Navigating Optimal Inflation Targeting in South Africa: A Regime-Switching DSGE Approach

Junior Maih, Ruthira Naraidoo and Christian Tipoy

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Abstract

South Africa's mineral-driven economy requires adaptive inflation targeting to manage global commodity price volatility. Global commodity price swings challenge the South African Reserve Bank's (SARB) 4.5% inflation target, adopted in 2000 (as of November 2025, the inflation target is now 3%). This paper uses a regime-switching DSGE model to determine the optimal inflation target for South Africa, incorporating heteroskedastic commodity shocks and a regime-dependent Taylor rule. The target varies with policy preferences: output focus raises it, inflation focus lowers it. Optimized policy outperforms historical policy, enhancing inflation control through balanced stabilization, but foreign shocks remain challenging. Excessive interest rate smoothing weakens stabilization, limiting responsiveness. A targeting approach in line with the paper's main results, is essential to enhance resilience against external shocks, offering SARB a framework to adapt policy to South Africa's commodity-driven conditions.

Keywords: Inflation Targeting, Regime-Switching DSGE, Commodity Price Volatility, Monetary Policy, Optimal Policy, Bayesian Estimation, External Shocks, Interest Rate Smoothing, Small Open Economy

JEL Classification: E52, E31, E17, F41, C61

[*]Norges Bank

[†]University of Pretoria, the author acknowledges the support by NRF Grant Number JSPS230914149324.

[‡]University of KwaZulu-Natal

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1 Introduction

South Africa's mineral-driven economy requires adaptive inflation targeting to manage global commodity price volatility. As a small open economy reliant on mineral exports like gold and platinum, South Africa is acutely exposed to global commodity price fluctuations, which drive volatility in inflation, output, and exchange rates.[1] Since adopting the inflation targeting framework in 2000, the South African Reserve Bank (SARB) has targeted a 4.5% midpoint within a 3–6% band (Honohan and Orphanides, 2022).[2] However, traditional inflation targeting frameworks, often designed for stable economies, struggle to accommodate regime shifts induced by commodity price volatility, which amplify external shocks like global demand fluctuations or foreign interest rate changes (Drechsel et al., 2019). This susceptibility underscores the need for a monetary policy approach tailored to South Africa's commodity-driven economic structure, capable of adapting to dynamic external conditions.

This paper extends a standard DSGE model for a commodity exporter, as in Medina and Soto (2007) to determine the optimal inflation target for South Africa, addressing how SARB should adjust policy in response to commodity price swings and inflation dynamics. The effectiveness of inflation targeting hinges on both the chosen target and SARB's response to deviations, particularly in a commodity-dependent economy where external shocks are frequent. Standard models, often relying on static frameworks like the Taylor rule (Taylor, 1993), assume fixed policy regimes and fail to capture the dynamic nature of monetary policy in volatile settings. Our regime-switching dynamic stochastic general equilibrium (DSGE) model incorporates heteroskedastic commodity price shocks and a regime-dependent Taylor rule, providing a robust framework to optimize SARB's inflation target.

The literature on inflation targeting in emerging markets highlights its global adoption and relevance but reveals limitations in addressing commodity-driven volatility (Mishkin, 2007; Fraga et al., 2003; Loewald et al., 2022). Loewald et al. (2022) provide valuable insights into

[1] The production and exports of commodities in South Africa make up to 6% of GDP, 3% of total employment and around 60% of total exports (Minerals Council South Africa, 2024). Importantly, it also generates significant output in terms of transportation, shipping and value added to other industries in the economy.

[2] The South African Reserve Bank formally adopted inflation targeting in 2000 with a target range of 3-6% and in 2014 under Governor Lesetja Kganyago, shifts to a midpoint target of 4.5%. In November 2025, the SARB and the Treasury announced the implementation of a 3% inflation target within a band of 2 and 4%.

South Africa's inflation targeting framework, emphasizing its role in stabilizing expectations in a volatile economy. Studies like Shapoval (2022) underscore how commodity price shocks influence inflation and policy responses, yet few explore the implications of the inflation target in response to commodity cycles and quantify the optimal inflation target for varying preferences of the central bank.

It is worth noting that the motivation for using commodity price volatilities rather than commodity price super cycle is in line with the findings of Fernández et al. (2018), namely that commodity price super cycle plays a significant but not a dominant role in driving fluctuations in aggregate activity, with two thirds of the fluctuations in economic activity of commodity exporters being explained by stationary world shocks, pertaining to stationary commodity price shocks. In this study which focuses on business cycles, using commodity price volatilities further reinforces concentrating on the stationary components of commodity prices as the key driving forces for the business cycles of these economies.

This paper hence adds to the literature on commodity price shocks in small open commodity exporting economies and monetary policy. While the literature has mostly relied on the fiscal effects of commodity price shocks, the effects of nominal features have recently been included in these models, such as Medina (2011); Chang (2014); Fornero (2014); Hevia (2014); Drechsel et al. (2019); Guerra-Salas and Tranamil (2021); Naraidoo and Paez-Farrell (2023) and more recently Arnabal and García-Cicco (2024). It should be noted that these research works have predominantly investigated how monetary policy reacts to commodity price shocks and less so as to how these shocks affect the inflation target amidst regime-switching commodity price volatilities, which is a key concern for the South African economy and hence a key contribution of this paper. At the time of writing, South Africa's new inflation target is 3%, with a 1 percentage point tolerance band (3% to 4%), implemented in November 2025, replacing the previous 4.5% target with 3%–6% range. Our work is also in close proximity to the recent ones by Gazzani et al. (2026) and Arnabal and García-Cicco (2024), whereby the latter for instance investigate optimal inflation targeting in a small open economy framework. Our work demarcates from theirs to the extent that we investigate how the inflation target emerges as an optimal decision in such a framework, amidst commodity price volatilities.

Under optimal policy framework, the Taylor rule guides monetary adjustments (Woodford, 2003), but lacks mechanisms for regime-dependent target shifts. Arnabal and García-Cicco (2024) examine optimal inflation in Uruguay, incorporating downward wage rigidities and dollarized pricing to find a 3.5% target. However, their static Taylor rule overlooks regime-switching dynamics and commodity volatility. Similarly, Cho et al. (2025) analyze optimal inflation in the Euro area, demonstrating lower targets in open economies due to trade openness, but their symmetric, zero-lower-bound-focused model neglects commodity shocks and regime shifts. Regime-switching models, used to capture policy and structural changes (Hamilton, 1989; Filardo, 1994), are rarely applied to inflation targeting in small open economies (Binder and Gross, 2013). When extended to DSGE, regime-switching models works are scarce and very few look at small open economies. They tend to neglect commodity price volatility in inflation targeting economies and there are limited studies on inflation target adjustments under changing monetary policy conditions.

DSGE models are a cornerstone of monetary policy analysis (Smets and Wouters, 2003; Nachane, 2016), and our approach extends these with regime-switching dynamics (Maih, 2015; Foerster et al., 2016). Bayesian estimation enhances model precision and uncertainty handling (Negro and Schorfheide, 2004; An and Schorfheide, 2007; Guerrón-Quintana and Nason, 2012), and we apply it to estimate regime-switching parameters (Bjørnland et al., 2018; Alstadheim et al., 2021; Chang et al., 2021; Hashimzade et al., 2024). We contribute to the literature by developing a regime-switching DSGE model tailored to South Africa. We introduce a central bank loss function to quantify trade-offs between inflation stability, output growth, and interest rate smoothing, with its rationale detailed in Section 5.[3] The model optimizes the inflation target based on SARB's policy preferences, conducts sensitivity analysis to explore varying weights, and performs counterfactual simulations to compare optimized outcomes with historical policy, all computed using the Rationality in Switching Environments (RISE) toolbox of Maih (2015).

The target varies with policy preferences: output focus raises it, inflation focus lowers it. Sensitivity analysis reveals that a stronger focus on output growth increases the target, while

[3] The quadratic loss function in Section 5, $L = (\Pi_t - \Pi_{\text{target}})^2 + \omega_y \cdot (\Delta G\hat{D}P_t)^2 + \omega_R \cdot (\Delta \hat{R}_t)^2$, penalizes deviations in inflation, output growth, and interest rate changes, aligning with SARB's practical objectives. Unlike maximizing the representative agent's utility, which assumes perfect foresight and welfare optimization, the loss function captures realistic goals in a volatile, regime-switching environment with commodity price shocks, offering transparency over welfare-based approaches (see Section 5).

prioritizing inflation stability reduces it. A stronger emphasis on inflation stabilization leads to greater price stability, but external shocks remain challenging to control. Counterfactual simulations demonstrate that optimized policy outperforms historical policy, enhancing inflation control through balanced stabilization, but highlighting persistent difficulties in mitigating foreign shocks, such as global commodity price or interest rate fluctuations. Interest rate smoothing calls for a stronger response to inflation to control the inertia and hence excessive interest rate smoothing weakens stabilization, limiting responsiveness and reducing effectiveness. A careful targeting approach is essential to strengthen South Africa's economic resilience, offering SARB a robust framework to adapt policy to its commodity-driven conditions.

The remainder of the paper is organized as follows. Section 2 presents the regime-switching DSGE model, detailing its structure and extensions. Section 3 outlines the calibration and Bayesian estimation using South African data from 2000:Q1 to 2019:Q2. Section 4 discusses posterior estimates and state probabilities, highlighting nominal rigidities and volatility regimes. Section 5 optimizes the inflation target, analyzing policy trade-offs and impulse responses. Section 6 presents the counterfactual's outcomes. Section 7 concludes with implications for SARB's adaptive inflation targeting strategy.

2 The Regime-Switching DSGE model

This section presents a DSGE model tailored to analyze business cycles in South Africa, a small open economy reliant on mineral exports (e.g., gold, platinum, chrome, among other critical minerals). The model extends Medina and Soto (2007)[4] to capture South Africa's commodity price shock driven dynamics. We introduce two extensions: heteroskedastic shocks to international commodity prices, governed by a two-state Markov process; and a regime-dependent monetary policy rule where the SARB's Taylor rule parameters vary with commodity price volatility. Specified in non-linear form for the RISE toolbox, the model includes nominal and real rigidities to ensure realistic dynamics.

[4] Following Smets and Wouters (2003, 2007); Christiano et al. (2005) and Altig et al. (2011).

2.1 Model Overview

The model is a New Keynesian DSGE framework for a small open economy, featuring households, firms, a government, and a monetary authority. Households include Ricardian agents, who optimize intertemporal consumption and savings, and non-Ricardian agents, who consume disposable income, amplifying fiscal policy effects. Firms operate in a commodity-exporting sector, producing minerals with exogenous output and international prices, a non-commodity sector producing differentiated intermediate goods under monopolistic competition, and an import sector distributing foreign goods. The government follows a fiscal rule to ensure sustainability, while the SARB sets interest rates via a Taylor rule.

Nominal and real rigidities—sticky prices and wages with partial indexation, incomplete exchange rate pass-through, investment adjustment costs, and habit persistence in consumption follow Medina and Soto (2007). Extensions include: (i) commodity prices with AR(1) heteroskedastic shocks switching between high- and low-volatility regimes, and (ii) a Taylor rule with volatility-dependent coefficients, enabling adaptive SARB responses. These features suit South Africa's business cycles, capturing commodity price impacts on inflation, output, and the real exchange rate.

2.2 Households

Households drive aggregate demand and labor supply in South Africa's economy. Ricardian households consume, supply labor, and save in domestic and foreign assets, influencing financial dynamics. Non-Ricardian households, consuming all disposable income, amplify fiscal policy effects.

Households, indexed by $j \in [0,1]$, consist of a fraction $\lambda \in [0,1]$ non-Ricardian and $1-\lambda$ Ricardian. Ricardian households ($j \in (\lambda, 1]$) maximize expected lifetime utility:

$$U_t = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \zeta_{C,t+i} \left[\log \left(C_{t+i}(j) - \tilde{h} C_{t+i-1} \right) - \zeta_{L,t+i} \frac{l_{t+i}(j)^{1+\sigma_L}}{1+\sigma_L} + \frac{\zeta_M}{\mu} \left(\frac{M_{t+i}(j)}{P_{C,t+i}} \right)^{\mu} \right] \right\}, \tag{1}$$

where $C_t(j)$ is consumption, $l_t(j)$ is labor effort, $M_t(j)$ is nominal money balances, $P_{C,t}$ is the consumption price index, $\beta \in (0,1)$ is the discount factor, $\tilde{h} = h(1+g_y)$ captures habit persistence adjusted for steady-state growth g_y, σ_L is the inverse Frisch elasticity, $\zeta_{C,t}$, $\zeta_{L,t}$ are AR(1) shocks to consumption and labor preferences respectively, ζ_M is a money demand parameter, and μ governs money demand elasticity. Non-Ricardian households $j \in [0, \lambda]$ solve:

$$C_t(j) = \frac{W_t(j)}{P_{C,t}} l_t(j) - \frac{T_{p,t}}{P_{C,t}}, \tag{2}$$

where $W_t(j)$ is the nominal wage and $T_{p,t}$ is lump-sum taxes, setting wages equal to Ricardian households' average.

Ricardian households face:

$$\begin{aligned} P_{C,t}C_t(j) + E_t\{d_{t,t+1}D_{t+1}(j)\} + \frac{\mathcal{E}_t B_t^*(j)}{(1+i_t^*)\Theta(\mathcal{B}_t)} + M_t(j) = \\ W_t(j)l_t(j) + \Pi_t(j) - T_{p,t} + D_t(j) + \mathcal{E}_t B_{t-1}^*(j) + M_{t-1}(j), \end{aligned} \tag{3}$$

where $D_t(j)$ is domestic state-contingent bonds, $B_t^*(j)$ is foreign bonds, $\mathcal{E}_t$ is the nominal exchange rate (domestic per foreign currency), i_t^* is the foreign interest rate, $\Pi_t(j)$ is firm profits, $\Theta(\mathcal{B}_t)$ is a risk premium with $\mathcal{B}_t = \frac{\mathcal{E}_t B_t^*}{P_{Y,t}Y_t}$, $B_t^* = \int_\lambda^1 B_t^*(j)dj$, and $d_{t,t+1}$ is the bond price with $E_t[d_{t,t+1}]^{-1} = 1 + i_t$, i_t being the domestic interest rate. In steady state, $\Theta(\cdot) = 1$, $\frac{\Theta'}{\Theta}\mathcal{B} = \varrho$. The consumption bundle is:

$$C_t(j) = \left[\alpha_C^{1/\omega_C} C_{Z,t}(j)^{\frac{\omega_C-1}{\omega_C}} + (1-\alpha_C)^{1/\omega_C} C_{O,t}(j)^{\frac{\omega_C-1}{\omega_C}}\right]^{\frac{\omega_C}{\omega_C-1}}, \tag{4}$$

where $C_{Z,t}(j)$ is core consumption, $C_{O,t}(j)$ is oil consumption, ω_C is the elasticity of substitution, and α_C is the core consumption share. Demands are:

$$C_{Z,t}(j) = \alpha_C \left(\frac{P_{Z,t}}{P_{C,t}}\right)^{-\omega_C} C_t(j), \quad C_{O,t}(j) = (1-\alpha_C)\left(\frac{P_{O,t}}{P_{C,t}}\right)^{-\omega_C} C_t(j), \tag{5}$$

with price index:

$$P_{C,t} = \left[\alpha_C P_{Z,t}^{1-\omega_C} + (1-\alpha_C) P_{O,t}^{1-\omega_C}\right]^{\frac{1}{1-\omega_C}}, \tag{6}$$

where $P_{Z,t}$ and $P_{O,t}$ are core consumption and oil price indices. The core bundle is:

$$C_{Z,t}(j) = \left[\gamma_C^{1/\eta_C} C_{H,t}(j)^{\frac{\eta_C-1}{\eta_C}} + (1-\gamma_C)^{1/\eta_C} C_{F,t}(j)^{\frac{\eta_C-1}{\eta_C}}\right]^{\frac{\eta_C}{\eta_C-1}}, \tag{7}$$

with demands:

$$C_{H,t}(j) = \gamma_C \left(\frac{P_{H,t}}{P_{Z,t}}\right)^{-\eta_C} C_{Z,t}(j), \quad C_{F,t}(j) = (1-\gamma_C)\left(\frac{P_{F,t}}{P_{Z,t}}\right)^{-\eta_C} C_{Z,t}(j), \tag{8}$$

and price index:

$$P_{Z,t} = \left[\gamma_C P_{H,t}^{1-\eta_C} + (1-\gamma_C) P_{F,t}^{1-\eta_C}\right]^{\frac{1}{1-\eta_C}}, \tag{9}$$

where $P_{H,t}$, $P_{F,t}$ are home and foreign goods price indices, and core inflation is $\pi_{Z,t} = \frac{P_{Z,t}}{P_{Z,t-1}} - 1$.

Ricardian households' FOCs from (1) and (3) include the Euler equation:

$$\beta E_t \left\{ (1+i_t) \frac{P_{C,t}}{P_{C,t+1}} \frac{\zeta_{C,t+1}}{\zeta_{C,t}} \frac{C_t(j) - \tilde{h} C_{t-1}}{C_{t+1}(j) - \tilde{h} C_t} \right\} = 1, \quad \forall j \in (\lambda, 1], \tag{10}$$

and uncovered interest parity (UIP):

$$\frac{1+i_t}{(1+i_t^*)\Theta(\mathcal{B}_t)} = \frac{E_t \left\{ \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \frac{\zeta_{C,t+1}}{\zeta_{C,t}} \frac{C_t(j) - \tilde{h} C_{t-1}}{C_{t+1}(j) - \tilde{h} C_t} \right\}}{E_t \left\{ \frac{\zeta_{C,t+1}}{\zeta_{C,t}} \frac{C_t(j) - \tilde{h} C_{t-1}}{C_{t+1}(j) - \tilde{h} C_t} \right\}}, \quad \forall j \in (\lambda, 1], \tag{11}$$

where i_t^* follows an AR(1) process. Households supply differentiated labor, aggregated as:

$$l_t = \left(\int_0^1 l_t(j)^{\frac{\epsilon_L - 1}{\epsilon_L}} dj \right)^{\frac{\epsilon_L}{\epsilon_L - 1}}, \tag{12}$$

with elasticity ϵ_L. Wage setting uses a Calvo mechanism. Each period, a household can adjust its nominal wage with probability $(1-\phi_L)$. The non-optimizing wages are updated via:

$$W_{t+i}(j) = \Gamma_{W,t}^i W_t(j), \quad \Gamma_{W,t}^i = \left(\frac{T_{t+i}}{T_{t+i-1}} \right) (1+\pi_{C,t+i-1})^{\chi_L} (1+\bar{\pi}_{t+i})^{1-\chi_L} \Gamma_{W,t}^{i-1}, \quad \Gamma_{W,t}^0 = 1, \tag{13}$$

where T_t is a productivity trend, $\pi_{C,t} = \frac{P_{C,t}}{P_{C,t-1}} - 1$, $\bar{\pi}_t$ is the inflation target, and χ_L is the wage indexation parameter. Re-optimizing households solve:

$$\max_{W_t(j)} E_t \left\{ \sum_{i=0}^{\infty} \phi_L^i \Lambda_{t,t+i} \left[\frac{\Gamma_{W,t}^i W_t(j)}{P_{C,t+i}} l_{t+i}(j) - \zeta_{L,t+i} \frac{l_{t+i}(j)^{1+\sigma_L}}{1+\sigma_L} \left(C_{t+i} - \tilde{h} C_{t+i-1} \right) \right] \right\}, \tag{14}$$

with demand $l_{t+i}(j) = \left(\frac{\Gamma_{W,t}^i W_t(j)}{W_{t+i}} \right)^{-\epsilon_L} l_{t+i}$, and $\Lambda_{t,t+i}$ as the discount factor.

2.3 Firms

Firms shape production, exports, and prices in the South African economy. The commodity sector produces minerals with exogenous output. Their prices are set internationally, and hence taken as given by small open commodity exporting countries. This drives export revenues and business cycle volatility. The intermediate tradable sector produces differentiated goods for domestic and foreign markets under monopolistic competition, influencing inflation and output.

Importer firms distribute foreign goods, affecting import prices and the real exchange rate.

The commodity sector produces output $Y_{S,t}$, following an AR(1) process, and takes the international price $P^*_{S,t}$ as given, with no optimization. Intermediate tradable firms, indexed by k, maximize profits, setting prices with Calvo rigidities. For domestic sales, they solve:

$$\max_{P_{H,t}(k)} E_t \sum_{i=0}^{\infty} \phi_H^i \Lambda_{t,t+i} \left[\Gamma^i_{H,t} P_{H,t}(k) Y_{H,t+i}(k) - MC_{H,t+i} Y_{H,t+i}(k) \right], \tag{15}$$

where $P_{H,t}(k)$ is the price, $Y_{H,t+i}(k)$ is output, $MC_{H,t+i}$ is nominal marginal cost, ϕ_H is the Calvo probability, $\Lambda_{t,t+i}$ is the discount factor, and $\Gamma^i_{H,t} = (1+\pi_{C,t+i-1})^{\chi_H}(1+\bar{\pi}_{t+i})^{1-\chi_H}\Gamma^{i-1}_{H,t}$, $\Gamma^0_{H,t} = 1$, with indexation χ_H. For exports, a similar problem uses ϕ_F, χ_F. Importer firms solve:

$$\max_{P_{F,t}(k)} E_t \sum_{i=0}^{\infty} \phi_F^i \Lambda_{t,t+i} \left[\Gamma^i_{F,t} P_{F,t}(k) Y_{F,t+i}(k) - \mathcal{E}_{t+i} P^*_{F,t+i}(k) Y_{F,t+i}(k) \right], \tag{16}$$

with $P_{F,t}(k)$, $Y_{F,t+i}(k)$, and indexation χ_F.

Commodity output $Y_{S,t}$ is exogenous, with price:

$$\log P^*_{S,t} = \rho_{p^*_S} \log P^*_{S,t-1} + \varepsilon_{p^*_S,t}, \quad \varepsilon_{p^*_S,t} \sim N(0, \sigma^2_{p^*_S,s_t}), \tag{17}$$

where the volatility regime $s_t \in \{H, L\}$ follows:

$$P(s_t = H \mid s_{t-1} = H) = p_{HH}, \quad P(s_t = L \mid s_{t-1} = L) = p_{LL}, \tag{18}$$

with $\sigma_{p^*_S,H} > \sigma_{p^*_S,L}$, and domestic price $P_{S,t} = \mathcal{E}_t P^*_{S,t}$. Intermediate firms produce:

$$Y_{H,t} = A_{H,t} \left[\gamma_H^{1/\omega_H} O_{H,t}^{\frac{\omega_H - 1}{\omega_H}} + (1-\gamma_H)^{1/\omega_H} V_{H,t}^{\frac{\omega_H - 1}{\omega_H}} \right]^{\frac{\omega_H}{\omega_H - 1}}, \tag{19}$$

where $A_{H,t}$ is productivity, $O_{H,t}$ is oil input, $V_{H,t} = [K^{\eta_H}_{t-1} L^{1-\eta_H}_t]^{\zeta_{T,t}}$, ω_H is the elasticity, η_H is the labor share, and $\zeta_{T,t}$ is a permanent shock. Demands are:

$$O_{H,t} = \gamma_H \left(\frac{P_{O,t}}{MC_{H,t}} \right)^{-\omega_H} Y_{H,t}, \quad V_{H,t} = (1-\gamma_H) \left(\frac{P_{V,t}}{MC_{H,t}} \right)^{-\omega_H} Y_{H,t}, \tag{20}$$

with:

$$V_{H,t} = \left[K^{\eta_H}_{t-1} L^{1-\eta_H}_t \right]^{\zeta_{T,t}}, \tag{21}$$

and:

$$L_t = (1-\eta_H) \left(\frac{W_t}{P_{V,t}} \right)^{-1} V_{H,t}, \quad K_{t-1} = \eta_H \left(\frac{Z_t}{P_{V,t}} \right)^{-1} V_{H,t}, \tag{22}$$

where Z_t is the rental rate. Home goods aggregate as:

$$Y_{H,t} = \left(\int_0^1 Y_{H,t}(k)^{\frac{\epsilon_H - 1}{\epsilon_H}} dk \right)^{\frac{\epsilon_H}{\epsilon_H - 1}}, \tag{23}$$

with price index:

$$P_{H,t} = \left(\int_0^1 P_{H,t}(k)^{1-\epsilon_H} dk \right)^{\frac{1}{1-\epsilon_H}}, \tag{24}$$

and foreign goods:

$$Y_{F,t} = \left(\int_0^1 Y_{F,t}(k)^{\frac{\epsilon_F - 1}{\epsilon_F}} dk \right)^{\frac{\epsilon_F}{\epsilon_F - 1}}, \tag{25}$$

with:

$$P_{F,t} = \left(\int_0^1 P_{F,t}(k)^{1-\epsilon_F} dk \right)^{\frac{1}{1-\epsilon_F}}, \tag{26}$$

where ϵ_H, ϵ_F are elasticities.

The FOC for domestic pricing is:

$$E_t \sum_{i=0}^{\infty} \phi_H^i \Lambda_{t,t+i} Y_{H,t+i}(k) \left[\Gamma_{H,t}^i P_{H,t}(k)(1 - \epsilon_H) + \epsilon_H MC_{H,t+i} \right] = 0, \tag{27}$$

with $Y_{H,t+i}(k) = \left(\frac{\Gamma_{H,t}^i P_{H,t}(k)}{P_{H,t+i}} \right)^{-\epsilon_H} Y_{H,t+i}$. For importers:

$$E_t \sum_{i=0}^{\infty} \phi_F^i \Lambda_{t,t+i} Y_{F,t+i}(k) \left[\Gamma_{F,t}^i P_{F,t}(k)(1 - \epsilon_F) + \epsilon_F \mathcal{E}_{t+i} P_{F,t+i}^*(k) \right] = 0, \tag{28}$$

with $Y_{F,t+i}(k) = \left(\frac{\Gamma_{F,t}^i P_{F,t}(k)}{P_{F,t+i}} \right)^{-\epsilon_F} Y_{F,t+i}$, and $P_{F,t+i}^*(k)$ includes a shock $\zeta_{F,t}$. Marginal cost is:

$$MC_{H,t} = \frac{1}{A_{H,t}} \left[\gamma_H P_{O,t}^{1-\omega_H} + (1 - \gamma_H) P_{V,t}^{1-\omega_H} \right]^{\frac{1}{1-\omega_H}}, \tag{29}$$

with $P_{V,t} = \left[\eta_H^{\eta_H} (1 - \eta_H)^{1-\eta_H} Z_t^{\eta_H} W_t^{1-\eta_H} \right]^{1/\zeta_{T,t}}$.

Heteroskedastic commodity price shocks in (17) and (18) capture high- and low-volatility regimes, affecting export revenues, fiscal income, and the current account, amplifying business cycles. Intermediate and importer sectors respond indirectly via input costs and exchange rates.

2.4 Government

The government ensures fiscal sustainability in South Africa, funding expenditure with lump-sum taxes and a share of mineral export revenues, influencing aggregate demand via non-Ricardian households.

The government sets real expenditure as a share of trend real GDP, solving a static problem:

$$G_t = \bar{g} \cdot \overline{Y}_t, \tag{30}$$

where $\bar{g}$ is a share, and $\overline{Y}_t = Y_t/\zeta_{T,t}$ is trend GDP (see Section 2.3). Taxes adjust to balance the budget.

The budget constraint is:

$$P_{G,t}G_t = T_{p,t} + \chi \mathcal{E}_t P^*_{S,t} Y_{S,t} + \frac{\mathcal{E}_t B^*_{G,t-1}}{\Theta(\mathcal{B}_t)(1+i^*_t)} - \frac{\mathcal{E}_t B^*_{G,t}}{\Theta(\mathcal{B}_t)(1+i^*_t)}, \tag{31}$$

where $P_{G,t}$ is the consumption price index, χ is the mineral revenue share, and $B^*_{G,t}$ is foreign assets. The consumption bundle is:

$$G_t = G_{H,t}, \tag{32}$$

with $\gamma_G = 1$, so $P_{G,t} = P_{H,t}$ (see Section 2.3).

The static rule (30) has no dynamic FOCs. Taxes $T_{p,t}$ balance (31). No cost minimization is needed due to $\gamma_G = 1$.

2.5 Monetary Authority

The SARB sets the nominal interest rate to stabilize core inflation and output growth, responding to shocks, including volatile mineral prices, anchoring expectations and mitigating output and real exchange rate fluctuations.

The SARB implements a regime-dependent Taylor rule, adjusting the interest rate based on core inflation $\pi_{Z,t}$ and output growth Δy_t, with smoothing.

The rule is:

$$i_t = \rho_r i_{t-1} + (1-\rho_r)\left[i + \alpha_\pi(s_t)\left(\pi_{Z,t} - \bar{\pi}_t\right) + \alpha_y(s_t)\left(\Delta y_t - g_y\right)\right], \tag{33}$$

where i is the steady-state rate, $\rho_r \in (0,1)$, $\pi_{Z,t}$, $\bar{\pi}_t$, Δy_t, and g_y are defined in Section 2.2.

The coefficients vary by regime $s_t \in \{H, L\}$ (see Section 2.3):

$$\alpha_\pi(s_t) = \alpha_{\pi,c} + \alpha_{\pi,s} \cdot \sigma_{p^*_S,s_t}, \quad \alpha_y(s_t) = \alpha_{y,c} + \alpha_{y,s} \cdot \sigma_{p^*_S,s_t}, \tag{34}$$

with $\alpha_{\pi,c}$, $\alpha_{y,c}$, $\alpha_{\pi,s}$, $\alpha_{y,s}$, and $\sigma_{p^*_S,s_t}$ from (17).

The regime-dependent Taylor rule (33), (34) allows the SARB to strengthen the targeting of inflation in high-volatility regimes ($s_t = H$).

3 Model Parameterization

3.1 Calibration and Estimation Strategy

The model parameters are divided into two groups. A first subset, denoted θ_1, is calibrated based on standard values in the literature and relevant empirical targets. The remaining parameters, including those governing the central bank's Taylor rule, are estimated using Bayesian techniques over the sample period 2000:Q1 to 2019:Q2.

Table 1: Calibrated (Non-Estimated) Parameters

LaTeX Name	**Description**	**Value**
ψ_τ	Weight on tax rule vs expenditure rule	1
$\mathrm{prsF}_{\mathrm{ref}}$	Reference level for foreign commodity price	0
σ_L	Inverse Frisch elasticity	1
ϱ_{de}	Exchange rate weight in UIP equation	0
g_y	Steady-state GDP growth (quarterly)	0.0086
π_C	Steady-state inflation (quarterly)	0.0110
NX/Y	Net exports to GDP ratio	0.02
CC^q/Y	Risk-adjusted net foreign asset flow	-0.018
β	Household discount factor	0.999
α_C	Share of oil in core consumption bundle	0.015
γ_C	Share of home goods in core consumption	0.65
γ_I	Share of home goods in investment	0.5

(continued)

LaTeX Name	Description	Value
Y_s/Y	Share of commodity output in GDP	0.1
χ	Fiscal rule weight on commodity revenues	0.4
δ_I	Depreciation rate (quarterly)	0.0142
γ_H	Share of oil in production	0.01
η_H	Elasticity of substitution in production	0.66
ε_L	Labor supply elasticity parameter	11
ε_H	Elasticity of demand for home goods	11
ε_F	Elasticity of demand for foreign goods	11
ρ_{shm}	Persistence of monetary policy shock	0
ρ_{proF}	Persistence of oil price shock	0.97
n	Population growth rate (quarterly)	0.0037
λ	Share of Non-Ricardian Households	0.5
G^h/Y	Government spending to GDP ratio	0.12
g_{yF}	Foreign output growth (quarterly)	0.0049
π_F	Foreign inflation (quarterly)	0.0049
r	Steady-state real interest rate (quarterly)	0.0103
i_F	Foreign nominal interest rate (quarterly)	0.0123
σ_C	Intertemporal elasticity of substitution (consumption)	1
θ_H	CES parameter in production	1
n_{prsF}	AR order for foreign commodity price process	40
σ_I	Scaling parameter in investment efficiency	100000
premio_s	Risk premium spread (steady state)	0
Pr^h	Relative price of home goods	1
Pr^f	Relative price of foreign goods	1
W^r	Real wage (steady state)	1
Pr^i	Investment price index	1
BalG/Y	Steady-state government balance-to-GDP ratio	0.01

(continued)

LaTeX Name	Description	Value
Tau/Y	Steady-state tax revenue-to-GDP ratio	0.092
σ_{proF}	Std. dev. of oil price shock	12

3.2 Data

The model is estimated using South African quarterly data from 2000Q1 to 2019Q2. There are 12 observables. The exchange rate depreciation, a trade-weighted, country-specific, export commodity price index expressed in dollars compiled by the IMF, the REER is from the Bank for international statement. The CPI, the GDP, the consumption, the real wage, the government expenditure, the investment series are from the IFS. The commodity price index is from the International Monetary Fund (IMF). The nominal interest rate, proxied by the South African treasury bill rate, and the current account as a percentage of GDP are from the FRED database, together with foreign variables, viz., foreign inflation, foreign output and foreign interest rate, where the data for the foreign country is sourced for the US economy. All the series, but the commodity-based price index, are demeaned using their sample averages. The commodity-based price index is detrended using the Hamilton filter. All the series match their respective model variables.

3.3 Prior Assumptions

The prior distributions reflect both theoretical priors and calibration practices from related small open economy models. Parameters governing behavioral elasticities, such as substitution between oil and other goods in consumption and production (ω_C, ω_H), labor supply (σ_L), habit formation (h), and investment frictions (θ_I, S_I), are assigned beta or gamma distributions with support consistent with previous estimates in the literature.

Price and wage rigidities are encoded through Calvo probabilities (ϕ_L, ϕ_F, ϕ_{Hd}, ϕ_{Hf}) and indexation parameters (ξ_L, ξ_F, ξ_{Hd}, ξ_{Hf}), with priors reflecting moderate to high nominal rigidity and partial indexation. For example, ϕ_L and ϕ_F follow beta distributions centered around 0.5, implying expected average durations of price or wage contracts near two quarters.

The prior for the central bank's Taylor rule response to inflation ($\alpha_{\pi,c}$) is centered around 1.0, consistent with a standard inflation-targeting framework, while the output response ($\alpha_{y,c}$) has a tighter prior near zero, consistent with a less aggressive response to output fluctuations. Shock processes are modeled as AR(1), with priors on autoregressive coefficients (ρ) centered around 0.5–0.6, and standard deviations (σ) following inverse gamma distributions. Transition probabilities governing volatility regime switching are also tightly bounded and governed by beta priors.

A full summary of the prior distributions and resulting posterior estimates is provided in Table 2.

3.4 Bayesian Estimation Procedure

Posterior inference is conducted using an Adaptive Paralell Tempering algorithm. The posterior mode and covariance matrix are obtained using the Bees Algorithm of Karaboga and Basturk (2007), and the scale factor is tuned to achieve an acceptance rate near 25 percent. Two independent chains are run, each producing one million draws. The first 200,000 draws in each chain are discarded as burn-in, and every 25th draw is retained. Convergence diagnostics confirm satisfactory mixing of the chains.

Table 2: Estimated Parameters with Descriptions, Priors, and Posteriors

		Prior			Posterior		
LaTeX Name	**Description**	Distrib	5%	95%	Mode	5%	95%
ω_C	Oil subst. in cons.	$\mathcal{B}$	0.100	0.500	0.313	0.043	0.538
ω_H	Oil subst. in prod.	$\mathcal{B}$	0.100	0.500	0.184	0.034	0.445
σ_L	Inv. Frisch elast.	$\mathcal{G}$	0.600	1.300	0.932	0.916	0.961
h	Habit formation	$\mathcal{B}$	0.100	0.800	0.312	0.285	0.471
ϕ_L	Calvo prob. (wages)	$\mathcal{B}$	0.400	0.900	0.723	0.494	0.712
ϕ_F	Calvo prob. (imports)	$\mathcal{B}$	0.400	0.800	0.988	0.969	0.989
ϕ_{Hd}	Calvo prob. (dom. prices)	$\mathcal{B}$	0.200	0.800	0.843	0.794	0.899
ϕ_{Hf}	Calvo prob. (exports)	$\mathcal{G}$	0.500	0.900	0.353	0.210	0.966
ξ_{Hd}	Indexation (dom. prices)	$\mathcal{B}$	0.100	0.500	0.184	0.057	0.259
ξ_{Hf}	Indexation (exports)	$\mathcal{B}$	0.100	0.500	0.155	0.080	0.561
ξ_L	Indexation (wages)	$\mathcal{B}$	0.300	0.700	0.348	0.166	0.422
ξ_F	Indexation (imports)	$\mathcal{B}$	0.100	0.500	0.299	0.077	0.411
η_C	Subst. in cons. bundle	$\mathcal{G}$	0.200	1.000	3.414	1.236	3.387
η_F	Foreign demand elast.	$\mathcal{G}$	0.200	1.000	3.423	0.054	3.827
θ_I	Inv. demand elast. (price)	$\mathcal{G}$	0.200	1.000	0.933	0.755	3.938
S_I	Inv. adj. cost/inertia	$\mathcal{G}$	0.200	1.000	2.258	2.302	5.562
ρ_r	Taylor rule smoothing	$\mathcal{B}$	0.300	0.800	0.952	0.923	0.963
$\alpha_{\pi,c}$	Infl. resp. (commit.)	$\mathcal{G}$	0.900	2.000	1.744	1.692	2.404
$\alpha_{\pi,s}$	Vol. scaling (infl.)	$\mathcal{N}$	-1.000	1.000	0.396	0.056	0.500
$\alpha_{y,c}$	Output resp. (commit.)	$\mathcal{G}$	0.100	0.500	1.607	0.388	1.792
$\alpha_{y,s}$	Vol. scaling (output)	$\mathcal{N}$	-1.000	1.000	-0.145	-0.233	0.770
ϱ	Risk prem. elast. (bonds)	$\mathcal{B}$	0.000	0.200	0.000	0.000	0.000
ρ_{ah}	AR(1) TFP shock	$\mathcal{B}$	0.300	0.800	0.992	0.855	0.995
ρ_{ys}	AR(1) comm. prod. shock	$\mathcal{B}$	0.300	0.800	0.753	0.766	0.996
ρ_{yF}	AR(1) foreign output	$\mathcal{B}$	0.300	0.800	0.484	0.338	0.928
ρ_{iF}	AR(1) foreign rate	$\mathcal{B}$	0.300	0.800	0.939	0.902	0.953

(continued)

			Prior		Posterior		
LaTeX Name	**Description**	Distrib	5%	95%	Mode	5%	95%
ρ_{piF}	AR(1) foreign infl.	$\mathcal{B}$	0.300	0.800	0.367	0.241	0.580
ρ_{sh_w}	AR(1) labor supply	$\mathcal{B}$	0.300	0.800	0.150	0.102	0.655
ρ_{sh_c}	AR(1) preference	$\mathcal{B}$	0.300	0.800	0.910	0.287	0.942
ρ_{gex}	AR(1) gov. spending	$\mathcal{B}$	0.300	0.800	0.601	0.405	0.637
ρ_{sh_i}	AR(1) inv. adj. cost	$\mathcal{B}$	0.300	0.800	0.920	0.736	0.916
ρ_{prfF}	AR(1) import prices	$\mathcal{B}$	0.300	0.800	0.944	0.889	0.953
ρ_T	AR(1) perm. TFP	$\mathcal{B}$	0.300	0.800	0.809	0.761	0.991
ρ_{prsF}	AR(1) comm. price (F)	$\mathcal{B}$	0.300	0.800	0.879	0.588	0.838
σ_{ah}	Std dev TFP shock	$\mathcal{IG}$	0.005	0.990	0.064	0.050	0.273
σ_{ys}	Std dev comm. prod.	$\mathcal{IG}$	0.005	0.990	0.543	0.443	0.870
σ_{yF}	Std dev foreign GDP	$\mathcal{IG}$	0.005	0.990	0.004	0.003	0.007
σ_{iF}	Std dev foreign rate	$\mathcal{IG}$	0.005	0.990	0.001	0.001	0.001
σ_{piF}	Std dev foreign infl.	$\mathcal{IG}$	0.005	0.990	0.005	0.005	0.006
σ_{sh_m}	Std dev mon. policy	$\mathcal{IG}$	0.005	0.990	0.001	0.001	0.002
σ_{sh_w}	Std dev labor supply	$\mathcal{IG}$	0.005	0.990	9.704	1.931	8.987
σ_{sh_c}	Std dev preference	$\mathcal{IG}$	0.005	0.990	0.509	0.008	0.595
σ_{gex}	Std dev gov. spend.	$\mathcal{IG}$	0.005	0.990	0.007	0.007	0.008
σ_{sh_i}	Std dev inv. cost	$\mathcal{IG}$	0.005	0.990	0.040	0.048	0.080
σ_{prfF}	Std dev For comm.	$\mathcal{IG}$	0.005	0.990	9.632	8.264	11.415
σ_{st}	Std dev perm. TFP	$\mathcal{IG}$	0.005	0.990	0.003	0.002	0.004
$\sigma_{prsF}(S_t^{Vol} = Low)$	Std dev comm. price (low)	$\mathcal{IG}$	0.005	0.990	0.055	0.037	0.066
$\sigma_{prsF}(S_t^{Vol} = High)$	Std dev comm. price (high)	$\mathcal{IG}$	0.005	1.200	0.203	0.095	0.211
$Vol_{TP}(Low, High)$	Prob. Low $\rightarrow$ High vol.	$\mathcal{B}$	0.050	0.300	0.123	0.045	0.169
$Vol_{TP}(High, Low)$	Prob. High $\rightarrow$ Low vol.	$\mathcal{B}$	0.050	0.500	0.300	0.093	0.416

4 Estimation Results

4.1 Posterior Estimates

The posterior results largely validate the priors while sharpening key policy-relevant features of the model. The central bank's reaction function plays a central role in the analysis. The posterior for the inflation response under commitment ($\alpha_{\pi,c} = 1.74$) suggests a highly proactive stance, well above the standard Taylor rule benchmark, and far above the discretionary regime counterpart ($\alpha_{\pi,s} = 0.40$), which reflects a much weaker inflation response when commitment breaks down. Similarly, the output growth response under commitment ($\alpha_{y,c} = 1.61$) indicates a relatively aggressive countercyclical posture, while the discretionary regime also shows a positive response ($\alpha_{y,s} = -0.15$), albeit with more moderate intensity.

The posterior of the interest rate smoothing parameter ($\rho_r = 0.95$) reveals a strong tendency for gradualism in policy adjustment, reinforcing the potential tension between responsiveness and smoothness in the monetary rule. This interacts directly with our counterfactual findings: excessive smoothing, even under optimized rules, can mute desirable policy actions.

Nominal rigidities are well identified in the price-setting block and wage-setting block. The Calvo parameter for imported goods ($\phi_F = 0.98$) indicates near-complete price stickiness, while domestic prices ($\phi_{Hd} = 0.84$) and wages ($\phi_L = 0.72$) show substantial rigidity. However, foreign demand prices ($\phi_{Hf} = 0.35$) are characterized by some moderate stickiness. Indexation varies: $\xi_{Hf} = 0.16$, $\xi_F = 0.30$, and $\xi_L = 0.35$, pointing to partial backward-looking behavior in price and wage formation. This mix of nominal rigidity and sluggish adjustment has direct implications for the transmission and persistence of shocks, especially under external volatility.

Shock processes appear highly persistent, with most ρ parameters estimated between 0.55 and 0.95, including ρ_{ah}, ρ_{ys}, and ρ_{shi}, underscoring the long-lasting nature of both domestic and external disturbances. Variance switching across volatility regimes is evident: the standard deviation of the foreign commodity price shock rises from 0.06 in the low-volatility state to 0.20 in the high-volatility regime. The transition probabilities confirm persistence in each regime ($Vol_{TP}(Low, High) = 0.12$, $Vol_{TP}(High, Low) = 0.30$).

Other structural parameters confirm expected features. The elasticity of substitution in consumption ($\eta_C = 3.41$) and investment ($\theta_I = 0.93$) are estimated at plausible values, while habit formation ($h = 0.31$) displays non negligible persistence.

Overall, the posterior estimates support the view that SARB operates in a rigid, shock-prone environment where policy design—particularly the inflation target and associated response coefficients—matters substantially for macroeconomic outcomes.

4.2 State probabilities

Figure 1 displays the smoothed probability of being in the high-volatility commodity price regime over the period 2000:Q1 to 2019:Q2. The probability spikes sharply during well-known episodes of global commodity market turmoil, most notably during the 2008–2009 global financial crisis and again around 2011–2012, coinciding with heightened uncertainty in international markets and elevated price swings. A more moderate spike is observed in 2016, aligning with renewed commodity price instability. These regime shifts appear to correlate closely with fluctuations in observed macroeconomic variables. For example, during high-volatility periods, the current account (top-left panel in Figure 7) tends to deteriorate, reflecting the adverse terms-of-trade impact. Domestic inflation and the real exchange rate also become more volatile, with the latter exhibiting stronger depreciation pressure. While the central bank responds through interest rate adjustments (middle-left panel), the ability to stabilize output remains limited, especially in the face of global commodity price shocks. These dynamics underscore the importance of accounting for volatility regimes when evaluating macroeconomic resilience and the design of optimal policy.

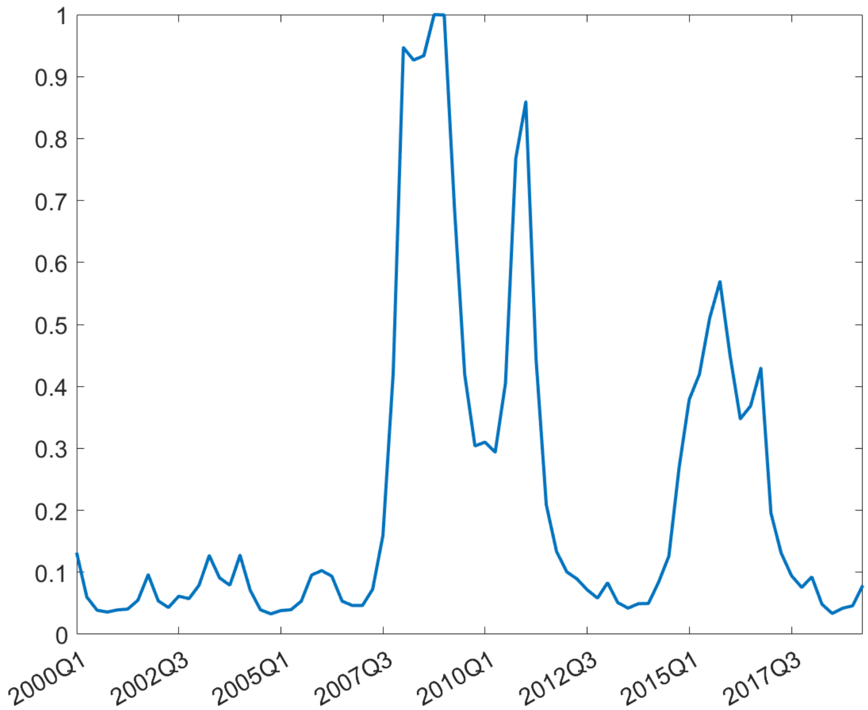

Figure 1: Smoothed Probability of the High-Volatility Commodity Price Regime

5 Optimization of the Inflation Target

5.1 Loss Function and Policy Preferences

In order to determine the optimal inflation target together with the optimal response of the central bank, we make use of optimized simple rule analogous to Schmitt-Grohe and Uribe (2007) for instance, whereby the central bank's loss function, similar to the ones used by Rogoff (1985), Walsh (1997) and Rudebusch and Svensson (1999), among others, is minimized by choosing the optimal parameters of the Taylor rule and the inflation target. Furthermore, the inflation target is quantified for varying weights (i.e., preferences) of the central bank on inflation, output and interest rate fluctuations.[5]

[5] In Appendix D on "Optimal Monetary Policy in a Simplified Small Open Economy", we analyze optimal policies under commitment and compare the results to a simple Taylor rule using a simplified DSGE model with commodity price shocks as in Drechsel et al. (2019). The appendix highlights how commodity price volatility affects π_t and $y_{h,t}$ and the interest rate response, providing theoretical insights that inform the SARB model's ad-hoc loss function (Section 5.1). In Appendix G, we provide the variance decomposition from the estimated model for some selected variables.

Hence, to evaluate the optimal inflation target, we begin by specifying the central bank's loss function. This quadratic objective penalizes deviations of inflation from its target, excessive fluctuations in output growth, and abrupt changes in the nominal interest rate. Formally, the loss is defined as:

$$L = (\Pi_t - \Pi_{\text{target}})^2 + \omega_y \cdot (\Delta G\hat{D}P_t)^2 + \omega_R \cdot (\Delta \hat{R}_t)^2,$$

where ω_y and ω_R represent the relative weights the SARB places on output growth and interest rate smoothing, respectively. The change in the interest rate is motivated by Rudebusch and Svensson (1999) for instance, to denote financial market stability. These preference parameters are not known a priori and are instead varied parametrically over empirically motivated ranges. Following the literature such as Adam and Billi (2006); Adolfson et al. (2011); Chen et al. (2017); Kirsanova and Le Roux (2018); Liu et al. (2020), we explore $\omega_y \in [0, 1.2]$ and $\omega_R \in [0, 0.8]$, using 10 equally spaced values in each dimension.

Although the RISE toolbox allows for solving optimal policy problems under full commitment or discretion by directly maximizing the welfare of the representative agent, we deliberately adopt a reduced-form loss function instead. Our choice is motivated by transparency, interpretability, and the need to expose the policy trade-offs faced by the SARB. A welfare-based approach—while internally consistent—would collapse these trade-offs into a single object (expected utility), potentially masking important tensions between inflation stabilization, output smoothing, and policy inertia. It would also require the policymaker's commitment regime to be specified up front, which may not reflect SARB's historical or institutional setting.

Moreover, a fully microfounded welfare criterion can yield optimal inflation targets that are difficult to interpret, sensitive to model details, and potentially implausible from a policy standpoint. These risks are amplified in our context due to agent heterogeneity: the model includes both Ricardian and hand-to-mouth households. Should one then maximize the utility of Ricardians, non-Ricardians, or a weighted average? What share should be used, and should it evolve over time? These choices, while conceptually important, introduce an additional layer of normative assumptions that are not central to our empirical goals. Instead, our focus is on quantifying the inflation target that minimizes SARB's trade-offs over plausible ranges of policy preferences, which can be evaluated transparently in the linear-quadratic framework.

5.2 Simulation-Based Optimization

Due to the presence of regime-switching and other nonlinear features, the loss function does not admit an analytical solution. We therefore resort to a simulation-based numerical optimization approach. Artificial shocks are generated and propagated through the model to simulate macroeconomic dynamics under a given inflation target and policy configuration. For each pair (ω_y, ω_R), we compute the loss associated with different values of Π_{target}, and identify the target that minimizes the average loss over the simulated horizon. This numerical minimization captures the optimal inflation target that balances competing policy goals under uncertainty.

5.3 Determinants of the Optimal Inflation Target

The inflation target in our model, which is also the steady-state (trend) inflation is similar in nature to Sims (2024) which analyses the effect of trend inflation in a simple New Keynesian DSGE model. It should be noted that Ascari and Sbordone (2014) analyze trend inflation in a generalized New Keynesian model to circumvent the usual assumption of monetary policy analysis around a zero inflation steady state.

The optimal inflation target in this work is shaped by the trade-offs the central bank faces between stabilizing inflation, supporting output growth, and smoothing interest rates. When more weight is placed on output stabilization (ω_y), the optimal inflation target tends to rise, reflecting the central bank's tolerance for higher inflation in exchange for more stable growth. In contrast, a greater emphasis on interest rate smoothing (ω_R) can dampen the incentive to increase the inflation target, as large interest rate adjustments would be penalized more heavily. These interactions underscore the importance of central bank preferences in determining the inflation target that minimizes expected economic distortions.

5.4 Optimal Target Surfaces and Policy Implications

To illustrate how the central bank's preferences shape the optimal inflation target and associated policy behavior, we present a set of surface plots in Figure 2. These plots map the dependence of the loss-minimizing inflation target Π_{target} and key policy coefficients on the weights assigned to output growth (ω_y) and interest rate smoothing (ω_R) in the central bank's loss function.

The top-left panel of the figure shows that the optimal inflation target increases systematically with ω_y: as the central bank places greater emphasis on output stabilization, it tolerates a higher inflation target. In contrast, variations in ω_R have a relatively muted effect, suggesting that interest rate smoothing concerns play a secondary role in determining the target level.

The remaining panels display how monetary policy coefficients adjust in response to shifts in preferences. Interest rate smoothing (ρ_R) rises with ω_R and declines with ω_y, reflecting a natural trade-off between responsiveness and inertia. The inflation response coefficients, $\alpha_{\pi,c}$ under commitment and $\alpha_{\pi,s}$ under discretion, both decline as ω_y increases. This decline is sharper for $\alpha_{\pi,c}$, while $\alpha_{\pi,s}$ exhibits how stronger commodity conditional inflation response is needed to offset inertia. Finally, the output growth coefficients $\alpha_{y,c}$ and $\alpha_{y,s}$ increase with ω_y, reinforcing the notion that central bank preferences are directly encoded into the aggressiveness of output stabilization as higher weight is placed on output stability, with stronger commodity-conditional output response becoming optimal.

Together, these surfaces reveal that optimizing the inflation target is not just about setting a single number, but about adjusting the entire policy stance to reflect trade-offs embedded in the loss function. They also underscore the multidimensionality of monetary design: a higher inflation target goes hand in hand with softer inflation responses, greater output stabilization, and a more nuanced approach to interest rate smoothing.

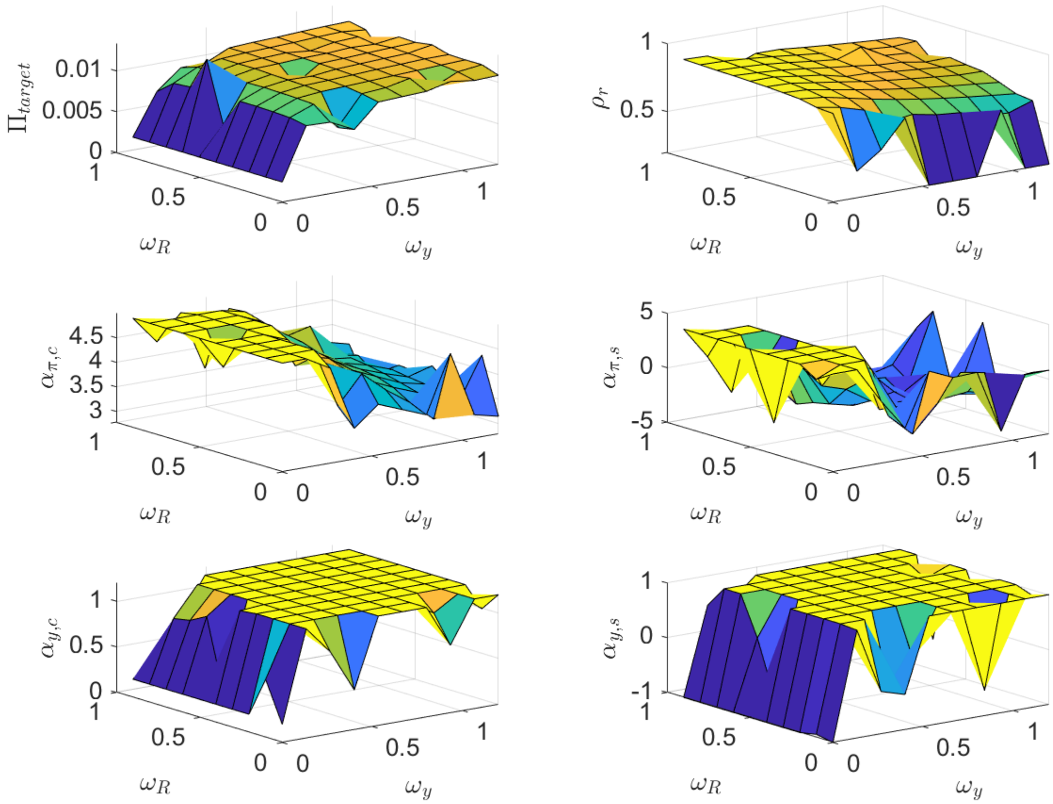

Figure 2: Effects of policy preference weights (ω_y, ω_R) on the optimal inflation target and selected monetary policy coefficients. Each surface shows how the optimal inflation target Π_{target}, interest rate smoothing ρ_R, inflation response coefficients $\alpha_{\pi,c}$ and $\alpha_{\pi,s}$, and output growth response coefficients $\alpha_{y,c}$ and $\alpha_{y,s}$ vary across the preference space.

5.5 Comparison of Impulse Responses under Optimized Rules

To evaluate the practical consequences of different monetary policy designs, we compare impulse response functions (IRFs) across three rule configurations: (i) the estimated policy rule (denoted **Estim**), (ii) an optimized rule focused solely on inflation control with $\omega_y = \omega_R = 0$, and (iii) a more balanced optimized rule with $\omega_y = 0.5$ and $\omega_R = 0.3$. These configurations allow us to assess how different weightings in the central bank's loss function influence macroeconomic stabilization following economic shocks.[6]

As our model features multiple regimes, we compute generalized IRFs rather than regime-

[6] We plot only selected variables for space and illustration.

specific ones[7] to ensure comparability across states. Figure 3 reports the responses to a foreign commodity price shock, while Figure 5 shows the effects of a domestic monetary policy shock.

A commodity price shock, in this model depicts a strong wealth effect due to the higher commodity prices that appreciate the real exchange rate. The higher wealth effect decreases labor supply and causes domestic output to fall, a Dutch disease scenario together with a trade balance deficit due to higher imports which is supported by a real exchange rate appreciation that makes imports cheaper. The strong currency appreciation causes deflation and monetary policy reacts by decreasing the policy rate. While a monetary policy rate hike produces the usual stylized facts in macro models of a contraction in the economy. The figures indicate that optimized rules consistently outperform the estimated rule, especially in terms of reducing inflation and output volatility.

Nonetheless, important asymmetries arise across shock types. Foreign shocks, such as those originating from commodity price fluctuations, prove significantly more difficult to stabilize, even under optimized policy. This highlights the limitations of domestic monetary autonomy in the face of global disturbances—a familiar constraint for small open economies. By contrast, domestic shocks are more effectively absorbed, with smoother interest rate paths and better-targeted inflation control under the optimized configurations.[8]

These findings underscore the value of recalibrating the central bank's policy rule. By aligning the rule more closely with an objective function that reflects current stabilization trade-offs, the SARB can improve macroeconomic outcomes—though some volatility, particularly from external sources, remains structurally unavoidable.

[7] In Appendix E, we provide regime specific IRFs together with the generalized IRFs with confidence bands.

[8] Moreover in Appendix F, we compare the benchmark model in the paper with the constant parameter DSGE model with a baseline scenario without regime switching and commodity (volatility) shocks to evaluate the incremental impact more clearly of the model features in this paper. The results show that the additional features to the baseline scenario. We furthermore provide regime specific IRFs together with the generalized IRFs with confidence bands.

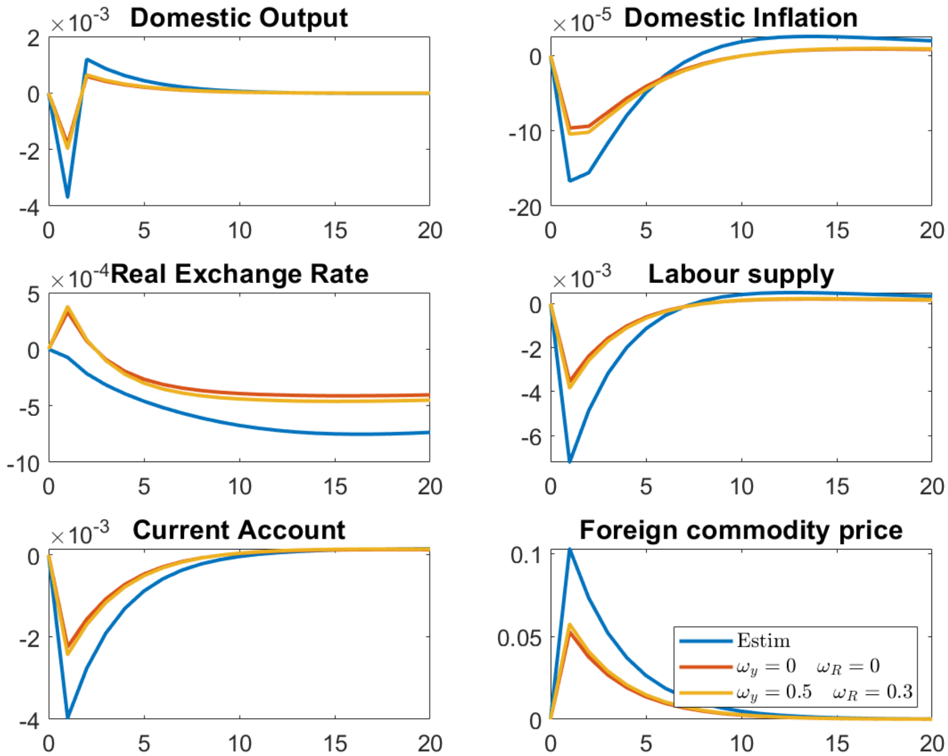

Figure 3: Generalized IRFs to a foreign commodity price shock under the estimated policy rule and two optimized rules ($\omega_y = \omega_R = 0$ and $\omega_y = 0.5, \omega_R = 0.3$).

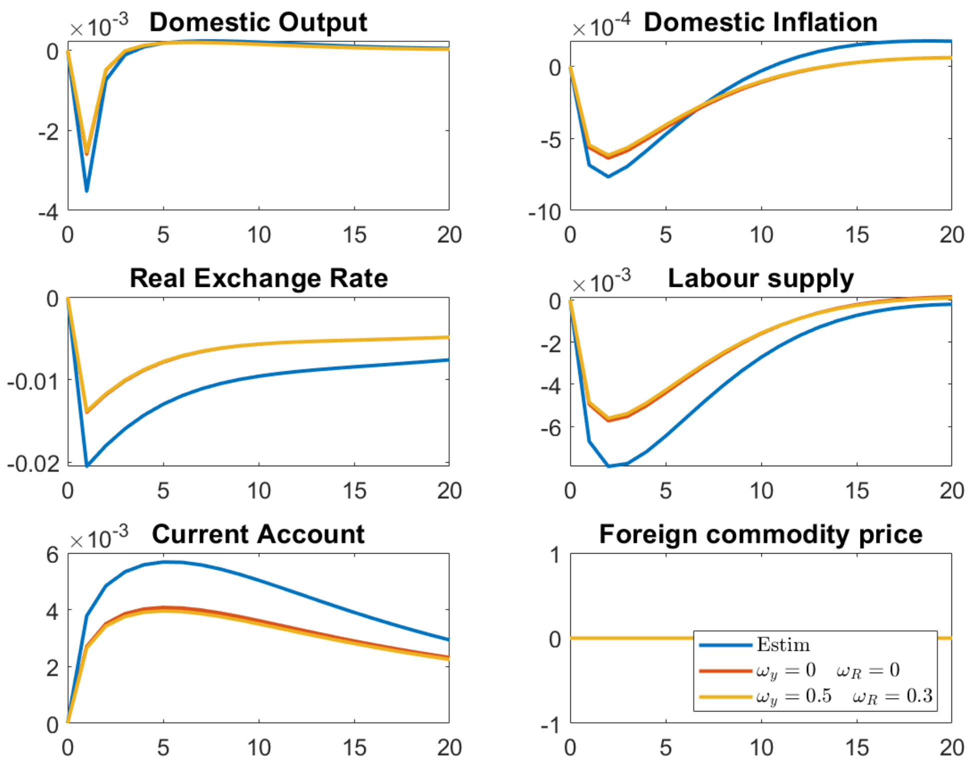

Figure 5: Generalized IRFs to a monetary policy shock under the estimated policy rule and two optimized rules ($\omega_y = \omega_R = 0$ and $\omega_y = 0.5, \omega_R = 0.3$).

6 Counterfactual Analysis

To assess the real-world implications of adopting an optimized inflation target, we conduct a counterfactual analysis comparing the historical trajectory of key macroeconomic variables with their simulated paths under alternative monetary policy rules. Specifically, we ask: how would the South African economy have evolved if the SARB had implemented the optimized inflation target derived from our loss minimization framework, rather than following the historical policy rule?

We consider two counterfactual scenarios that correspond to distinct preferences in the central bank's loss function. The first imposes strict inflation targeting with $\omega_y = \omega_R = 0$, while the second allows for a broader stabilization objective, assigning positive weights to output growth and interest rate smoothing ($\omega_y = 0.5, \omega_R = 0.3$). In both cases, we simulate the economy using historical shocks but replace the policy rule with the optimized version consistent with the specified weights. The goal is to isolate the effect of the alternative policy design while holding the economic environment constant.

Figure 6 presents the simulated outcomes under the strict inflation targeting rule. The results show a notable reduction in inflation volatility, as expected, but at the cost of greater fluctuations in output growth and sharper interest rate movements. The focus on inflation alone limits the central bank's ability to respond to real-side shocks, resulting in less macroeconomic balance.

In contrast, Figure 7 illustrates the outcomes under the more balanced rule. While inflation remains relatively well-behaved, the inclusion of interest rate smoothing ($\omega_R = 0.3$) significantly dampens policy responsiveness towards the later part of the sample. As a result, the central bank underreacts to shocks in some periods, allowing inflation or output to deviate from their desired paths for longer. These outcomes highlight the delicate trade-offs involved in policy design: while interest rate inertia can help avoid excessive volatility, too much smoothing may prevent timely interventions when needed.

Overall, the counterfactual analysis reveals that optimized policy rules can yield meaningful gains in inflation control, but these gains depend critically on how the central bank values competing objectives. Overemphasis on interest rate smoothing can undermine stabilization efforts, while singular focus on inflation can neglect output dynamics. A well-calibrated policy rule must therefore strike a balance—prioritizing inflation control while preserving the flexibility to adapt to evolving economic conditions.

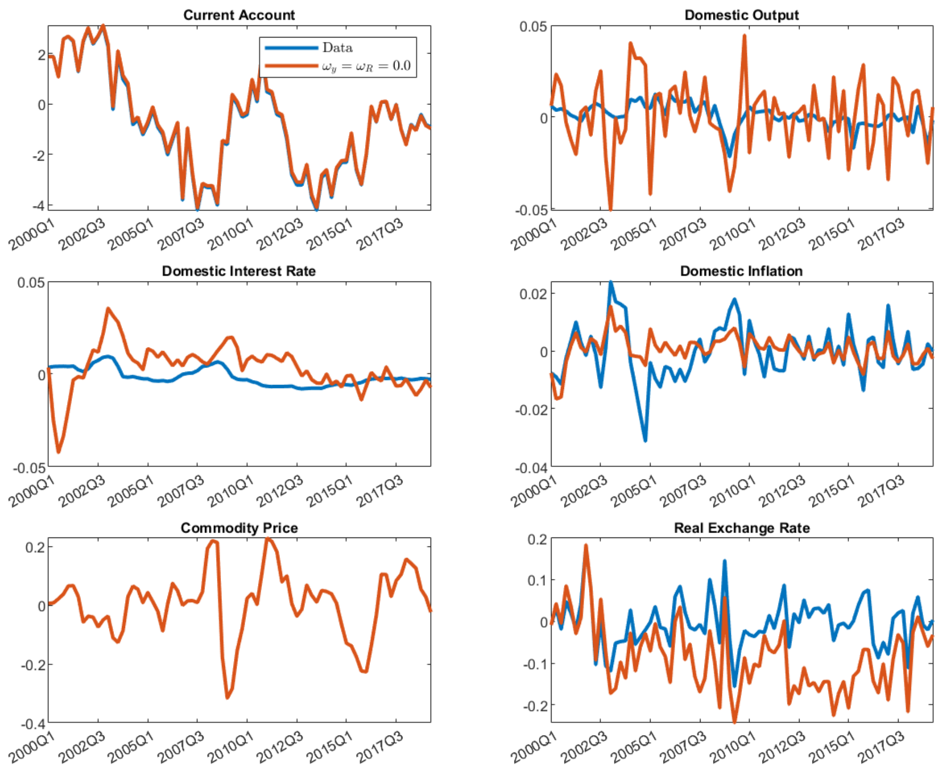

Figure 6: Counterfactual simulation under the optimized policy with strict inflation targeting ($\omega_y = \omega_R = 0$).

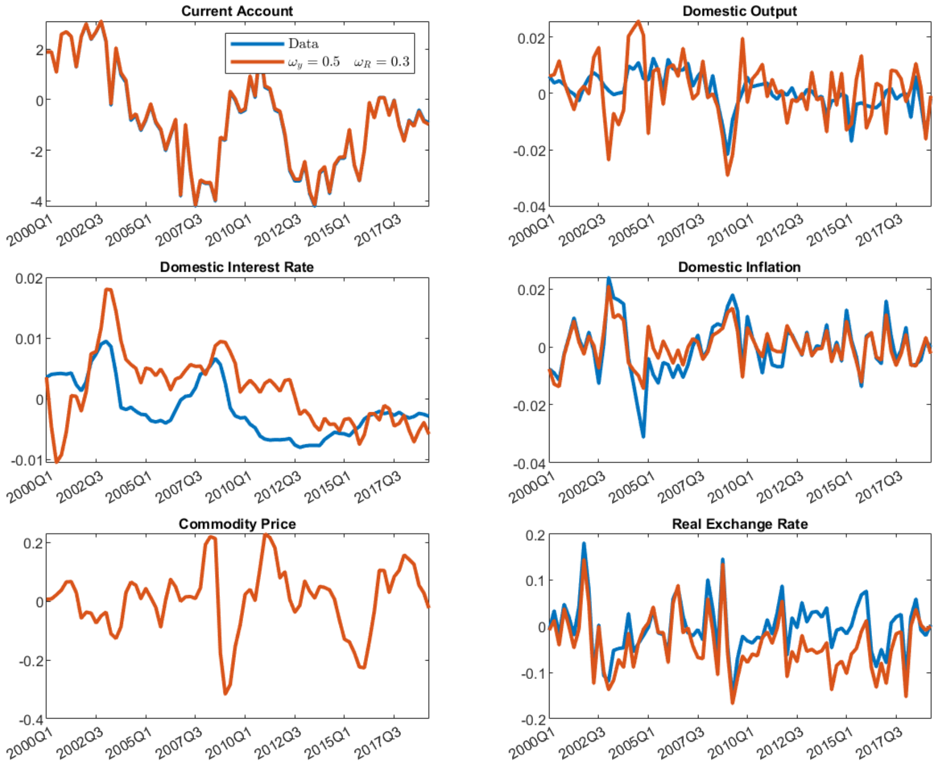

Figure 7: Counterfactual simulation under the optimized policy with balanced objectives ($\omega_y = 0.5, \omega_R = 0.3$).

7 Conclusion

This paper has investigated the optimal inflation target for South Africa within a regime-switching DSGE framework that captures the economy's exposure to external volatility, especially through commodity prices and global financial conditions. By embedding the central bank's preferences into a loss function—balancing inflation, output growth, and interest rate stability—we evaluated how alternative weights affect the optimal policy design.

Our results show that the optimal inflation target is not a fixed number but an outcome of deeper policy trade-offs. A stronger focus on output growth raises the inflation target, while stricter inflation control lowers it. However, these adjustments come with consequences: foreign shocks are harder to stabilize than domestic ones, and overly rigid preferences—such as excessive interest rate smoothing—can undermine stabilization, even under an otherwise optimized framework.

Counterfactual simulations confirm that adopting an optimized rule would have improved inflation control relative to historical policy. Yet they also highlight the limits of monetary policy in shielding the economy from external disturbances. These findings underscore the importance of flexible inflation targeting—one that allows the central bank to adapt its instance depending on the source and nature of shocks, rather than adhering to a single static target.

Ultimately, the pursuit of an optimal inflation target must be dependent on the goals of the central bank, recognizing that the best policy is one that evolves with the economy it aims to stabilize.

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