{It} (I standing for inner) is the inner regime Taylor rule that represents the behavior of policymakers when inflation is expected to lie between the bands π^L and π^U. R_{Ot} (O standing for outer) is a Taylor rule that describes the behavior of policymakers in the outer regime where inflation is expected to be outside the inflation bands.

The nonlinear function $\lambda_t(E_t\pi_{t+p};\gamma,\pi^L,\pi^U)$ can take a number of specifications. It could take a threshold specification where the authorities would behave linearly, but with different speeds of response depending on the value of a given variable (Bec *et al*. 2002). The nonlinear function can be smooth rather than discrete and it could measure, for instance, the weight at the beginning of period t, that inflation at period $t + p$ will be less than x percentage points, in which case it is modelled using the logistic function (see Granger and Terasvirta, 1993; and van Dijk *et al*., 2002). Bec *et al*. (2000) use a STAR representation to model monetary policy in the United States, France and Germany. They allow monetary policy to vary between periods of 'boom' and 'slump'. For our purpose, we prefer using the quadratic logistic function (see for e.g., Martin and Milas, 2004 for an application to the UK) as it allows for an inflation zone targeting regime as is the case for South Africa, as well as for allowing a nonlinear adjustment toward the band. This form of the Taylor rule allows the response of the interest rate to differ between the two inflation regimes, inner and outer. The weight λ_t is modelled as follows:

$$\lambda_t = 1 - \frac{1}{1 + e^{-\gamma(E_t\pi_{t+p} - \pi^L)(E_t\pi_{t+p} - \pi^U)/\sigma^2_{E_t\pi_{t+p}}}} \qquad (2)$$

Equation (2) equates the regime weight λ_t to the probability that expected inflation will lie between the bands π^L and π^U. This function has the properties that (1) λ becomes constant as $\gamma \to 0$ and (2) as $\gamma \to \infty$,

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[2]Note that Woodford (2003) uses a slightly different framework for the specificaton of a linear Taylor rule where the weight on the desired interest rate and the lagged responses sum to one.

$\lambda = 1$ if $\pi^L < E_t\pi_{t+p} < \pi^U$ (see Jansen and Teräsvirta 1996). To illustrate this, if it is known with certainty that inflation will (resp. will not) be between the bands, then policy is determined by R_I (resp. R_O). In general, the weight on R_I increases, with increases in the probability that expected inflation will lie between π^L and π^U. If one regime is always dominant, our model simplifies to a familiar Taylor rule model of monetary policy. In (2), the smoothness parameter $\gamma > 0$ determines the smoothness of the transition regimes. We follow Granger and Teräsvirta (1993) and Teräsvirta (1994) in making γ dimension-free by dividing it by the variance of $E_t\pi_{t+p}$. In addition, van Dijk *et al.* (2002) argue that the likelihood function is very insensitive to γ, suggesting that precise estimation of this parameter is unlikely in our relatively short sample. For this reason, we do not attempt to use estimates of γ to test our model against the alternative of a linear model. Note that our approach differs from STAR models in using a forward-looking variable to determine the regime weights.

Monetary Policy before 2000

There have been two broad monetary policy regimes before 2000[3]. The first regime was a liquid asset ratio-based system with quantitative controls on interest rates and credit, operated until the early 1980s. A low degree of importance was attached to the interest rate as a corrective tool, the main form of monetary control being the use of liquid asset requirements. Commercial banks held particular assets defined as "liquid" as a specified minimum proportion of deposits. The limited supply and low yields of these assets were expected to curtail bank lending and money supply growth.

Increasing dissatisfaction with the financial constraints of the liquid asset ratio system saw a range of reforms, enacted from the early 1980s, toward a cash reserves-based system. Under the cash reserves system, pre-announced monetary targets were used for the first time from 1986, to be achieved indirectly through adjusting interest rates. Therefore, the main policy emphasis was on the central bank's discount rate in influencing the cost of overnight collateralized lending and hence, market interest rates. We therefore propose to analyze the period from 1983 to 1999. We choose this particular period as it is difficult to estimate stable policy rules using data from before this date, when the Reserve Bank switched to using the interest rate as the main instrument of monetary policy with reference to monetary targets. It is also worth noting that during this period, there was also emphasis on an eclectic set of economic indicator, such as the exchange rate, asset prices, output gap, balance of payments, wage settlements, total credit extension, and the fiscal stance (SARB Quarterly Bulletin, October, 1997). Modeling all of these features and going prior to 1983 will take us beyond the scope of this study. Moreover, note a dual exchange rate system was introduced to South Africa in 1979 - the financial rand was a free-floating market-based currency for capital transactions, whilst the commercial rand was artificially held at higher levels to attract foreign investment. This dual system was abolished in 1983 and replaced by a floating rate with Reserve Bank intervention.[4] Also given our rather short sample size in the later period, it would not be feasible to model these using a nonlinear policy rule which is already heavily parameterised.

We use a similar approach in developing a model of monetary policy for the period before inflation targets were introduced in 2000; that is, from 1983. We specify our model as:

$$r_t = \bar{r} + \lambda'_t(E_t\pi_{t+p}; \gamma, \pi^{L'}, \pi^{U'})R'_{It} + (1 - \lambda'_t(E_t\pi_{t+p}; \gamma, \pi^{L'}, \pi^{U'}))R'_{Ot} + \varepsilon_t \qquad (3)$$

where $R'_{It} = \alpha'_{Ii}(L)r_t + \alpha'_{I\pi}E_t\pi_{t+p} + \alpha'_{Iy}E_t(y_{t+p} - y^*) + \alpha'_{Ie}E_t(e_{t+p} - e^*)$ and

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[3] See Aron and Muellbauer (2000) for an extensive survery on the monetary regimes and institutions in place in South Africa since the 1960s.
[4] However, due to various disturbances such as the Rubicon speech, economic sanctions and the debt-standstill agreement, the free floating exchange rate performed very poorly. Thus, the 'finrand' was reintroduced in 1985 and finally abolished in March 1995.

$$R_{Ot}' = \alpha_{Oi}'(L)r_t + \alpha_{O\pi}' E_t \pi_{t+p} + \alpha_{Oy}' E_t(y_{t+p} - y^*) + \alpha_{Oe}' E_t(e_{t+p} - e^*)$$ and λ_t' is the probability that expected inflation will lie between the bands π^{L^-} and $\pi^{U'}$. The only main difference here is that the Taylor rule uses inflation rather than inflation relative to the target.

Model Hypothesis

In this section, we set out the model hypothesis that will allow us to address the questions raised on inflation targeting in the introduction. The way in which monetary policy has changed since the advent of inflation targeting can be investigated by considering differences in the estimated parameters between regimes.

Firstly, if we expect the SARB to place greater importance on inflation since 2000, then we would expect the regime boundaries to narrow, implying $\pi^{L'} < \pi^L$ and $\pi^{U'} > \pi^U$. Secondly, we would expect changes across the two monetary regimes so that under the inflation targeting regime, the response to inflation is higher and that to output is lower, implying that $\alpha_{I\pi} > \alpha_{I\pi}'$, $\alpha_{O\pi} > \alpha_{O\pi}'$, $\alpha_{Iy} < \alpha_{Iy}'$, $\alpha_{Oy} < \alpha_{Oy}'$. We would also expect the weight on the exchange rate to increase, implying that, $\alpha_{Oe} > \alpha_{Oe}'$. Thirdly, to test asymmetric responses to inflation after 2000, implying that deviations of inflation (either positive or negative) from the target zone are not seen as equally bad, we devise the following hypothesis. We therefore amend the outer regime R_{Ot} in equation (1) to include positive deviation of inflation from the upper band $E_t(\pi_{t+p} - \pi^*)^+$ and negative deviation of inflation from the lower band $E_t(\pi_{t+p} - \pi^*)^-$ as in equation (4) below. The relevant hypothesis, if policy is symmetric after 2000, is:

$$H_0 : \rho_{O\pi}^+ = \rho_{O\pi}^- \text{ v/s } H_1 : \rho_{O\pi}^+ > \rho_{O\pi}^- \text{ if, for instance, we suspect that the SARB has more of a deflationary bias.}$$

$$R_{Ot} = \alpha_{Oi}(L) + \alpha_{O\pi}^+ E_t(\pi_{t+p} - \pi^*)^+ + \alpha_{O\pi}^- E_t(\pi_{t+p} - \pi^*)^- + \alpha_{Oy} E_t(y_{t+p} - y^*) + \alpha_{Oe} E_t(e_{t+p} - e^*) \qquad (4)$$

Fourthly we can also examine whether policymakers are pursuing a point target or a target range. If they are attempting to keep inflation within the range of $\pi^L - \pi^{U'}$, then $\alpha_{O\pi} > 0$ and $\alpha_{I\pi} = 0$, which implies that monetary policy responds to inflation only when inflation lies outside the regime bands. If policymakers are aiming at a precise value of inflation, then $\alpha_{O\pi} > 0$ and $\alpha_{I\pi} > 0$, which implies that monetary policy always strives to move inflation towards the target. Finally, we can examine whether monetary policy responds more to expected inflation when inflation is further away from the target by testing whether $\alpha_{O\pi} > \alpha_{I\pi}$.

Alternative Specifications

Simple linear version of the Taylor rule, such as equation (4), has been used in the literature to test changes in monetary policy conduct (see for e.g., Taylor, 1993, for the US and Nelson, 2000, for the UK). In the South African context, Aron and Muellbauer (2000), and in later stages Woglom (2003), have employed a similar structure to investigate whether inflation targeting has affected the conduct of monetary policy.[5]

$$r_t = \bar{r} + \alpha_i(L)r_t + \alpha_\pi E_t(\pi_{t+p} - \pi^*) + \alpha_y E_t(y_{t+p} - y^*) \qquad (5)$$

However, these Taylor rules cannot be used to address the other issues considered in this paper. Asymmetry in monetary policy might be analyzed using an augmented Taylor rule of the form:

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[5]Note that Aron and Muellbauer (2000) and Woglom (2003) use an extended version of the Taylor rule to include other arguments such as the exchange rate, money supply growth and so on.

$$r_t = \bar{r} + \alpha_i(L)r_t + \alpha_\pi^+ E_t(\pi_{t+p} - \pi^*)^+ + \alpha_\pi^- E_t(\pi_{t+p} - \pi^*)^- + \alpha_y E_t(y_{t+p} - y^*) \tag{6}$$

This model includes inflation rates above and below the inflation target as separate variables and so allows for differential responses from policymakers. This type of model has been used by Dolado *et al.* (2000) to analyze monetary policy in Germany, France, Spain and the United States in the period before monetary union (see also Gerlach (2000) and Surico (2002)). Although helpful and informative about asymmetry, this model cannot be used to address any of the other issues. We might also use the augmented Taylor rule:

$$r_t = \bar{r} + \alpha_i(L)r_t + \alpha_{1\pi} E_t(\pi_{t+p} - \pi^*) + \alpha_{2\pi} E_t(\pi_{t+p} - \pi^*)^2 + \alpha_y E_t(y_{t+p} - y^*) \tag{7}$$

to analyze monetary policy where policymakers are more responsive to inflation when it is further from the inflation target. (Dolado *et al.* 2000 use a similar model in a non-inflation targeting context.) However, there is no other model that could be used to address the issue of whether policymakers have a point target or a target range, nor is there any other single model that can be used to analyze all of the other issues.

ECONOMETRIC RESULTS

Our analysis is based on quarterly data (1983q1-2007q4) for South Africa. The sample period corresponds roughly to the two monetary regimes discussed above. We use the money market rate as the nominal interest rate. Inflation is the annual proportional change in the consumer price index. Output is measured using the real GDP and we measure the output gap as the deviation of this from a Hodrick-Prescott (1997) trend. We also use the growth rate of the nominal effective exchange rate as an explanatory variable in the interest rate rule.[6]

In estimation, we compute the measure of expected future inflation for the post-1999q4 period by a simple inflation learning rule. King (1996) analyzes two extreme cases of inflation formation: 1) a completely credible policy regime where private sector expectations adjust immediately to the inflation target (since the announcement is fully credible), which is the case of rational or model consistent expectations, and 2) exogenous learning. In general, expectations are affected both by the inflation target and by actual inflation performance. After experiencing high inflation for a long period of time, there may be good reasons for the private sector not to believe the disinflation policy fully (see also Bomfim and Rudebusch, 2000, and Schaling, 2003). In his discussion of endogenous learning, King (1996) says that it might be rational for the private sector to suppose that, in trying to learn about the future inflation rate, many of the relevant factors are exogenous to the path of inflation itself. In light of this, King assumes that private sector inflation expectations follow a simple rule; that is, a linear function of the inflation target and the lagged inflation rate. In this respect, we model the one period ahead expected inflation, $E_t\pi_{t+1} = \rho\pi^T + (1-\rho)\pi_{t-1}$ (where ρ captures the credibility of the new regime, we set $\rho = 0.5$ and $E_t\pi_{t+p}$ uses $p = 1$ as our preferred specification), denotes that agents use the target inflation rate (where $\pi^T = (\pi^L + \pi^U)/2$ is an average of the two pre-announced bands $\pi^L = 3\%$ and $\pi^U = 6\%$) and past information of up to the first lag to form their view of what inflation would be in the next period.[7] For 1983q1-1999q4, we use the first lag of inflation as a measure of the one period ahead expected inflation, $E_t\pi_{t+1} = \pi_{t-1}$, and for the output gap, we use $E_t(y_{t+p} - y^*) = (y_{t-1} - y^*)$.

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[6]All data have been obtained from the official website of the SARB.

[7]We also make use of an alternative measure of one period ahead expected inflation, $E_t\pi_{t+1} = \rho\pi^T + (1-\rho)0.25\sum_{i=1}^{4}\pi_{t-i}$ to capture the use of past information at higher lag order. However, this specification does not significantly change the results under study.

Unit root tests[8] showed that the nominal interest rate, inflation, the output gap, and the growth rate in the exchange rate are stationary variables. The order of integration of the inflation rate is more ambiguous.[9]

Table 1 is a comparison of the results from estimating the model given by equation 1, capturing the inflation targeting era (post-1999q4) and the monetary policy model given by equation 3, and depicting the pre-inflation targeting period (1983q1-1999q4). Because of the short sample size in the post-1999q4 period and our use of a heavily parameterized nonlinear model, estimates of the full model were poorly determined. When the least significant variables were removed, we obtained a well-determined simplified model. Column 1 reports nonlinear least squares estimates with lag inflation for the inflation targeting period; column 2 presents corresponding nonlinear estimates with expected future inflation, using the learning rule for the inflation targeting period; and column 3 presents a case of perfect foresight for inflation expectation by replacing expected future inflation with actual one-period ahead future inflation and uses lagged variables as instruments for the inflation targeting era. Estimates of our comparison model of monetary policy in the 1983q1–1999q4 period are presented in columns 4 and 5 for lag inflation and the case of perfect foresight for measures of inflation expectations, respectively. The diagnostic tests show no serious misspecification in Table 1, except for a slight serial correlation issue in columns 1 and 3 for the models which use lag inflation and perfect foresight.

First, it is worth mentioning that the model with the 'inflation learning rule' for expected future inflation provides a better data-generating process than the models which use lag inflation and perfect foresight as measures of expected future inflation. There are a number of key findings that help us to answer the questions we pose in the introduction. We find that the adoption of inflation targets in 2000 led to significant changes in monetary policy. We estimate $\pi^L = 4.5\%$ and $\pi^U = 6.9\%$ (the estimates from the model with lag inflation are not much different), $\pi^{L'} = 0.7\%$ and $\pi^{U'} = 18.4\%$ and cannot reject the hypothesis that $\pi^{L'} = 0$. These estimates provide some explanations that monetary policy became more stringent towards high inflation after 1999. We also find that $\alpha_{O\pi} > \alpha'_{O\pi}$ and $\alpha_{Iy} < \alpha'_{Iy}$, and that $\alpha_{I\pi}$, $\alpha'_{I\pi}$, α_{Oy} and $\alpha'_{Oy} = 0$. These estimates confirm that monetary policy became more responsive to inflation and less responsive to output within each regime. It is worth noting that the 'inflation learning rule' provides a response to inflation which is almost twice the magnitude of just using lag inflation and three times the magnitude of the perfect foresight case. In a linear version of the Taylor rule, Woglom (2003), using a combination of lagged inflation and the lagged output gap, found that the coefficient is higher when CPIX is used in the place of CPI. However, the magnitude of the response coefficient happens to be of a marginally lesser value than the one we obtain under the 'inflation learning rule'. The response to output was significantly much higher prior to the inflation targeting period. In addition, Woglom (2003) also found that the real exchange rate appears to play no role in the formulation of monetary policy, a result that we confirm in this study with respect to the appreciation and depreciation of the currency. As far as the exchange rate is concerned, a similar result has also been obtained by Ortiz and Sturzenegger (2007) using an estimated version of a small-open economy Dynamic Stochastic General Equilibrium (DSGE) model of South Africa covering the period of 1983q1-2002q4.[10]

Second, the hypothesis test for asymmetric responses to inflation post-1999 shows that there is an inflation bias to monetary policy as the response to inflation is lower for larger inflation values. Notice that the results are contradictory as to whether one uses lag inflation, perfect foresight or the learning rule for expected future inflation given that the models with lag inflation and perfect foresight tend to suggest that the policy maker is more of a 'hawk' than a 'dove', therefore attaching greater priority to increases in inflation above the target than to decreases below the target. These results support the recent announcement of the South African Reserve Bank to respond to expansionary/recessionary pressures and therefore, to be more tolerable to inflationary pressures in order to mitigate business cycle downturns. However, we would like to emphasize that there may be caveat to this finding. Our finding of a strong asymmetry, with respect to an inflationary bias, needs to be reinvestigated when sufficient data are available.

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[8]The results are not reported but are available on request.

[9]The inflation rate could be stationary or not depending on the specification of an intercept or a trend and an intercept in the test for a unit root.

[10]In addition, Ortiz and Sturzenegger (2007) found the policy reaction function of the SARB to be stable with a consistent anti inflation bias, and a somewhat large weight on output. However, with Ortiz and Sturzenegger (2007) not comparing across regimes, it is difficult to put their results into context with our findings.

Third, we find that policymakers are attempting to pursue an inflation zone targeting regime rather than a point target one. The estimate of $\alpha_{O\pi}$ is significantly greater than zero, so policymakers adjust the interest rate in the outer regime in order to move inflation towards the target. However, we find that the estimate of $\alpha_{I\pi}$ is insignificant, suggesting that policymakers do not adjust interest rates to move inflation towards the target when in the inner regime. This also tells us that the response of monetary policy to inflation is nonlinear as interest rates respond more when inflation is further from the target.

CONCLUSION

This paper argues that there have been important changes in the conduct of monetary policy in South Africa since the adoption of an inflation targeting regime in 2000, which is also our focus of the study. We have estimated a simple nonlinear structural model of monetary policy and the appeal of this method lies in its ability to reveal structure in data that might be missed by classical linear methods. Also, a model embodying a simple 'inflation learning rule' seems to capture the dynamics of the policy instrument better than alternative specifications of how agents form their expectation of future inflation. We argue that inflation targeting in practice has been asymmetric, we suggest that monetary policy throughout this period has responded more to inflation when it is further from the target, and we speculate that in the post-1999 period policymakers may have been marginally overshooting the announced target zone within a range of 4.5%–6.9%. It is also worth mentioning that we should take these results with a pinch of caution given the relatively small sample size of the inflation targeting regime. We intend to explore these issues in future work.

AUTHOR INFORMATION

Rangan Gupta is currently a Professor at the Department of Economics, University of Pretoria. After having completed my Ph.D. in May 2005 from the Department of Economics, University of Connecticut, I joined the Department of Economics, University of Pretoria, as a Senior Lecturer in August 2005 and got promoted to an Associate Professor in July 2007. I secured my BSc (Honours) degree from the R.K.M.R. College, Narendrapur, and the MSc degree from the University of Calcutta. My academic interests are mainly Monetary Theory and Policy, Business Cycles, and Time Series Econometrics. I have published widely in international and domestic journals.

Ruthira Naraidoo is currently a Senior Lecturer at the Department of Economics, University of Pretoria. I have completed my Ph.D. in 2004 from the Department of Economics, Cardiff University and have worked as a lecturer in economics at the Department of Economics, Keele University and University of Nottingham, Ningbo. I secured my BSc (Honours) degree from University of Mauritius and MSc degree from Cardiff University. My research interests are in the areas of applied macroeconomic theory and policy with focus on monetary economics, labour economics and time series econometrics. I have published in international and domestic journals.

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Table 1

Parameter estimates for equ. (1) and (3)

	NL LS Estimates	NL LS Estimates	NL IV Estimates	NL LS Estimates	NL IV Estimates
	2000(I)-2007(IV)	2000(1)-2007(IV)	2000(1)-2007(IV)	1983(I)-1999(IV)	1983(I)-1999(IV)
	Lag Inf	Exp future Inf Learning	Exp future Inf	Lag Inf	Exp future Inf
$\hat{i}$	1.54** (0.52)	1.49** (0.24)	0.92** (0.31)	3.62** (1.07)	3.61** (1.39)
R_I(or $M_{I'}$)					
i_{t-1}	1.34** (0.57)	1.33* (0.80)	1.43** (0.71)	1.04** (0.12)	1.04** (0.12)
i_{t-2}	-0.48 (0.51)	-0.49 (0.58)	-0.54 (0.69)	-0.29** (0.12)	-0.29** (0.13)
$E_t(\pi_{t+p} - \pi^T)$	-0.13 (0.60)	-0.09 (0.74)	0.02 (0.08)	0.01 (0.05)	0.01 (0.05)
$(y_{t-1} - y^*)$	-	-	-	0.48** (0.13)	0.48** (0.15)
$E_t(e_{t+p} - e^*)$	-	-	-	-	-
R_O(or $M_{O'}$)					
i_{t-1}	1.20** (0.25)	1.20** (0.29)	1.32** (0.15)	1.19** (0.45)	1.20** (0.46)
i_{t-2}	-0.43* (0.26)	-0.42 (0.29)	-0.45** (0.16)	-0.61** (0.23)	-0.60** (0.22)
$E_t(\pi_{t+p} - \pi^T)$	0.12** (0.04)	0.22** (0.11)	0.07** (0.03)	0.16 (17.53)	0.16 (1.44)
$(y_{t-1} - y^*)$	-	-	-	-	-
$E_t(e_{t+p} - e^*)$	-	-	-	-	-
π^L(or $\pi^{L'}$)	4.07** (0.83)	4.55** (2.27)	4.34** (2.01)	0.73 (1.15)	0.70 (1.32)
π^U(or $\pi^{U'}$)	6.85** (2.5)	6.85** (1.90)	6.1** (2.45)	18.44** (2.42)	18.36** (2.38)
$E_t(\pi_{t+p} - \pi^U)^+$	0.24** (0.08)	0.01** (0.002)	0.16** (0.07)		
$E_t(\pi_{t+p} - \pi^L)^-$	0.08* (0.04)	0.61** (0.22)	0.01 (0.05)		
γ	52.17 (945.51)	43.22 (707.56)	51.6 (650.12)	10.0 (15.50)	13.23 (35.20)
$\bar{R}^2$	0.90	0.93	0.90	0.88	0.88
s.e	0.57	0.48	0.58	1.27	1.25
F ar	2.43 [0.09]	2.13 [0.14]	2.48 [0.08]	1.82 [0.12]	1.74 [0.13]
F arch	1.68 [0.19]	1.01 [0.42]	0.17 [0.95]	0.15 [0.70]	0.04 [0.96]

Notes: Two asterisks denotes statistical significance at the 5% level and one asterisk at the 10% level. Newey-West corrected standard errors in parenthesis. F ar is the Lagrange multiplier F-test for residual serial correlation of up to fifth order. F arch is the fifth-order autoregressive conditional heteroscedasticity F-test. p value in parenthesis.