SA-TIED

Southern Africa – Towards Inclusive Economic Development

WORKING PAPER 240

Spillover effects of the recent US monetary policy shocks on the South African economy

The role of monetary and fiscal policy coordination

Guangling Liu and Marrium Mustapher*

November 2024

UNU WIDER
national treasury
Department: National Treasury
REPUBLIC OF SOUTH AFRICA
SARS
Co-funded by the European Union
British High Commission Pretoria

About the project

Southern Africa – Towards Inclusive Economic Development (SA-TIED)

SA-TIED is a unique collaboration between local and international research institutes and the government of South Africa. Its primary goal is to improve the interface between research and policy by producing cutting-edge research for inclusive growth and economic transformation in the southern African region. It is hoped that the SA-TIED programme will lead to greater institutional and individual capacities, improve database management and data analysis, and provide research outputs that assist in the formulation of evidence-based economic policy.

The collaboration is between the United Nations University World Institute for Development Economics Research (UNU-WIDER), the National Treasury of South Africa, the South African Revenue Services, and other universities and institutes. It is funded by the National Treasury of South Africa, the Delegation of the European Union to South Africa and UNU-WIDER through the Institute's contributions from Finland, Sweden, and the United Kingdom to its research programme.

[1] Department of Economics, Stellenbosch University, Stellenbosch, South Africa; corresponding author: gliu@sun.ac.za

WIDER Working Paper 2024/68

Spillover effects of the recent US monetary policy shocks on the South African economy

The role of monetary and fiscal policy coordination

Guangling Liu and Marrium Mustapher*

November 2024

United Nations University World Institute for Development Economics Research

wider.unu.edu

Abstract: This study examines how different policy mix regimes affect the impact of recent US contractionary monetary policy on South Africa's inflation and business cycles. The study uses a small open economy New Keynesian Dynamic Stochastic General Equilibrium model with an integrated fiscal block to analyse these effects. Regime M (active monetary policy) is more effective at containing the spillover effects but leads to higher public debt, requiring larger future fiscal surpluses. The commitment to price stability under Regime M increases real interest rates, raising domestic debt service costs and the debt-to-GDP ratio. Regime F (active fiscal policy), in contrast, stabilizes debt more quickly but at the cost of higher inflation, as it does not use future surpluses to manage public debt. These spillover effects are more amplified under both Regime M and Regime F in the case of a complete exchange rate pass-through and a higher degree of trade openness, with Regime F exhibiting a stronger amplification effect.

Key words: foreign monetary policy, monetary and fiscal policy coordination, New Keynesian Dynamic Stochastic General Equilibrium, policy spillovers, small open economy

JEL classification: E3, E5, E6, E12

Acknowledgements: We are grateful to UNU-WIDER for supporting this project.

* Department of Economics, Stellenbosch University, Stellenbosch, South Africa; corresponding author: gliu@sun.ac.za

This study has been prepared within the UNU-WIDER project Southern Africa—Towards Inclusive Economic Development (SA-TIED).

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9267-531-8

https://doi.org/10.35188/UNU-WIDER/2024/531-8

Typescript prepared by Gary Smith.

United Nations University World Institute for Development Economics Research provides economic analysis and policy advice with the aim of promoting sustainable and equitable development. The Institute began operations in 1985 in Helsinki, Finland, as the first research and training centre of the United Nations University. Today it is a unique blend of think tank, research institute, and UN agency—providing a range of services from policy advice to governments as well as freely available original research.

The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland and Sweden, as well as earmarked contributions for specific projects from a variety of donors.

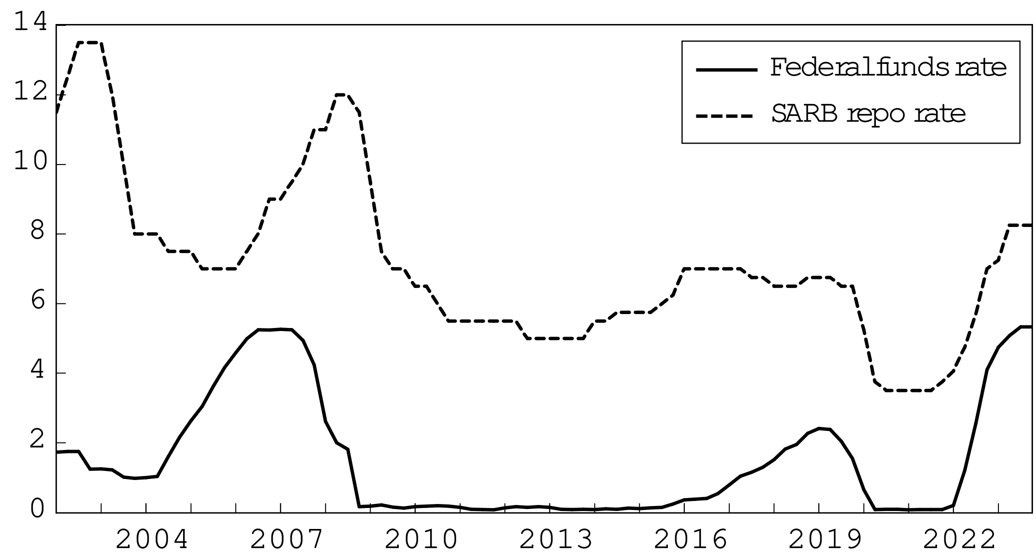
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

The present study aims to investigate the role of monetary and fiscal policy coordination in the spillover effects of the recent unprecedented US contractionary monetary policy shocks on South Africa's business cycle fluctuations, focusing on inflation and other key macroeconomic variables. In today's macroeconomic landscape, coordinating monetary and fiscal policy has become increasingly important as policy-makers align their policies to address economic crises. For instance, the 2007–08 global financial crisis (GFC) and the Covid-19 pandemic (the pandemic) prompted policy-makers to implement aggressive expansionary fiscal and monetary policy measures. These joint expansionary policy measures led to an unprecedented increase in public debt and a global surge in inflation, prompting a shift to contractionary fiscal and monetary policy.

The aggressive contractionary monetary policy implemented by central banks worldwide in the post-pandemic period resulted in a global co-movement in policy rates. For instance, in 2022, the Federal Reserve (Fed) began hiking the federal funds rate (FFR) to counter the increases in inflation. The FFR increased from nearly zero in 2020 to a peak of 5.33 per cent in 2023. Other economies (both advanced and developing) adopted a similar policy measure. The South African Reserve Bank (SARB) also raised its repo rate from 3.5 per cent in 2020 to a peak of 8.25 per cent in 2023, mirroring the actions of the Fed (Figure 1). This co-movement in the policy rates between the United States and South Africa can also be observed during the pre-pandemic period. The FFR and the repo rate show similar patterns during the GFC (2007–08) and the zero lower bound period in the United States (2010–15).

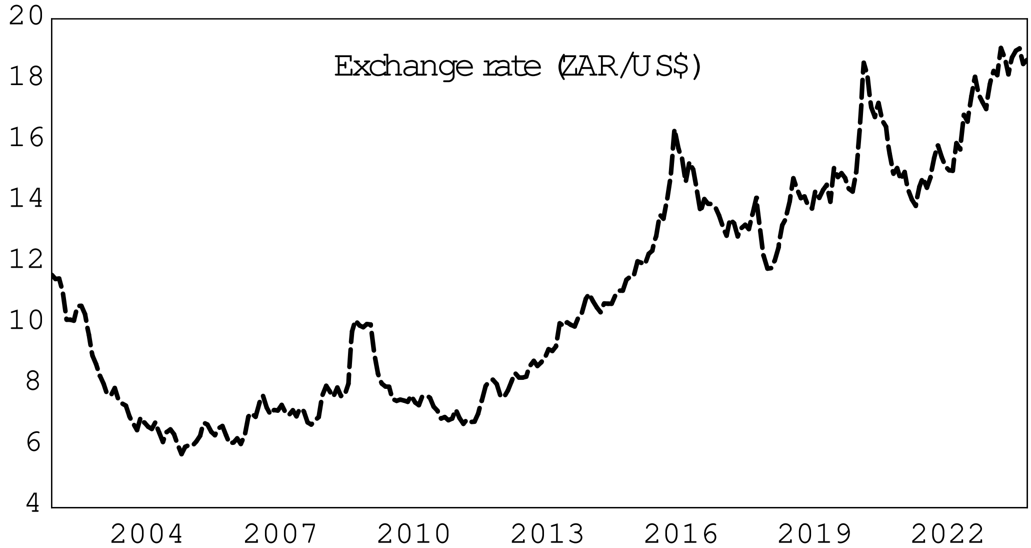
Figure 1: Federal funds rate and SARB repo rate (%)



Source: authors' illustration based on data from Federal Reserve Bank of St. Louis (FRED) and SARB databases (2024).

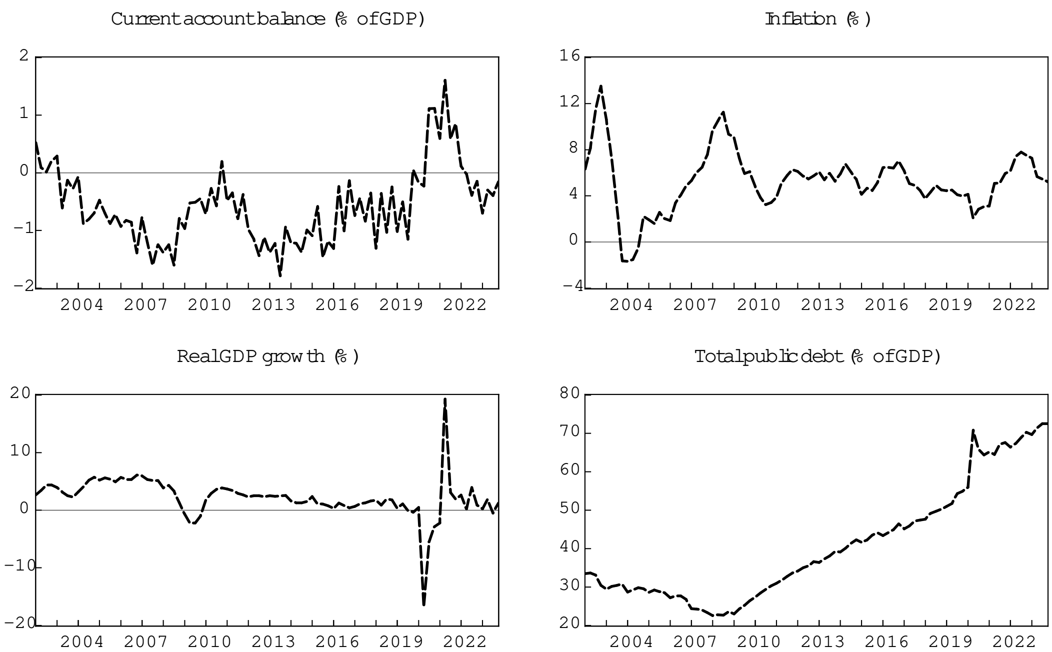
At the same time, the South African rand has depreciated against the US dollar significantly since the GFC (Figure 2). The recent simultaneous increase in the policy rate and the persistent depreciation of the domestic currency promote a re-investigation of the spillover effects of US monetary policy shocks on the South African economy. The current adverse macroeconomic conditions—characterized by weak economic growth, weak external current account, high public debt, and high inflation in most economies, including South Africa (Figure 3)—also motivate the present study.

Figure 2: Exchange rate (ZAR/US$)



Source: authors' illustration based on SARB database (2024).

Figure 3: Inflation, public debt, real GDP, and current account balance (%)



Source: authors' illustration based on SARB database (2024).

There is an extensive literature on spillover effects of US monetary policy shocks on other economies.[1] However, these studies predominantly focus on the spillover effects of US monetary policy shock on other advanced economies or emerging market economies (EMEs). Moreover, most of these studies adopt econometric models. Arbatli-Saxegaard et al. (2024) adopted structural VAR to examine the spillover effects of US contractionary monetary policy shocks on the real economy. The authors find that the shock reduces output growth and inflation in both advanced economies and EMEs, as the financial and demand channels offset the exchange rate channel, which supports economic activity through the

[1] These studies include but are not limited to: Chen et al. (2014), Anaya et al. (2017), Tillmann (2016), Tillmann et al. (2019), Mishra et al. (2018), Miranda-Agrippino and Rey (2020), Lastauskas and Nguyen (2024), and Arbatli-Saxegaard et al. (2024).

depreciation of the exchange rate. Some studies find that the US monetary policy shocks spill over to other economies through various transmission channels, such as financial markets, international trade, and policy reaction by domestic central banks (see, e.g., Chen et al. 2016; Neely 2015; Tillmann et al. 2019). Other studies find that the most important channel of US policy spillovers is the financial markets channel, which includes capital flows, exchange rates, and asset prices, such as sovereign bond yields and equity prices (see, e.g., Anaya et al. 2017; Chen et al. 2014; Miranda-Agrippino and Rey 2020; Rohit and Dash 2019; Tillmann 2016). Thus, a US contractionary monetary policy results in a decline in the prices of global financial assets denominated in US dollars, triggering capital outflows from EMEs and small open economies (SOEs), and causing their currencies to depreciate against the US dollar (Miranda-Agrippino and Rey 2020). In South Africa, this depreciation is more pronounced and volatile during and after the pandemic (Figure 2), a period marked by stronger and more prolonged US monetary policy tightening compared to the past. This is mainly reflected by the scale and speed of policy interventions during the economic crisis. This observation underscores the relevance of the present study, which focuses on the spillover effects of the recent US contractionary monetary policy in response to the post-pandemic persistently high inflation. The role of monetary and fiscal policy coordination on the spillover effects of foreign monetary policy shocks is yet to be thoroughly explored.[2]

The present study builds on the existing literature on the spillover effects of the US monetary policy shocks by considering the role of policy mix regimes, namely Regime M and Regime F (Leeper and Leith 2016). Under Regime M (active monetary policy and passive fiscal policy), monetary policy is responsible for price stability, whereas fiscal policy is responsible for debt stability. In contrast, under Regime F (passive monetary policy and active fiscal policy), monetary policy stabilizes public debt through inflation, thus fiscal policy ultimately controls inflation. This is also referred to as the fiscal theory of price level (FTLP) (see, e.g., Cochrane 2011, 2023; Leeper 1991; Leeper and Leith 2016; Sims 1994). There is extensive literature on monetary and fiscal policy coordination, focusing on the two policy mix regimes.[3] Thus, the growing need for coordination between monetary and fiscal policy motivates this study, which examines the role of such coordination in the spillover effects of foreign monetary policy shocks.

The literature on spillover effects of US monetary policy shocks in the context of South Africa is limited, and the results are inconclusive. Kabundi et al. (2020) analyse the spillover effects of US expansionary monetary policy on the South African economy during the pre- and post-GFC periods. Using a Bayesian VAR model, the authors find that a US expansionary monetary policy shock decreases South Africa's long-term rates. This, in turn, raises asset prices, attracts capital inflows, and causes the South African rand to appreciate against the US dollar. The domestic currency appreciation reduces domestic inflation, prompting monetary policy easing in South Africa during both periods. However, on the spillover effects to the real economy, industrial production increases in the pre-GFC period, while it declines in the post-GFC period. Anaya et al. (2017) use structural global VAR to investigate the impact of US unconventional monetary policy on a group of EMEs, which includes South Africa. The study also finds that a US expansionary monetary policy shock increases portfolio inflows to EMEs, leading to the appreciation of exchange rate, a decrease in short-term interest rates, an increase in asset prices, and an increase in real GDP growth. These studies on the South African economy focus on the spillover effects of US expansionary monetary policy before or during the GFC, while the spillover effects of the recent US contractionary monetary policy have yet to be examined.

---

[2] Jia et al. (2015) and Wang et al. (2022) examine the stabilization role of monetary and fiscal policy mix regimes on macroeconomic fluctuations in response to various macroeconomic shocks, with a focus on China. While both studies analyse various domestic and foreign shocks, including a foreign monetary policy shock, they do not specifically focus on the spillover effects of foreign monetary policy shocks.

[3] A non-exhaustive list of studies includes: Leeper (1991), Sims (1994), Leeper and Yun (2006), Davig and Leeper (2011), Bianchi (2012), Leeper and Leith (2016), Bianchi and Ilut (2017), Bianchi and Melosi (2019), and Chen et al. (2022).

The present study contributes to the literature on spillover effects in several ways. First, this study is the first to examine the influence of monetary and fiscal policy mix regimes on the spillover effects of foreign monetary policy shocks on the South African economy. Second, from the model perspective, the study adopts a Small Open Economy New-Keynesian Dynamic Stochastic General Equilibrium (SOE-NK-DSGE) model with monetary and fiscal policy coordination. This is the first study in the literature on the spillover effects of foreign policy shocks adopting a NK-DSGE model with monetary and fiscal policy coordination. Most existing studies on the spillover effects predominantly employ distinct forms of VAR models in the analysis, such as global VAR, structural VAR, and Bayesian VAR.[4] Third, the present study evaluates the spillover effects of the recent unprecedented US contractionary monetary policy shocks. Thus, this study contributes new evidence to the literature, as existing studies largely focus on the spillover effects of US expansionary monetary policy shocks occurring before or during the GFC. Furthermore, most existing studies focus on other advanced economies or large EMEs, whereas specific studies in the context of SOEs such as South Africa are limited. Lastly, this study is the first to consider the role of the degree of exchange rate pass-through on the spillover effects of US monetary policy shocks on the South African economy with monetary and fiscal policy coordination.

The present study develops an SOE-NK-DSGE model based on Gali and Monacelli (2005). The model is extended to include a fiscal block, taking into account monetary and fiscal policy coordination, which is missing in the existing SOE-NK-DSGE literature (see, e.g., Chang et al. 2015; Clarida et al. 2001, 2002; Gali and Monacelli 2005; Lubik and Schorfheide 2007). Additionally, the model incorporates incomplete exchange rate pass-through by introducing nominal rigidity in domestic importing firms (see, e.g., Adolfson et al. 2007; Lindé et al. 2009; Monacelli 2005; Smets and Wouters 2002), a key feature for analysing the role of the degree of exchange rate pass-through on the spillover effects of foreign monetary policy shocks. The model nests the complete exchange rate pass-through. Furthermore, the model includes imperfect international financial markets through a debt-elastic country risk premium, as in Schmitt-Grohé and Uribe (2003) and Uribe and Schmitt-Grohé (2017), to induce stationarity in the model.

The results show that a US contractionary monetary policy shock has stronger spillover effects under Regime F than under Regime M, except for domestic interest rates and primary surpluses. Under Regime F, an increase in US interest rates leads to a sharper depreciation of the South African rand, leading to a more pronounced transitory increase in inflation, as the monetary authority does not commit to stabilizing inflation. Consequently, interest rates increase moderately, resulting in a relatively smaller increase in domestic debt service costs. In contrast, under Regime M, the transitory increase in inflation is moderate, as the monetary authority commits to price stability. Thus, interest rates increase more strongly, leading to a more significant increase in domestic debt service costs. The public debt-to-GDP ratio increases and remains persistently high under Regime M, necessitating an increase in future primary surpluses, as the fiscal authority commits to debt stabilization.

For both Regime M and Regime F, these spillover effects are amplified with complete exchange rate pass-through compared to incomplete pass-through. This is because complete exchange rate pass-through to import prices amplifies the domestic economy's trade competitiveness via the expenditure-switching effect. Moreover, with imperfect international financial markets, complete pass-through amplifies the spillover effects via the negative net worth effect on households' foreign debt holdings. The sensitivity analysis on the degree of trade openness supports these findings. Additionally, higher trade openness amplifies the spillover effects of foreign monetary policy shocks under both Regime M and Regime F, with Regime F showing a more pronounced amplification effect at all levels of trade openness compared to Regime M.

[4] A study by Alpanda and Kabaca (2020) uses a medium-scale two-country NK-DSGE model to analyse the effects of US large-scale asset purchases on other advanced economies and EMEs. The role of monetary and fiscal policy coordination was not incorporated.

These findings indicate that when SOEs encounter foreign monetary policy shocks, Regime M is more effective at containing spillover effects, except for public debt and private consumption. Thus, inflation is well contained but domestic public debt is maintained at a high level, necessitating higher future primary surpluses for debt stabilization. However, given the current limited fiscal space in South Africa, the fiscal authority is constrained to increase primary surpluses proportionally with the increase in public debt. Conversely, Regime F better stabilizes public debt but at the cost of high inflation. Although this high inflation cost is transitory, the current persistently high inflation makes this policy option infeasible. These findings are exclusively observed based on foreign monetary policy shocks, which may overlook crucial domestic factors that also impact the dynamics of inflation, public debt, and other main macroeconomic variables. It is, therefore, important to interpret the results with caution, especially when considering their policy implications.

The subsequent sections of the paper are as follows. Section 2 outlines the model. Section 3 provides parameter values of the model. Section 4 discusses the main results, Section 5 conducts sensitivity analysis, and Section 6 concludes.

2 The model

The present study develops an SOE-NK-DSGE model that features a domestic economy representing the South African economy and a foreign economy representing the US economy. The domestic economy shares the basic features of the benchmark SOE-NK-DSGE models: complete pass-through of exchange rate movements following Clarida et al. (2002) and Gali and Monacelli (2005), nominal rigidity in price setting in the form of Rotemberg (1982) type, quadratic adjustment costs as in Lindé et al. (2009), and real rigidity in the form of internal habit formation in consumption (Christiano et al. 2005).

We add the following additional features to the model developed in this study. First, the model features imperfect international financial markets through a debt-elastic country risk premium, which is increasing in external debt-to-GDP ratio to induce stationarity in the model (see, e.g., Schmitt-Grohé and Uribe 2003; Uribe and Schmitt-Grohé 2017). This feature permits deviation from uncovered interest rate parity (UIP). Second, the model incorporates incomplete exchange rate pass-through by introducing nominal rigidity in domestic importing firms (see, e.g., Adolfson et al. 2007; Lindé et al. 2009; Monacelli 2005; Smets and Wouters 2002). Lastly, and most importantly, considering that this study focuses on the impact of monetary and fiscal policy mix regimes on the spillover effects of foreign monetary policy shocks, the model is augmented with a fiscal block in the domestic economy.

The basic model framework features infinitely lived households, firms that produce intermediate and final goods, importing firms, a fiscal authority responsible for fiscal policy, a monetary authority responsible for monetary policy, and a foreign economy. The representative household consumes domestically produced final goods and imported goods, supplies labour to the firms, and holds one-period domestic bonds and foreign debt. The representative intermediate-good producing firm uses only labour in production and faces nominal rigidity in price-setting. The final-good firm produces final goods by aggregating domestically produced intermediate goods. The remaining domestic final goods are consumed by the government and exported.[5]

[5] Given that the production sector is a standard one in the NK-DSGE model, it is presented in Appendix A. The presentation of this section focuses on the rest of the model.

2.1 The households

The representative household chooses consumption (c_t) and decides on labour hours (N_t) to maximize the following lifetime expected utility function:

$$E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t - hc_{t-1})^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\eta}}{1+\eta} \right] \tag{1}$$

subject to the budget constraint:

$$(1+\tau_t)c_t + \frac{B_t}{P_t} + \frac{\varepsilon_t R^*_{t-1} \Phi_{t-1} B^*_{t-1}}{P_t} = \frac{W_t}{P_t} N_t + \frac{R_{t-1} B_{t-1}}{P_t} + \frac{\varepsilon_t B^*_t}{P_t} + \frac{D_t}{P_t} \tag{2}$$

where the parameter $\beta \in (0,1)$ denotes the household's discount factor, $\sigma > 0$ is the inverse intertemporal elasticity of substitution in consumption, $h \in (0,1)$ is the degree of internal habit formation in consumption, $\chi > 0$ denotes utility weight for labour supply, and $\eta > 0$ is the inverse of the Frisch elasticity of labour supply.

The household receives a nominal wage (W_t) and nominal profits (D_t) from intermediate firms, and pays a tax rate (τ_t) on consumption. The household holds one-period domestic bonds (B_t) earning a domestic gross nominal return (R_t). The household also borrows at international markets (B^*_t) and pays a foreign gross nominal interest rate ($R^\star_t$) plus a debt-elastic country risk premium (Φ_t) given by Equation 3. ε_t denotes the nominal exchange rate and P_t denotes the domestic aggregate price as defined in Equation 8.

Following Schmitt-Grohé and Uribe (2003) and Uribe and Schmitt-Grohé (2017), the debt-elastic country risk premium takes the following functional form:

$$\Phi_t = 1 + \Omega \left(\exp \left[\left(\frac{\varepsilon_t B^*_t}{P_t y_t} - \frac{\varepsilon B^*}{P y} \right) \right] - 1 \right) \tag{3}$$

where the parameter Ω denotes the elasticity of country risk premium. The country risk premium is increasing in foreign debt-to-GDP ratio. This indicates that households incur additional costs for increasing their foreign borrowing (in deviation from the steady state). This friction introduces imperfect international financial markets in the domestic economy, which is required to ensure stationarity of the model. Additionally, it limits the ability of households to hold foreign debt (Akinci and Queralto 2024).

As noted by Gali and Monacelli (2005), the representative household consumes both domestically produced final goods ($c_{d,t}$) and imported goods ($c_{f,t}$). Therefore, c_t represents a composition of $c_{d,t}$ and $c_{f,t}$, aggregated using constant elasticity of substitution (CES) technology, as follows:

$$c_t = \left[\varphi^{\frac{1}{\varphi}} (c_{d,t})^{\frac{\varphi-1}{\varphi}} + (1-\varphi)^{\frac{1}{\varphi}} (c_{f,t})^{\frac{\varphi-1}{\varphi}} \right]^{\frac{\varphi}{\varphi-1}} \tag{4}$$

where $\varphi \in (0,1)$ denotes the share of domestically produced goods in consumption, hence it measures the degree of home bias in consumption. The parameter $\varphi > 0$ denotes the elasticity of substitution between domestically produced consumption goods and imported goods.

The optimal allocation of domestically produced consumption goods and imported goods is as follows:

$$c_{d,t} = \varphi \left(\frac{P_{d,t}}{P_t} \right)^{-\varphi} c_t \tag{5}$$

$$c_{f,t} = (1-\varphi)\left(\frac{P_{f,t}}{P_t}\right)^{-\varphi} c_t \tag{6}$$

where $P_{d,t}$ is the price index of domestically produced goods and $P_{f,t}$ is the price index of imported goods in domestic currency.

The relative price of imported goods to domestically produced goods gives the following equation for the terms of trade:

$$ToT_t = \frac{P_{f,t}}{P_{d,t}} \tag{7}$$

The aggregate price index for final goods is given by:

$$P_t = \left[\varphi(P_{d,t})^{1-\varphi} + (1-\varphi)(P_{f,t})^{1-\varphi}\right]^{\frac{1}{1-\varphi}} \tag{8}$$

Using λ_t as the Lagrangian multiplier for the representative household's budget constraint, the household's optimization problem in real terms is:

$$\begin{aligned} L = \quad & E_t \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t - hc_{t-1})^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\eta}}{1+\eta} \right) \\ & + \lambda_t \left(w_t N_t + \frac{R_{t-1} b_{t-1}}{\Pi_t} + q_t b_t^* + d_t - (1+\tau_t) c_t - b_t - \frac{q_t R_{t-1}^* \Phi_{t-1} b_{t-1}^*}{\Pi_t^*} \right) \end{aligned} \tag{9}$$

where Π_t denotes gross domestic CPI inflation and Π_t^* denotes gross foreign CPI inflation. q_t is the real exchange rate defined as foreign price expressed in domestic currency relative to domestic aggregate price:

$$q_t = \frac{\varepsilon_t P_t^*}{P_t} \tag{10}$$

The first-order conditions with respect to the control variables c_t, b_t, $b_t^\star$, and N_t are derived as:

$$\lambda_t = \frac{1}{1+\tau_t}(c_t - hc_{t-1})^{-\sigma} \tag{11}$$

$$1 = \beta E_t \left[\left(\frac{\lambda_{t+1}}{\lambda_t}\right) \left(\frac{R_t}{\Pi_{t+1}}\right) \right] \tag{12}$$

$$1 = \beta E_t \left[\left(\frac{\lambda_{t+1}}{\lambda_t}\right) \left(\frac{q_{t+1}}{q_t}\right) \right] \frac{R_t^*}{\Pi_t^*} \left[\Phi_t + b_t^* \Phi_t'\right] \tag{13}$$

$$w_t = \frac{\chi N_t^\eta}{\lambda_t} \tag{14}$$

Equation 11 gives the optimal consumption. Equation 12 gives the optimal domestic bond holdings. This equation equates the intertemporal marginal rate of substitution in consumption to the real return on domestic financial assets. Combining Equations 11 and 12 gives the standard consumption Euler equation. Equation 13 gives the optimal demand for foreign debt. This equation equates the intertemporal marginal rate of substitution in consumption to the return on foreign debt, adjusted for the country risk premium incurred by the households on their total foreign borrowing. Equation 14 gives the optimal condition for labour supply. Combining Equations 12 and 13 yields the following UIP equation:

$$\beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) \left[\frac{R_t}{\Pi_{t+1}} - \left(\frac{q_{t+1}}{q_t}\right) \frac{R_t^*}{\Pi_t^*} (\Phi_t + b_t^* \Phi_t') \right] = 0 \tag{15}$$

where $\Phi'_t = q_t\Omega\left(\exp\left[q_t\left(\frac{b^*_t}{y_t} - \frac{b^*}{y}\right)\right] - 1\right)$. The debt-elastic country risk premium introduces a wedge between the domestic gross nominal interest rate and foreign gross nominal interest rate, hence the UIP condition does not hold. In the absence of the country risk premium (i.e. $\Omega = 0$), the UIP condition holds and Equation 15 reduces to:

$$\beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\left[\frac{R_t}{\Pi_{t+1}} - \frac{R^*_t}{\Pi^*_t}\left(\frac{q_{t+1}}{q_t}\right)\right] = 0 \tag{16}$$

The UIP equation links the domestic and foreign interest rates along with the expected depreciation of the domestic currency. Since the SOE has no influence on the foreign economy, changes in the foreign interest rate following the contractionary foreign monetary policy shock affect the domestic interest rate primarily through its impact on the real exchange rate, a key channel the present study aims to explore.

2.2 Domestic importing firms and exchange rate pass-through

The baseline model features the assumption of complete exchange rate pass-through to imports, hence the law of one price holds. In the literature, this corresponds to the producer currency pricing regime, which stipulates that prices are sticky in the currency of the producing country and the law of one price holds, as imports are highly responsive to changes in the nominal exchange rate (see, e.g., Casas et al. 2017; Girstmair 2024). Therefore, the domestic price of imported goods ($P_{f,t}$) equals the foreign price (P^*_t) in terms of domestic currency—that is, $P_{f,t} = \varepsilon_t P^*_t$.

This study further considers the case of incomplete exchange rate pass-through to import prices as in Smets and Wouters (2002) and Monacelli (2005). This corresponds to a dominance currency pricing regime, in which prices are assumed to be sticky in a dominant currency, such as the US dollar, in international trade. Consequently, import prices are not fully sensitive to changes in nominal exchange rate (see, e.g., Casas et al. 2017; Girstmair 2024; Gopinath et al. 2020). Thus, the law of one price no longer holds, at least in the short run. Additionally, empirical evidence shows that changes in the nominal exchange rate lead to gradual adjustments in import prices, leading to an incomplete exchange rate pass-through (see, e.g., Jiménez-Rodríguez and Morales-Zumaquero 2016; Kabundi and Mbelu 2018; Ozkan and Erden 2015).

Incomplete exchange rate pass-through is introduced by assuming that the domestic price of imported goods is sticky. Therefore, this study assumes that the law of one price holds at the border, as domestic importing firms purchase the foreign good at the world-market price expressed in domestic currency ($\varepsilon_t P^*_t$). However, these local importing firms face Rotemberg (1982)-type quadratic adjustment costs when setting the domestic currency price of imported goods ($P_{f,t}$). This nominal rigidity in price setting generates short-run deviations from the law of one price.

A continuum of importing firms indexed by $j \in [0,1]$ import differentiated foreign goods ($c_{f,t}(j)$) and aggregate them using CES technology:

$$c_{f,t} = \left(\int_0^1 c_{f,t}(j)^{\frac{\theta_f - 1}{\theta_f}}\, dj\right)^{\frac{\theta_f}{\theta_f - 1}} \tag{17}$$

where the parameter θ_f denotes the elasticity of demand for differentiated imported goods.

The representative importing firm chooses optimal $P_{f,t}(j)$ by solving the problem:

$$\max_{P_{f,t}(j)} E_t \sum_{t=0}^{\infty} \Lambda_t \left[\left(\frac{P_{f,t}(j)}{P_{f,t}}\right)^{1-\theta_f} c_{f,t} - \frac{MC_{f,t}}{P_{f,t}}\left(\frac{P_{f,t}(j)}{P_{f,t}}\right)^{-\theta_f} c_{f,t} - \frac{\Omega_{p_f}}{2}\left(\frac{P_{f,t}(j)}{\Pi P_{f,t-1}(j)} - 1\right)^2 c_{f,t}\right] \tag{18}$$

where $MC_{f,t}$ denotes the nominal marginal cost for domestic importing firms. We obtain the following optimal domestic price for imported goods:

$$P_{f,t} = \frac{\theta_f}{\theta_f - 1} MC_{f,t} - \frac{\Omega_{p_f}}{\theta_f - 1}\left[\left(\frac{\Pi_{f,t}}{\Pi} - 1\right)\frac{\Pi_{f,t}}{\Pi} - \left(\frac{\Lambda_{t+1}}{\Lambda_t}\right)\left(\frac{\Pi_{f,t+1}}{\Pi} - 1\right)\left(\frac{\Pi_{f,t+1}}{\Pi}\right)\left(\frac{c_{f,t+1}}{c_{f,t}}\right)\right] \tag{19}$$

where $\Pi_{f,t} = \frac{P_{f,t}}{P_{f,t-1}}$ denotes imported inflation.

With flexible import prices (i.e. $\Omega_{p_f} = 0$), the law of one price holds. Therefore, importing firms set the domestic price for imported goods equal to the nominal real marginal cost, which in turn equals the foreign currency price converted to domestic currency (see, e.g., Lindé et al. 2009; Smets and Wouters 2002):

$$P_{f,t} = \frac{\theta_f}{\theta_f - 1} MC_{f,t} = \varepsilon_t P_t^* \tag{20}$$

Thus, Equation 19 can be rewritten as:

$$P_{f,t} = \varepsilon_t P_t^* - \frac{\Omega_{p_f}}{\theta_f - 1}\left[\left(\frac{\Pi_{f,t}}{\Pi} - 1\right)\frac{\Pi_{f,t}}{\Pi} - \left(\frac{\Lambda_{t+1}}{\Lambda_t}\right)\left(\frac{\Pi_{f,t+1}}{\Pi} - 1\right)\left(\frac{\Pi_{f,t+1}}{\Pi}\right)\left(\frac{c_{f,t+1}}{c_{f,t}}\right)\right] \tag{21}$$

2.3 Fiscal and monetary policy rules

The government's budget constraint is:

$$b_t + \tau_t c_t = \frac{R_{t-1} b_{t-1}}{\Pi_t} + g_t \tag{22}$$

where $g_t = \frac{G_t}{P_t}$ denotes real government expenditure.[6]

The present study adopts the standard fiscal rule as in Leeper (1991), with public debt either fully backed by future fiscal surpluses (Regime M) or entirely not backed (Regime F). The fiscal authority adjusts primary surpluses as a percentage of GDP (s_t/y_t) in response to changes in the total public debt-to-GDP ratio from its steady state:

$$\frac{s_t}{y_t} = \left(\frac{\bar{s}}{\bar{y}}\right)\left(\frac{R_{t-1} b_{t-1}}{y_{t-1}} / \frac{Rb}{y}\right)^{\delta_b} \tag{23}$$

where $s_t = \tau_t c_t - g_t$ denotes real primary surpluses. The parameter δ_b measures the extent to which the fiscal authority adjusts future primary surpluses in response to changes in public debt. This fiscal rule reflects recent consolidation efforts by South Africa's National Treasury. Due to the prolonged years of low economic growth, the Treasury has sought to stabilize rising public debt by raising taxes and cutting government spending to improve the primary balance (National Treasury 2024). However, government spending cuts in South Africa face significant criticism for shrinking the economy and further lowering the economic growth rate. Additionally, the increase in tax rates may have been insufficient to eliminate the primary deficit. Thus, this study adopts future tax adjustments as the main strategy for increasing primary surpluses to stabilize public debt under Regime M.

The monetary policy rule follows the standard Taylor-type interest rate rule as follows:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_r}\left[\left(\frac{\Pi_t}{\Pi}\right)^{\alpha_\pi}\left(\frac{y_t}{y}\right)^{\alpha_y}\right]^{1-\rho_r} \tag{24}$$

[6] For simplicity, real government expenditure is exogenously determined in proportion to output, represented as $g_t = g y_t$, where g is the steady state real government expenditure-to-GDP ratio. Some studies simplify the model by assuming $g_t = 0$ (see, e.g., Leeper 1991; Leeper and Leith 2016).

where ρ_r denotes the degree of interest rate smoothing. The parameters α_π and α_y measure the response of interest rates to changes in inflation and output from their respective steady states.

The values of the policy response parameters (δ_b and α_π) will depend on whether the policy mix is Regime M or Regime F. Under Regime M, the monetary authority is committed to stabilizing inflation and the fiscal authority fully stabilizes public debt with future primary surpluses. In contrast, under Regime F, the fiscal authority does not stabilize public debt with future primary surpluses, and as such the monetary authority primarily stabilizes the debt through inflation (Leeper 1991; Leeper and Leith 2016). A unique equilibrium exists under Regime M when $\alpha_\pi \beta > 1$ and $|\beta^{-1} - \delta_b| < 1$, and under Regime F when $\alpha_\pi \beta < 1$ and $|\beta^{-1} - \delta_b| > 1$.

2.4 Foreign economy and current account

The domestic economy imports goods for household consumption and exports part of the domestically produced final goods. Thus, the current account balance is defined as net exports ($x_t - im_t$) less net foreign interest payments on foreign debt as follows:

$$ca_t = (x_t - im_t) - q_t(R^*_{t-1}\Phi_{t-1} - 1)\frac{b^*_{t-1}}{\Pi^*_t} \tag{25}$$

where x_t denotes exports and $im_t = c_{f,t}$ denotes imported goods as defined in Equation 6. Following Chang et al. (2015), exports are defined as:

$$x_t = \gamma (q_t)^{\upsilon} y^*_t Z_t \tag{26}$$

where γ is the parameter for export demand.[7] The parameter υ is the export demand elasticity. Thus, foreign demand for domestic goods is positively related to the real exchange rate (q_t) and aggregate demand in the foreign economy (y^*_t) (Chang et al. 2015).

The current account can also be defined as the change in the home country's net foreign assets position. Accordingly, it is equivalent to the law of motion of aggregate foreign debt as follows:

$$ca_t = q_t \left(\frac{b^*_{t-1}}{\Pi^*_t} - b^*_t \right) \tag{27}$$

Following Kollmann (2002) and Chang et al. (2015), the foreign economy is treated as exogenous to the domestic economy. As such, the foreign interest rate (R^*_t), foreign output (y^*_t), and foreign inflation (Π^*_t) are modelled as stationary AR(1) processes:[8]

$$\log(R^*_t) = (1 - \rho_{R^*})\log(R^*) + \rho_{R^*}\log(R^*_{t-1}) + \nu_t \tag{28}$$

$$\log(y^*_t) = (1 - \rho_{y^*})\log(y^*) + \rho_{y^*}\log(y^*_{t-1}) \tag{29}$$

$$\log(\Pi^*_t) = (1 - \rho_{\pi^*})\log(\Pi^*) + \rho_{\pi^*}\log(\Pi^*_{t-1}) \tag{30}$$

where $\rho_{R^*} \in (0,1)$, $\rho_{b^*} \in (0,1)$, and $\rho_{\pi^*} \in (0,1)$ are persistent parameters for the foreign interest rate, foreign output, and foreign inflation, respectively. ν_t is a white noise process, normally distributed with mean zero and variance σ^2_ν.

---

[7] The export demand parameter serves as a modelling device to ensure that the exports-to-GDP ratio matches that observed in the actual data.

[8] It is worth noting that the results obtained from modelling these foreign variables as stationary stochastic processes are qualitatively the same as those obtained when modelled as a system of the standard three-equation New-Keynesian model, comprising an IS curve, a Phillips curve, and Taylor-type interest rate rule.

2.5 Market clearing

In a symmetric equilibrium, all intermediate and importing firms make identical decisions, such that $Y_{d,t}(j) = Y_{d,t}$, $P_{d,t}(j) = P_{d,t}$, $N_t(j) = N_t$, $c_{f,t}(j) = c_{f,t}$, and $P_{f,t}(j) = P_{f,t}$. Additionally, the market clearing condition $c_{f,t} = im_t$ holds.

The market clearing condition for output is given as:

$$y_t = c_{d,t} + g_t + x_t + \frac{\Omega_{p_d}}{2}\left(\frac{\Pi_t}{\Pi} - 1\right)^2 y_t + \frac{\Omega_{p_f}}{2}\left(\frac{\Pi_{f,t}}{\Pi} - 1\right)^2 im_t \tag{31}$$

Real GDP is defined as the sum of consumption, government expenditure, and net exports, as follows:

$$gdp_t = c_t + g_t + x_t - im_t \tag{32}$$

2.6 Balanced growth path

Technology grows at a constant rate: $\lambda_z = Z_t/Z_{t-1}$ for all t, which corresponds to the growth rate of the economy. On a balanced growth path, the following variables are detrended with technology to obtain stationary variables expressed as: $\tilde{y}_t = \frac{y_t}{Z_t}$, $\tilde{c}_t = \frac{c_t}{Z_t}$, $\tilde{c}_{d,t} = \frac{c_{d,t}}{Z_t}$, $\tilde{w}_t = \frac{W_t/P_t}{Z_t}$, $\tilde{b}_t = \frac{B_t/P_t}{Z_t}$, $\tilde{b}^*_t = \frac{B^*_t/P^*_t}{Z_t}$, $\tilde{\Phi}_t = \frac{\Phi_t}{Z_t}$, $\tilde{\Phi}'_t = \frac{\Phi'_t}{Z_t}$, $\tilde{s}_t = \frac{S_t/P_t}{Z_t}$, $\tilde{g}_t = \frac{G_t/P_t}{Z_t}$, $\tilde{x}_t = \frac{x_t}{Z_t}$, $\tilde{im}_t = \frac{im_t}{Z_t}$, $\tilde{ca}_t = \frac{ca_t}{Z_t}$, $\tilde{gdp}_t = \frac{gdp_t}{Z_t}$. The Lagrangian multiplier is defined as $\tilde{\lambda}_t = \lambda_t Z_t$, and the stochastic discount factor as $\tilde{\Lambda}_t = \Lambda_t Z_t$. The model equations in the balanced growth path are listed in Appendix A2.

3 Calibration

The model is calibrated to the South African quarterly data over the sample period of 2002:Q1–2023:Q4.[9] Certain parameters are calibrated to match the steady-state conditions of the model with those observed in the actual data over the sample period. Some parameter values are borrowed from the literature. Table 1 reports the calibrated parameter values and Table 2 reports the steady-state ratios of the main variables as a percentage of GDP.

The household discount factor (β) is set to 0.985 to match the annualized average interest rate of 7.1 per cent. The inverse intertemporal elasticity of substitution in consumption (σ) is set to 1, as commonly found in the literature (see, e.g., Gali and Monacelli 2005). The consumption habit persistent parameter (h) is set at 0.7, as in Steinbach et al. (2009) and Alpanda et al. (2010). The inverse Frisch elasticity of labour supply (η) is set to 1 (Sims and Wu 2020). In the literature, estimates of the elasticity of substitution between domestically produced and imported goods (φ) vary widely. Some studies report a low elasticity of around 0.6 (see, e.g., Lindé et al. 2009), while others calibrate it to values between 1 and 2 (see, e.g., Chari et al. 2002; Devereux et al. 2006; Gali and Monacelli 2005). Adolfson et al. (2007) use a higher elasticity of 5. Following Chari et al. (2002), this study sets φ to 1.5. This value implies that domestic and imported goods are substitutes, hence making the consumption pattern relatively more sensitive to changes in import prices. The share of domestic goods in consumption (φ) is calibrated to 0.667. This value ensures that the imports-to-GDP ratio matches that observed in the actual data.

[9] The data is obtained from the SARB website, except for the Federal funds rate, which is sourced from the FRED.

Table 1: Calibration of model parameters

Parameter	Notation	Value
Households		
Household discount factor	β	0.985
Inverse intertemporal elasticity of substitution	σ	1
Consumption habit formation	h	0.7
Inverse Frisch elasticity	η	1
Share of domestic produced goods in consumption	φ	0.667
Elasticity of substitution between domestic and foreign consumption	φ	1.5
Firms		
Technology growth rate	λ_z	1.0025
Elasticity of demand for domestically produced intermediate goods	θ	10
Elasticity of demand for imported goods	θ_f	10
Price adjustment cost parameter on domestic goods	Ω_{p_d}	60
Price adjustment cost parameter on imported goods	Ω_{p_f}	120
Foreign		
The parameter for export demand	γ	0.280
Export demand elasticity	υ	1.5
Elasticity of country risk premium	Ω_{b^*}	0.00074
Monetary and fiscal policy parameters		
Domestic interest rate response to output	α_y	0.5
Domestic interest rate smoothing parameter	ρ_R	0.73
Regime M		
Domestic interest rate response to inflation	α_π	1.5
Response of surpluses to public debt	δ_b	1.0
Regime F		
Domestic interest rate response to inflation	α_π	0.01
Response of surpluses to public debt	δ_b	0.005
Exogenous processes		
Persistence of foreign interest rate	ρ_{R^*}	0.75

Source: authors' compilation based on calibration and obtained from the literature.

Table 2: Key steady state ratios

Parameter	Notation	SS value
Public debt to GDP (calibrated)	b/y	0.410
Government expenditure to GDP (calibrated)	g/y	0.168
Consumption to GDP (obtained)	c/y	0.828
Tax revenue to GDP (obtained)	$\tau c/y$	0.174
Surplus to GDP (obtained)	s/y	0.006
Imports to GDP (calibrated)	im/y	0.276
Exports to GDP (obtained)	x/y	0.280
Foreign debt to GDP (obtained)	b^*/y	0.268

Source: authors' compilation based on SARB data.

For the parameters in the production sector, the constant technology growth rate (λ_z) is calibrated at 1.0025 to match South Africa's annual real GDP growth rate of 1.0 per cent over the sample period. This implies that all aggregate variables are on a balanced growth path, growing at a constant rate of 0.25 per cent quarterly (1.0 per cent annually). The elasticity of demand for domestically produced intermediate goods (θ) is set to 10, as in Chang et al. (2015). The Rotemberg quadratic adjustment cost parameter on domestic goods price setting (Ω_{p_d}) is set to 60, implying that, on average, firms adjust their prices every four quarters (Chang et al. 2015; Garcia-Barragan and Liu 2021).

For the parameters governing the degree of exchange rate pass-through, the Rotemberg quadratic adjustment cost parameter on domestic price setting for imported goods (Ω_{p_f}) is set to 0 for complete exchange rate pass-through, and 120 for incomplete exchange rate pass-through, following Devereux et al. (2006). The elasticity of demand for imported goods (θ_f) is set to 10, consistent with the value used for elasticity of demand for intermediate goods.

Regarding the parameters in the foreign sector, the export demand elasticity (υ) is set to 1.5, as in Chang et al. (2015). The parameter for export demand (γ) is set to 0.280, to ensure that the exports-to-GDP ratio matches that observed in the actual data. The elasticity of country risk premium (Ω_{b^*}) is set to 0.00074, as in Schmitt-Grohé and Uribe (2003). We assume that the law of one price holds in steady state (i.e. $P = \varepsilon P^*$), hence the nominal exchange rate (ε) and the real exchange rate (q) are all equal to 1 in the steady state.

The steady-state ratios of the main variables are calibrated to match the average ratios observed in the South African data over the sample period. Specifically, the public debt-to-GDP ratio (b/y) is set to 0.41. The imports-to-GDP ratio (im/y) is calibrated at 0.276 and the government expenditure-to-GDP ratio (g/y) is set to 0.168. The exports-to-GDP ratio (x/y) is derived at 0.280 using the current account Equation 25 and Equation 27, matching the average exports-to-GDP ratio of 0.281 observed in the actual data. Similarly, the consumption-to-GDP ratio (c/y) is derived at 0.828 using the market clearing Equation 32. The steady-state tax rate (τ) is derived at 0.21 to satisfy the government budget constraint in the steady state. This gives a tax receipt-to-GDP ratio ($\tau c/y$) of 0.174 and a primary surplus-to-GDP ratio (s/y) of 0.006. The steady-state foreign debt-to-GDP ratio (b^*/y) is derived at 0.268.

The policy response parameters in the fiscal and monetary policy rules are calibrated to be consistent with conditions for a unique stationary solution as laid out in Section 2.3. For Regime M, the parameter for domestic interest rate response to inflation (α_π) is set to 1.5, as in Taylor (1993) and Gali and Monacelli (2005), and the response of surpluses to public debt (δ_b) is set to 1.0. For Regime F, α_π is set to 0.01, which is close to zero, as in Leeper and Leith (2016) and Bianchi et al. (2023), and δ_b is set to 0.005. The parameter for domestic interest rate response to output is set to 0.5, as commonly found in the literature (see, e.g., Leeper and Leith 2016; Smets and Wouters 2003). The domestic interest rate smoothing parameter (ρ_R) is set to 0.73, as in Steinbach et al. (2009).

For the exogenous process parameter, the persistence parameter of foreign interest rate (ρ_{R^*}) is set to 0.75, as in Kollmann (2002).

4 Results

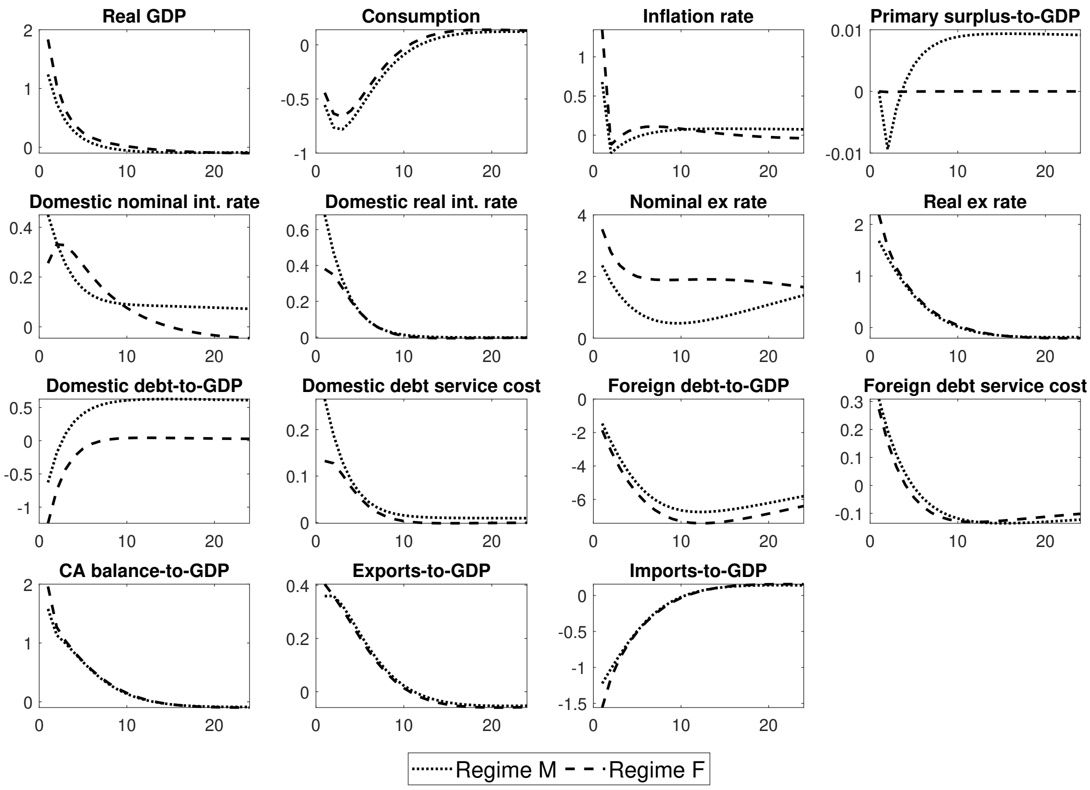
This section analyses the effects of a 1 per cent US contractionary monetary policy shock on South Africa's business cycles under two policy mix regimes: Regime M and Regime F. Additionally, this section investigates the role of exchange rate pass-through in shaping the spillover effects of the US contractionary monetary policy shock on South Africa's key macroeconomic variables under the two regimes.

The South African economy has the most integrated bond market with the international bond markets among the SOEs in the region (Kabundi et al. 2020), exposing it to policy actions in advanced economies such as the United States. The exchange rate is a key channel for transmitting US monetary policy shocks to other economies, given the dominant role of the US dollar in the international monetary system (see, e.g., Chen et al. 2016; Neely 2015). Therefore, this study explores the exchange rate channel in examining the role of policy mix regimes in the spillover effects of US contractionary monetary policy shocks. Additionally, this study explores the domestic and foreign debt service cost channels.

4.1 Foreign monetary policy shock spillovers: Regime M vs Regime F

Figure 4 presents the impulse responses of South Africa's key macroeconomic variables to a 1 per cent US contractionary monetary policy shock. The baseline calibration of the model reflects South Africa's current macroeconomic conditions, characterized by a low economic growth rate and high interest rates. It, however, adopts a moderate public debt-to-GDP ratio that aligns with the average from the data over the sample period.[10] The results show that an increase in US nominal interest rates causes depreciation of the exchange rate under both Regime M and Regime F, as higher US interest rates make US assets more attractive, thereby inducing capital outflows from the domestic economy. The dynamics of key variables differ based on the policy mix regime. The nominal exchange rate depreciates more strongly under Regime F (dashed line) than under Regime M (dotted line). Similarly, the depreciation of the real exchange rate is relatively larger under Regime F than under Regime M.

Figure 4: Responses of the main variables to a 1 per cent contractionary US monetary policy shock under two policy mix regimes: Regime M (dotted line) and Regime F (dashed line)



Note: the variables are expressed as percentage deviations from steady states, except for the fiscal variables, inflation, and interest rates, which are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

The initial decline in imports is also relatively larger under Regime F than under Regime M, due to higher import prices following the larger real exchange rate depreciation, while exports increase more or less the same under the two regimes. As such, the boost in trade competitiveness is more pronounced under Regime F, leading to a greater improvement in the current account balance and a larger increase in real GDP (output) compared to Regime M. This leads to a more pronounced initial increase in do-

[10] In Section 5.2 we conduct sensitivity analysis considering different public debt-to-GDP ratios.

mestic CPI inflation under Regime F, as the monetary authority does not commit to stabilizing inflation. The contemporaneous increase in inflation is approximately 1.5 per cent and the effect quickly diminishes over time. Consequently, both nominal and real interest rates increase moderately, resulting in a relatively smaller increase in domestic debt service costs. In contrast, under Regime M, the transitory increase in domestic CPI inflation is moderate (approximately 0.7 per cent), as the monetary authority commits to price stability. As a result, interest rates increase more strongly, leading to a relatively higher increase in domestic debt service costs.

After the initial decline of approximately 0.7 per cent, the public debt-to-GDP ratio increases by approximately 0.6 per cent and remains persistently high under Regime M due to a larger increase in domestic debt service costs. As a result, future primary surpluses increase, as the fiscal authority commits to stabilizing public debt with future primary surpluses. In contrast, under Regime F, the public debt initially declines by approximately 1.2 per cent and subsequently stabilizes more quickly with higher inflation. Subsequently, primary surpluses remain unchanged, as the fiscal authority does not commit to debt stabilization.

Consumption declines by a relatively larger magnitude under Regime M than under Regime F, as the positive wealth effect from higher interest receipts on households' domestic bond holdings is eliminated following private agents' expectations of adjustments in future taxes. This is in addition to the negative effect of a decline in foreign debt held by households due to higher foreign debt service costs, thus reducing the resources available for private consumption. Therefore, with coordination of monetary and fiscal policy, the positive demand channel from trade competitiveness is offset by the negative net worth effect of households' foreign debt and the elimination of the wealth effect of domestic interest receipts.

These findings indicate that when SOEs encounter foreign monetary policy shocks, Regime M is more effective at containing spillover effects, except for public debt and private consumption. Thus, inflation is well contained but domestic public debt is maintained at a high level, requiring higher future primary surpluses to stabilize it. However, the fiscal authority's ability to increase primary surpluses one-on-one with the increase in public debt is constrained by the current fiscal space in South Africa. Thus, increases in primary surpluses are insufficient to stabilize the debt. While the National Treasury macroeconomic report (National Treasury 2024) notes that stabilizing public debt by adjusting future primary surpluses (either through raising taxes or reducing government expenditure) slows economic growth more rapidly, our study finds that in the case of foreign contractionary monetary policy shocks, increased primary surpluses can coincide with higher economic growth due to improved trade competitiveness.

Conversely, Regime F better stabilizes public debt but at the cost of high inflation. Although inflation is higher under Regime F than under Regime M, it remains transitory in both regimes. These findings suggest that Regime F may be a preferable policy option, as the cost of stabilizing public debt is contemporary. However, it may not be feasible, given the persistently high inflation in the aftermath of the pandemic. These results highlight the significant macroeconomic policy challenges facing the South African economy amid an unsustainable fiscal path (National Treasury 2024). The recent aggressive interest rate hikes by most central banks (including the SARB) in response to persistently high inflation have increased debt service costs, resulting in a more significant increase in public debt.

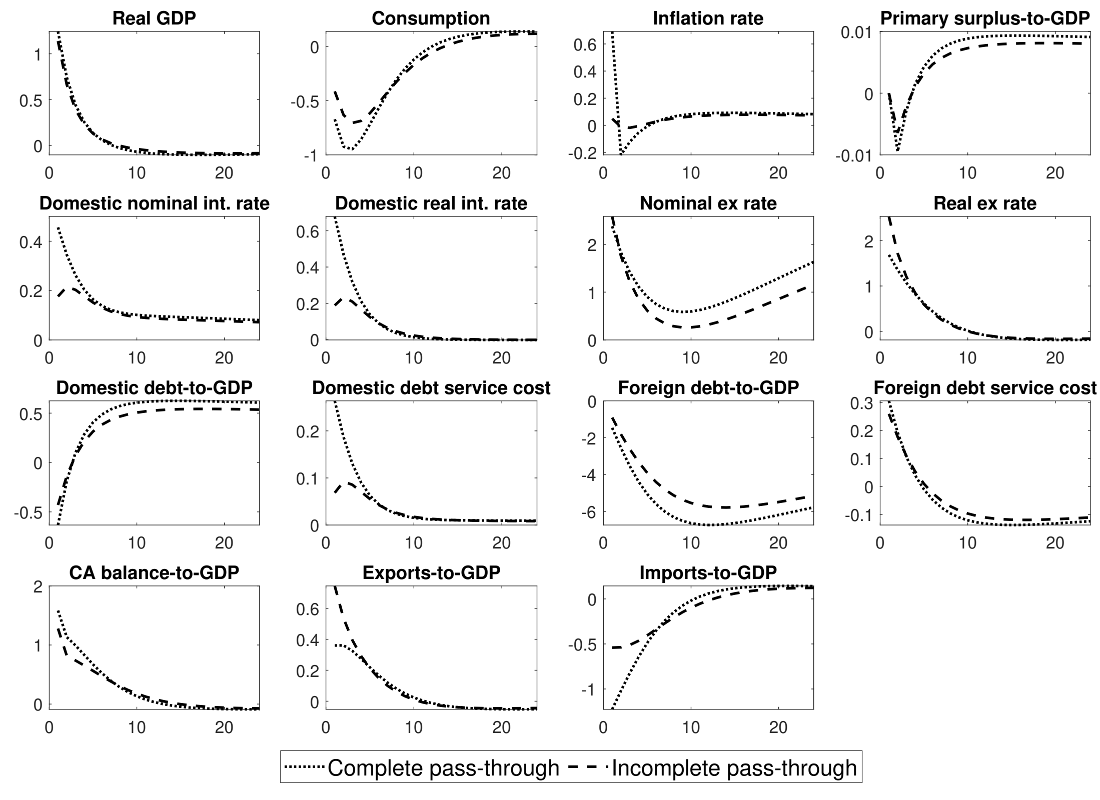
The literature shows that countries with stronger macroeconomic conditions experience dampened spillover effects of foreign policy shocks (see, e.g., Bowman et al. 2015; Chen et al. 2014; Mishra et al. 2014). However, South Africa's current weak macroeconomic environment makes it more vulnerable to foreign policy shocks, hence the more pronounced spillover effects observed here. It is important to note that the increases in inflation, interest rates, debt service costs, and public debt observed in our analysis do not fully capture the significant increases seen in actual data. This is because our model's dynamics are driven solely by foreign monetary policy shocks, while domestic factors also play a crucial role in shaping public debt dynamics (see, e.g., Burger 2024). Therefore, the results obtained here should be interpreted cautiously when considering policy implications.

4.2 The role of exchange rate pass-through

This section examines the impact of the degree of exchange rate pass-through on the dynamics of inflation and other key macroeconomic variables under Regime M and Regime F, following a 1 per cent US contractionary monetary policy shock. As noted by Smets and Wouters (2002) and Monacelli (2005), empirical evidence is widespread on the deviation from the law of one price, justifying the assumption of incomplete exchange rate pass-through. In South Africa, studies suggest different degrees of exchange rate pass-through to import prices, ranging between 0.44 and 1.0 (see, e.g., Kabundi and Mbelu 2018; Karoro et al. 2009).

The analysis compares the responses of these variables to the shock in the cases of complete and incomplete exchange rate pass-through under the two regimes. Under Regime M (Figure 5), the initial depreciation of the nominal exchange rate is more or less the same in the case of both complete and incomplete pass-through, but thereafter it is more persistent in the case of a complete pass-through. However, the real exchange rate depreciation is more pronounced with an incomplete pass-through compared to the complete pass-through, as the increase in inflation is nearly negligible with incomplete pass-through.

Figure 5: Responses of the main variables to a 1 per cent US contractionary monetary policy shock under Regime M with different pass-through of the exchange rate to import prices: complete exchange rate pass-through (dotted line) and incomplete exchange rate pass-through (dashed line)



Note: the variables are expressed as percentage deviations from steady states, except for the fiscal variables, inflation, and interest rates, which are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

Imports decline more sharply with complete exchange rate pass-through compared to an incomplete pass-through, due to a larger increase in import prices relative to export prices, following a more persistent depreciation of the exchange rate. This induces a higher demand for domestically produced goods, amplifying expenditure switching. Conversely, with incomplete pass-through, the decline in imports is moderate, due to a subdued increase in import prices, as imports are less sensitive to exchange rate fluctuations (see, e.g., Gopinath et al. 2020), hence a moderate expenditure-switching effect. These results align with the findings of Casas et al. (2017), which suggest that the expenditure-switching effect primarily operates through imports rather than exports. Exports increase more strongly with incomplete exchange rate pass-through than with complete exchange rate pass-through, as greater real exchange rate depreciation boosts foreign demand for domestic goods.[11] As a result, the improvement in the current account balance and the corresponding increase in real GDP are more or less the same in the case of both complete and incomplete exchange rate pass-through. Furthermore, following the larger increase in import prices, domestic CPI inflation increases by a relatively larger magnitude with complete pass-through compared to a nearly negligible increase in inflation with incomplete pass-through.

Under Regime M, since the monetary authority commits to price stability, higher inflation prompts a stronger monetary policy response, leading to a relatively higher increase in domestic nominal interest rates with complete pass-through than with incomplete pass-through. Consequently, the initial increases in real interest rates and debt service costs are also higher with complete pass-through.

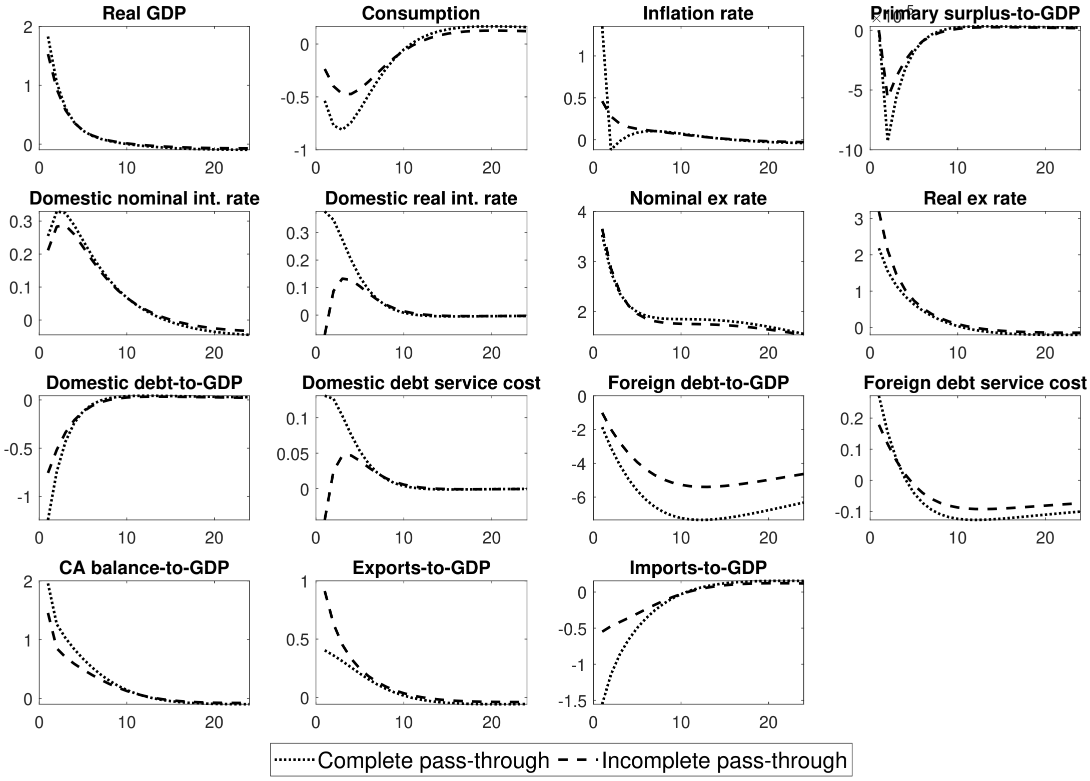
The eventual increase in public debt-to-GDP ratio is also slightly higher with complete pass-through than with incomplete pass-through. Since the fiscal authority commits to stabilizing public debt with future primary surpluses, the increase in primary surpluses is also relatively larger in the case of complete pass-through compared to incomplete pass-through.

The debt-elastic country risk premium leads to a relatively larger reduction in foreign borrowing, thereby decreasing households' net worth. Consequently, despite the increase in real GDP, consumption declines more sharply with complete pass-through. This is because increases in US interest rates and the depreciation of exchange rate lead to a relatively higher real burden of foreign debt held by households in the case of a complete exchange rate pass-through compared to an incomplete pass-through.

Similarly, under Regime F (Figure 6), the responses of all variables to the shock are larger with complete pass-through than incomplete pass-through, except for the real exchange rate and exports. Furthermore, for both complete and incomplete pass-through, the responses of all variables to the foreign shock are more amplified under Regime F than under Regime M, except for domestic interest rates and domestic debt service costs. Accordingly, domestic CPI inflation increases more strongly in the case of both complete and incomplete pass-through, with the increase being more pronounced with complete pass-through. Since under Regime F, the monetary authority does not commit to price stability, both nominal and real interest rates increase moderately in the case of both complete and incomplete pass-through, with the increase being relatively higher in the case of a complete pass-through. As a result, domestic debt service costs also increase moderately in both cases, but more so in the case of complete pass-through.

[11] This finding differs from the observation in Gopinath et al. (2020), which indicates that an exchange rate depreciation has a negligible impact on exports to dominant-currency destination, whereas exports in our model are denominated in domestic currency.

Figure 6: Responses of the main variables to a 1 percent US contractionary monetary policy shock under Regime F with different pass-through of the exchange rate to import prices: complete exchange rate pass-through (dotted line) and incomplete exchange rate pass-through (dashed line)



Note: the variables are expressed as percentage deviations from steady states, except for the fiscal variables, inflation, and interest rates, which are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

The initial decline in the public debt-to-GDP ratio is larger with complete pass-through than with incomplete pass-through, but subsequently the debt stabilizes more or less the same in both cases. Primary surpluses remain relatively unchanged[12] as the fiscal authority does not adjust future primary surpluses to achieve debt stabilization.

The results align with the literature, showing that complete exchange rate pass-through (namely producer currency pricing) amplifies the effects of foreign monetary policy shocks on the domestic economy via the expenditure-switching effect (see, e.g., Casas et al. 2017; Devereux et al. 2006; Girstmair 2024). Moreover, with imperfect international financial markets, complete pass-through amplifies the spillover effects via the negative net worth effect on households' foreign debt holdings, aligning with findings in the literature (see, e.g., Akinci and Queralto 2024). More importantly, the present study provides new insights by showing that the amplification effect from higher exchange rate pass-through depends on the policy mix regime. Regime F amplifies the spillover effects of the shock more than Regime M, except for domestic interest rates and domestic debt service costs.

---

[12] The response of primary surpluses is nearly zero, similar to Regime F in Figure 5. The sharp drop shown in Figure 6 is due to the scaling on the *y*-axis.

5 Sensitivity analysis

This section conducts the sensitivity analysis comparing the impulse responses of the main variables under Regime M and Regime F, following a 1 per cent US contractionary monetary policy shock. For the sake of space, we only present the results of the baseline case of complete exchange rate pass-through.[13] Section 5.1 compares the impulse responses of the main variables with varying degrees of trade openness under Regime M and Regime F. Section 5.2 compares the responses of the selected key variables considering different initial public debt-to-GDP ratios under the two regimes.

5.1 Degree of trade openness

Trade openness, commonly measured by the imports-to-GDP ratio, has gained importance in studies of open economies, especially given the substantial growth in global trade in recent decades, and the important role of external demand in the transmission of monetary policy shocks. Recently, economists have become increasingly interested in exploring the macroeconomic effects of trade openness (see, e.g., Cwik et al. 2011; Povoledo 2018). These few studies, however, focus on the effects of trade openness in the transmission of domestic monetary policy shocks, and the evidence remains inconclusive. The authors find that domestic contractionary monetary policy shocks have a larger negative impact on output and inflation with higher trade openness, due to a sharper reduction in net exports and import prices following the appreciation of the exchange rate. This suggests that trade openness influences the effects of monetary policy shocks through the external demand channel. The present study extends the literature by examining the influence of trade openness on the spillover effects of the US contractionary monetary policy shocks on the South African economy, under Regime M and Regime F. The baseline calibration of the model uses an imports-to-GDP ratio of 27.6 per cent, reflecting the average for South Africa during the sample period. The analysis here considers alternative steady-state imports-to-GDP ratios of 15 per cent and 40 per cent, respectively, reflecting the minimum and the maximum import-to-GDP ratio during the sample period.[14]

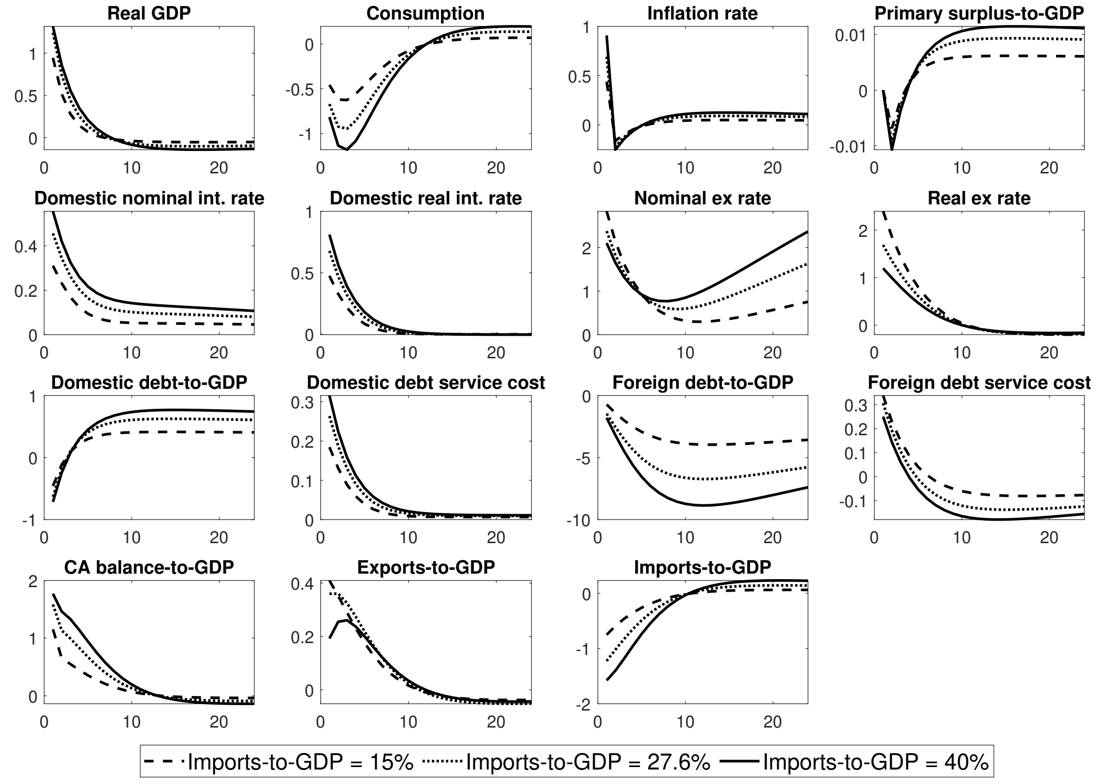
Under Regime M (Figure 7), the initial depreciation of both nominal and real exchange rate is larger when the imports-to-GDP ratio is higher (solid and dotted lines) compared to when it is lower (dashed line). Subsequently, the depreciation of the real exchange rate becomes relatively smaller with a higher imports-to-GDP ratio due to a relatively larger increase in domestic CPI inflation, while the depreciation of the nominal exchange rate becomes greater and more persistent with a higher imports-to-GDP ratio.

The decline in imports is relatively larger in the case of a higher imports-to-GDP ratio, due to a larger increase in import prices following a more persistent exchange rate depreciation. This leads to a greater improvement in the current account balance and a slightly larger increase in real GDP, despite a relatively smaller increase in exports. The increase in domestic CPI inflation is also relatively higher with a higher imports-to-GDP ratio. In response, the monetary authority increases domestic nominal interest rates more strongly and keeps them elevated in the case of a higher imports-to-GDP ratio, resulting in a higher increase in real interest rates and debt service costs.

[13] The results in the case of incomplete exchange rate pass-through are qualitatively the same and available upon request.

[14] The steady state imports-to-GDP ratios of 15 per cent and 40 per cent are obtained by calibrating the home bias in consumption parameter (φ) at 0.818 and 0.515, respectively.

Figure 7: Responses of the main variables to a 1 per cent US contractionary monetary policy shock under Regime M, with varying degrees of trade openness (i.e. different imports-to-GDP ratios): 15 (dotted line), 27.6 (dashed line), and 40 per cent (solid line)



Note: the variables are expressed as percentage deviations from steady states, except for the fiscal variables, inflation, and interest rates, which are expressed as linear deviations from the steady state.

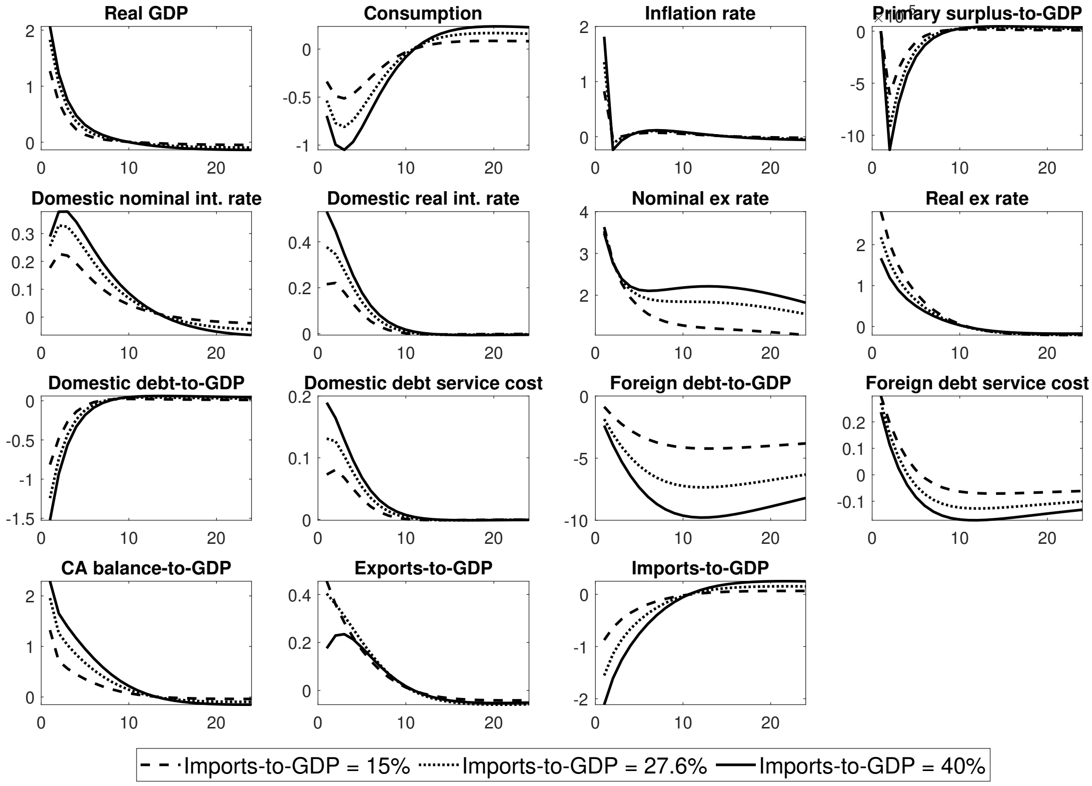
Source: authors' illustration based on the results obtained.

The public debt-to-GDP ratio also increases by a relatively higher magnitude in the case of a higher imports-to-GDP ratio, following higher debt service costs. Since under Regime M the fiscal authority commits to debt stabilization, primary surpluses increase by a relatively larger magnitude in the case of a higher imports-to-GDP ratio. Meanwhile, the decrease in foreign debt held by households is larger with a higher imports-to-GDP ratio. As a result, private consumption declines more sharply in the case of a higher imports-to-GDP ratio due to the combined negative effects of reduced households' net worth and the loss of positive wealth effect of higher interest receipts on domestic bond holdings.

Similarly, under Regime F (Figure 8), the responses of all variables to the shock are higher with a higher imports-to-GDP ratio, except for the real exchange rate and exports. Additionally, the responses of these variables are more pronounced under Regime F than under Regime M at all levels of trade openness, except for domestic interest rates and domestic debt service costs.

These results suggest that higher trade openness amplifies the spillover effects of foreign monetary policy shocks under both Regime M and Regime F, with Regime F showing a more pronounced amplification effect at all levels of trade openness compared to Regime M. These results align with the literature, which shows that trade openness increases the sensitivity of output and inflation to domestic monetary policy shocks through the demand channel (see, e.g., Cwik et al. 2011; Povoledo 2018). These results also support our findings on how the degree of exchange rate pass-through influences the spillover effects of foreign shocks.

Figure 8: Responses of the main variables to a 1 per cent US contractionary monetary policy shock under Regime F, with varying degrees of trade openness (i.e. different imports-to-GDP ratios): 15 (dotted line), 27.6 (dashed line), and 40 per cent (solid line)



Note: the variables are expressed as percentage deviations from steady states, except for the fiscal variables, inflation, and interest rates, which are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

5.2 Different public debt-to-GDP ratios

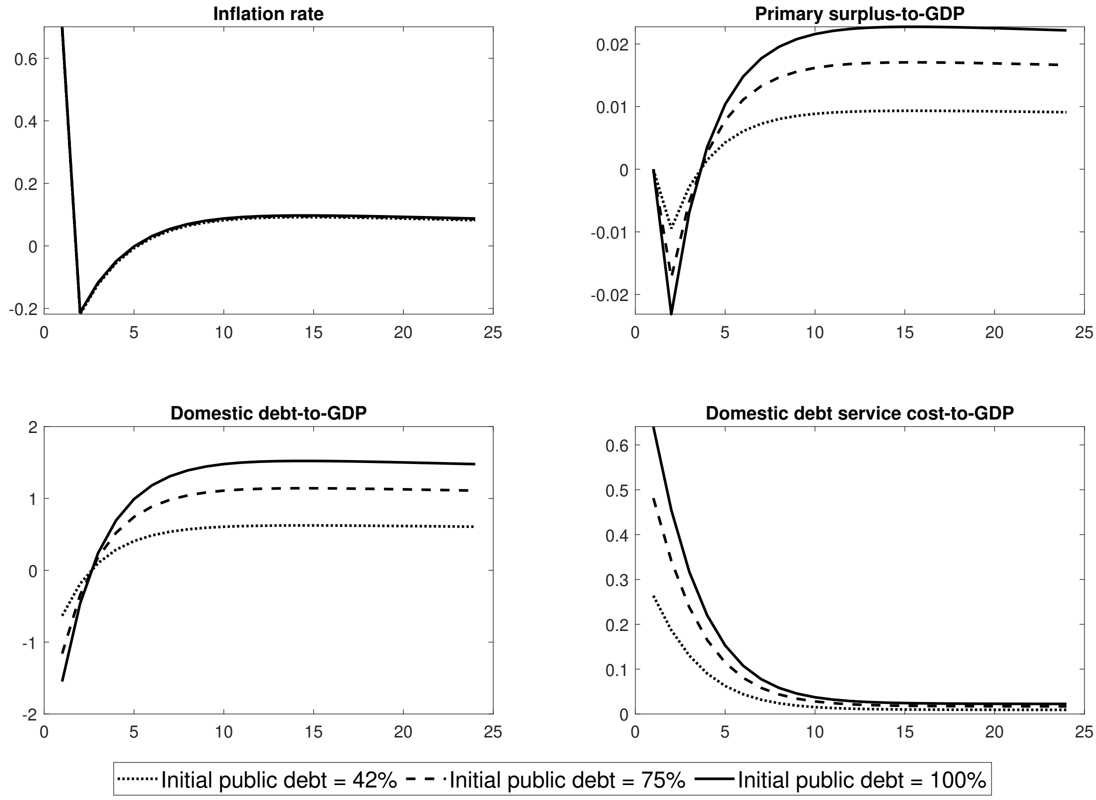
This section examines the impact of high public debt-to-GDP ratio on the responses of key macroeconomic variables to a 1 per cent US contractionary monetary policy shock under Regime M and Regime F. In the baseline calibration, the public debt-to-GDP ratio is set to the average of 41 per cent from the data over the sample period, which is considered moderate. This analysis considers different debt-to-GDP ratios that reflect South Africa's current debt situation. Specifically, it considers scenarios with a debt-to-GDP ratio of approximately 75 per cent (National Treasury 2024) and a much higher ratio of 100 per cent.

The responses of all variables to the shock are more or less the same under both Regime M and Regime F with different public debt-to-GDP ratios, except for domestic debt service costs, public debt-to-GDP ratio, and primary surpluses.[15] We, therefore only report the responses of these three variables and inflation under Regime M (Figure 9) and Regime F (Figure 10), respectively.

The increase in US interest rates causes the depreciation of the exchange rate, which leads to an increase in domestic CPI inflation, prompting the monetary authority to raise domestic interest rates. The magnitude of interest rate hikes depends on the policy mix regime, impacting domestic debt service costs and public debt differently, depending on the debt-to-GDP ratio.

[15] Since the model includes only one-period bonds, we define the domestic debt service cost as the repo rate (which is close to the 91-day Treasury bill rate) multiplied by the gross public debt.

Figure 9: Responses of the main variables to a 1 per cent US contractionary monetary policy shock under Regime M, with different initial public debt-to-GDP ratios: 42 (dotted line), 75 (dashed line), and 100 per cent (solid line)



Note: the variables are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

Under Regime M, the increase in the public debt-to-GDP ratio is larger with a higher debt-to-GDP ratio, following a larger increase in domestic debt service costs. The responses of future primary surpluses closely mirror the dynamics of the public debt-to-GDP ratio, as the fiscal authority commits to debt stabilization. Thus, future primary surpluses also increase more strongly to stabilize the higher public debt-to-GDP ratio. However, the dynamics of inflation remain relatively consistent regardless of the initial debt-to-GDP ratio.

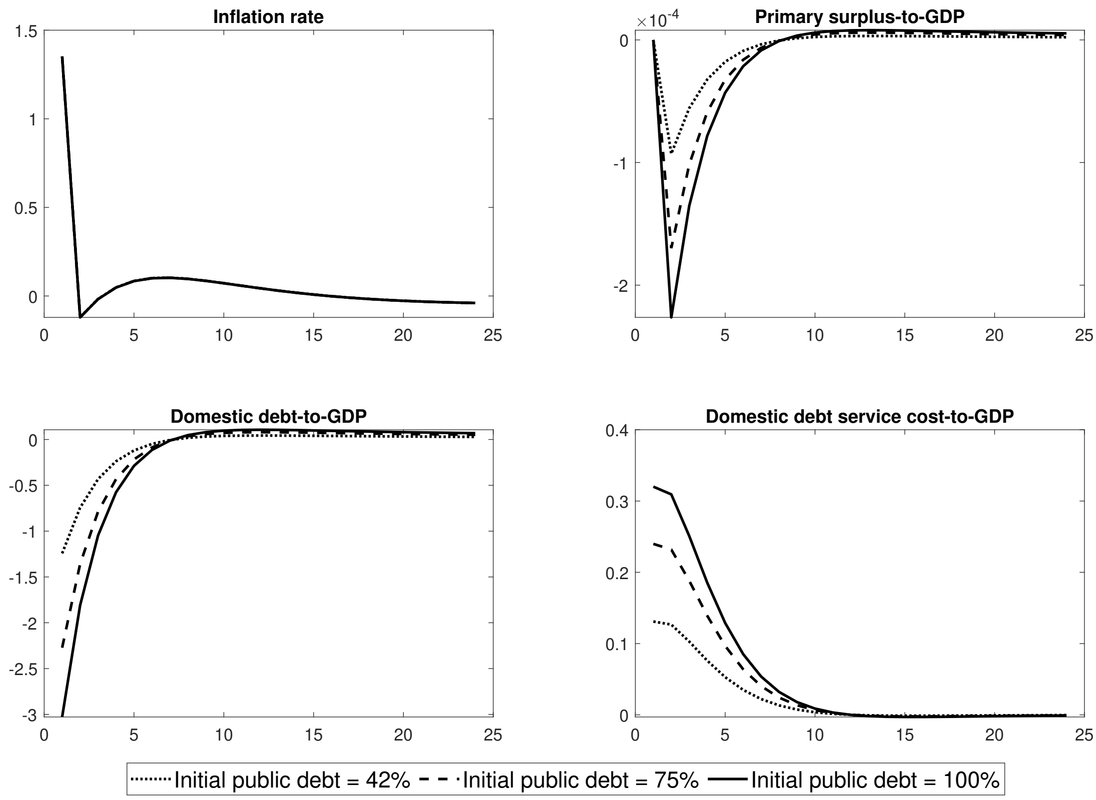
In contrast, under Regime F, the initial decrease in the domestic debt-to-GDP ratio is larger when the initial debt-to-GDP ratio is higher, despite a larger increase in domestic debt service costs. Thereafter, the debt stabilization process is largely consistent across different initial debt-to-GDP ratios, as the increase in inflation that stabilizes the debt is more or less the same regardless of the ratio. Primary surpluses decrease more with a higher domestic debt-to-GDP ratio, as the decline in debt-to-GDP ratio is more pronounced. Nonetheless, the responses of primary surpluses are negligible, as the fiscal authority does not commit to debt stabilization with future primary surpluses under Regime F.[16]

The results of this sensitivity analysis support our earlier findings that Regime M is more effective at containing inflation, as public debt is well-stabilized with higher future fiscal surpluses when the initial debt-to-GDP ratio is relatively low. However, with a higher initial debt-to-GDP ratio, public debt increases significantly, necessitating much higher future primary surpluses to cover the increased debt service costs and stabilize public debt. In contrast, Regime F is more effective at stabilizing public debt (the initial decline in debt is double that under Regime M) at the cost of high inflation (the increase in

[16] The sharp drop in primary surpluses showing in Figure 10 is due to the scaling on the *y*-axis.

inflation is twice as large as that under Regime M). This finding is consistent with the policy proposal in the recent National Treasury macroeconomic report (National Treasury 2024), which supports the view that closing fiscal deficit by raising taxes as an appropriate fiscal policy in an environment of low economic growth and higher interest rates. Alternatively, the sustainability of public debt in the presence of a fiscal deficit can be guaranteed when the economic growth rate exceeds the real interest rate. However, the current macroeconomic environment in South Africa, characterized by low economic growth and high real interest rates (hence high debt service costs), means that the fiscal policy option under Regime M is more appropriate to achieve well-balanced macroeconomic conditions. This is, however, conditional on a moderate debt-to-GDP level.

Figure 10: Responses of the main variables to a 1 per cent US contractionary monetary policy shock under Regime F, with different initial public debt-to-GDP ratios: 42 (dotted line), 75 (dashed line), and 100 per cent (solid line)



Note: the variables are expressed as linear deviations from the steady state.

Source: authors' illustration based on the results obtained.

6 Conclusion

This study examines the impact of monetary and fiscal policy mix regimes on the spillover effects of the recent unprecedented US contractionary monetary policy shocks on inflation and business cycles in South Africa. The results show stronger spillover effects under Regime F than under Regime M, except for domestic interest rates and primary surpluses. For both Regime M and Regime F, these spillover effects are more amplified with complete exchange rate pass-through and a higher degree of trade openness.

These findings suggest that Regime M is more effective at containing the spillover effects of foreign monetary policy shocks on the domestic economy. With a stronger response of the monetary authority to inflation, debt service costs increase, leading to a larger increase in public debt. This requires larger future primary surpluses to stabilize the debt. However, with the current limited fiscal space in South Africa, future primary surpluses do not necessarily increase one-on-one with the increase in public debt. In contrast, Regime F better stabilizes public debt but at the cost of transitory high inflation. This suggests that Regime F may be a preferable policy option, as public debt is stabilized with the cost of only temporary high inflation. Yet, given the persistently high inflation in the aftermath of the pandemic, adopting this policy option may not be feasible. It is important to point out that these findings should be interpreted cautiously, as the increase in debt here is driven by a foreign monetary policy shock, while in reality other factors can also influence the dynamics of public debt (see, e.g., Burger 2024).

These results highlight the significant macroeconomic policy challenges facing the South African economy amid an unsustainable fiscal path (National Treasury 2024). Another policy implication here is that the calls for the SARB to decrease the inflation target band from 3–6 per cent to a lower range, such as 2–4 per cent, may not be feasible given the current fiscal position and its impact on inflation. Therefore, the monetary and fiscal authorities need to coordinate with each other, opting for a balanced approach to achieve balanced debt and price stability. In this regard, the policy mix regime proposed by Bianchi et al. (2023), where Regime M and Regime F coexist, may offer a better policy option. This will be explored in future research.

References

Adolfson, M., S. Laséen, J. Lindé, and M. Villani (2007). 'Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through'. *Journal of International Economics*, 72(2): 481–511. https://doi.org/10.1016/j.jinteco.2007.01.003

Akinci, Ö., and A. Queralto (2024). 'Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets'. *The Review of Financial Studies*, 37(2): 309–55. https://doi.org/10.1093/rfs/hhad078

Alpanda, S., and S. Kabaca (2020). 'International Spillovers of Large-Scale Asset Purchases'. *Journal of the European Economic Association*, 18(1): 342–91. https://doi.org/10.1093/jeea/jvy053

Alpanda, S., K. Kotzé, and G. Woglom (2010). 'The Role of the Exchange Rate in a New Keynesian DSGE Model for the South African Economy'. *South African Journal of Economics*, 78(2): 170–91. https://doi.org/10.1111/j.1813-6982.2010.01239.x

Anaya, P., M. Hachula, and C.J. Offermanns (2017). 'Spillovers of US Unconventional Monetary Policy to Emerging Markets: The Role of Capital Flows'. *Journal of International Money and Finance*, 73: 275–95. https://doi.org/10.1016/j.jimonfin.2017.02.008

Arbatli-Saxegaard, E.C., D. Furceri, P.G. Dominguez, J.D. Ostry, and S.J. Peiris (2024). 'Spillovers from US Monetary Policy: Role of Policy Drivers and Cyclical Conditions'. *Journal of International Money and Finance*, 143: 103053. https://doi.org/10.1016/j.jimonfin.2024.103053

Bianchi, F. (2012). 'Evolving Monetary/Fiscal Policy Mix in the United States'. *American Economic Review*, 102(3): 167–72. https://doi.org/10.1257/aer.102.3.167

Bianchi, F., and C. Ilut (2017). 'Monetary/Fiscal Policy Mix and Agents' Beliefs'. *Review of Economic Dynamics*, 26: 113–39. https://doi.org/10.1016/j.red.2017.02.011

Bianchi, F., and L. Melosi (2019). 'The Dire Effects of the Lack of Monetary and Fiscal Coordination'. *Journal of Monetary Economics*, 104: 1–22. https://doi.org/10.1016/j.jmoneco.2018.09.001

Bianchi, F., R. Faccini, and L. Melosi (2023). 'A Fiscal Theory of Persistent Inflation'. *The Quarterly Journal of Economics*, 138: 2127–79. https://doi.org/10.1093/qje/qjad027

Bowman, D., J.M. Londono, and H. Sapriza (2015). 'US Unconventional Monetary Policy and Transmission to Emerging Market Economies'. *Journal of International Money and Finance*, 55: 27–59. https://doi.org/10.1016/j.jimonfin.2015.02.016

Burger, P. (2024). 'The Sustainability of South African Fiscal Policy'. Working Paper 2024/59. Helsinki: UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2024/521-9

Casas, C., M.F. Diez, G. Gopinath, and P.-O. Gourinchas (2017). *Dominant Currency Paradigm: A New Model for Small Open Economies*. Washington, DC: IMF.

Chang, C., Z. Liu, and M.M. Spiegel (2015). 'Capital Controls and Optimal Chinese Monetary Policy'. *Journal of Monetary Economics*, 74: 1–15. https://doi.org/10.1016/j.jmoneco.2015.04.003

Chari, V.V., P.J. Kehoe, and E.R. McGrattan (2002). 'Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?' *The Review of Economic Studies*, 69(3): 533–63. https://doi.org/10.1111/1467-937X.00216

Chen, J., T.M. Griffoli, and R. Sahay (2014). 'Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?'. Working Paper 2014/240. Washington, DC: IMF.

Chen, Q., A. Filardo, D. He, and F. Zhu (2016). 'Financial Crisis, US Unconventional Monetary Policy and International Spillovers'. *Journal of International Money and Finance*, 67: 62–81. https://doi.org/10.1016/j.jimonfin.2015.06.011

Chen, X., E.M. Leeper, and C. Leith (2022). 'Strategic Interactions in US Monetary and Fiscal Policies'. *Quantitative Economics*, 13(2): 593–628. https://doi.org/10.3982/QE1678

Christiano, L.J., M. Eichenbaum, and C.L. Evans (2005). 'Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy'. *Journal of Political Economy*, 113(1): 1–45. https://doi.org/10.1086/426038

Clarida, R., J. Gali, and M. Gertler (2001). 'Optimal Monetary Policy in Open Versus Closed Economies: An Integrated Approach'. *American Economic Review*, 91(2): 248–52. https://doi.org/10.1257/aer.91.2.248

Clarida, R., J. Galı, and M. Gertler (2002). 'A Simple Framework for International Monetary Policy Analysis'. *Journal of Monetary Economics*, 49(5): 879–904. https://doi.org/10.1016/S0304-3932(02)00128-9

Cochrane, J.H. (2011). 'Understanding Policy in the Great Recession: Some Unpleasant Fiscal Arithmetic'. *European Economic Review*, 55(1): 2–30. https://doi.org/10.1016/j.euroecorev.2010.11.002

Cochrane, J.H. (2023). *The Fiscal Theory of the Price Level*. Princeton, NJ: Princeton University Press. https://doi.org/10.1515/9780691243245

Cwik, T., G.J. Müller, and M.H. Wolters (2011). 'Does Trade Integration Alter Monetary Policy Transmission?' *Journal of Economic Dynamics and Control*, 35(4): 545–64. https://doi.org/10.1016/j.jedc.2010.11.006

Davig, T., and E.M. Leeper (2011). 'Monetary–Fiscal Policy Interactions and Fiscal Stimulus'. *European Economic Review*, 55(2): 211–27. https://doi.org/10.1016/j.euroecorev.2010.04.004

Devereux, M.B., P.R. Lane, and J. Xu (2006). 'Exchange Rates and Monetary Policy in Emerging Market Economies'. *The Economic Journal*, 116(511): 478–506. https://doi.org/10.1111/j.1468-0297.2006.01089.x

Gali, J., and T. Monacelli (2005). 'Monetary Policy and Exchange Rate Volatility in a Small Open Economy'. *The Review of Economic Studies*, 72(3): 707–34. https://doi.org/10.1111/j.1467-937X.2005.00349.x

Garcia-Barragan, F., and G. Liu (2021). 'Great Recession, Exports Crunch, and China's Fiscal Stimulus in a Global Zero Lower Bound Environment'. *Journal of Asian Economics*, 75: 101323. https://doi.org/10.1016/j.asieco.2021.101323

Girstmair, S. (2024). 'Determinacy in Multi-Country DSGE Models: The Role of Pricing Paradigms and Economic Openness'. Dynare Working Paper 82. Paris: CEPREMAP.

Gopinath, G., E. Boz, C. Casas, F.J. Díez, P.-O. Gourinchas, and M. Plagborg-Møller (2020). 'Dominant Currency Paradigm'. *American Economic Review*, 110(3): 677–719. https://doi.org/10.1257/aer.20171201

Jia, J., J. Guo, and Z. Wang (2015). 'The Fiscal–Monetary Policy Mix and Exchange Rate Stability: A Dynamic Stochastic General Equilibrium Model with Chinese Characteristics'. *Emerging Markets Finance and Trade*, 51(4): 729–46. https://doi.org/10.1080/1540496X.2015.1046345

Jiménez-Rodríguez, R., and A. Morales-Zumaquero (2016). 'A New Look at Exchange Rate Pass-Through in the G-7 Countries'. *Journal of Policy Modeling*, 38(5): 985–1000. https://doi.org/10.1016/j.jpolmod.2016.06.007

Kabundi, A., and A. Mbelu (2018). 'Has the Exchange Rate Pass-Through Changed in South Africa?' *South African Journal of Economics*, 86(3): 339–60. https://doi.org/10.1111/saje.12197

Kabundi, A., T. Loate, and N. Viegi (2020). 'Spillovers of the Conventional and Unconventional Monetary Policy from the US to South Africa'. *South African Journal of Economics*, 88(4): 435–71. https://doi.org/10.1111/saje.12262

Karoro, T.D., M.J. Aziakpono, and N. Cattaneo (2009). 'Exchange Rate Pass-Through to Import Prices in South Africa: Is There Asymmetry?'. *South African Journal of Economics*, 77(3): 380–98. https://doi.org/10.1111/j.1813-6982.2009.01216.x

Kollmann, R. (2002). 'Monetary Policy Rules in the Open Economy: Effects on Welfare and Business Cycles'. *Journal of Monetary Economics*, 49(5): 989–1015. https://doi.org/10.1016/S0304-3932(02)00132-0

Lastauskas, P., and A.D.M. Nguyen (2024). 'Spillover Effects of US Monetary Policy on Emerging Markets Amidst Uncertainty'. *Journal of International Financial Markets, Institutions and Money*, 92: 101956. https://doi.org/10.1016/j.intfin.2024.101956

Leeper, E.M. (1991). 'Equilibria Under "Active" and "Passive" Monetary and Fiscal Policies'. *Journal of Monetary Economics*, 27(1): 129–47. https://doi.org/10.1016/0304-3932(91)90007-B

Leeper, E.M., and C. Leith (2016). 'Understanding Inflation as a Joint Monetary–Fiscal Phenomenon'. *Handbook of Macroeconomics*, 2: 2305–415. https://doi.org/10.1016/bs.hesmac.2016.03.012

Leeper, E.M., and T. Yun (2006). 'Monetary–Fiscal Policy Interactions and the Price Level: Background and Beyond'. *International Tax and Public Finance*, 13: 373–409. https://doi.org/10.1007/s10797-006-8599-2

Lindé, J., M. Nessén, and U. Söderström (2009). 'Monetary Policy in an Estimated Open-Economy Model with Imperfect Pass-Through'. *International Journal of Finance & Economics*, 14(4): 301–33. https://doi.org/10.1002/ijfe.377

Lubik, T.A., and F. Schorfheide (2007). 'Do Central Banks Respond to Exchange Rate Movements? A Structural Investigation'. *Journal of Monetary Economics*, 54(4): 1069–87. https://doi.org/10.1016/j.jmoneco.2006.01.009

Miranda-Agrippino, S., and H. Rey (2020). 'US Monetary Policy and the Global Financial Cycle'. *The Review of Economic Studies*, 87(6): 2754–76. https://doi.org/10.1093/restud/rdaa019

Mishra, M.P., M.K. Moriyama, P.M. N'Diaye, and L. Nguyen (2014). 'Impact of Fed Tapering Announcements on Emerging Markets. Working Paper 2014/109. Washington, DC: IMF.

Mishra, P., P. N'Diaye, and L. Nguyen (2018). 'Effects of Fed Announcements on Emerging Markets: What Determines Financial Market Reactions?'. *IMF Economic Review*, 66: 732–62. https://doi.org/10.1057/s41308-018-0068-2

Monacelli, T. (2005). 'Monetary Policy in a Low Pass-Through Environment'. *Journal of Money, Credit and Banking*, 37: 1047–66.

National Treasury of South Africa (2024). 'Macroeconomic Policy: A Review of Trends and Choices'. Report. Pretoria: National Treasury of South Africa.

Neely, C.J. (2015). 'Unconventional Monetary Policy Had Large International Effects'. *Journal of Banking & Finance*, 52: 101–11. https://doi.org/10.1016/j.jbankfin.2014.11.019

Ozkan, I., and L. Erden (2015). 'Time-Varying Nature and Macroeconomic Determinants of Exchange Rate Pass-Through'. *International Review of Economics & Finance*, 38: 56–66. https://doi.org/10.1016/j.iref.2015.01.007

Povoledo, L. (2018). 'Pricing Behavior and the Role of Trade Openness in the Transmission of Monetary Shocks'. *Journal of Macroeconomics*, 57: 231–47. https://doi.org/10.1016/j.jmacro.2018.06.004

Rohit, A.K., and P. Dash (2019). 'Dynamics of Monetary Policy Spillover: The Role of Exchange Rate Regimes'. *Economic Modelling*, 77: 276–88. https://doi.org/10.1016/j.econmod.2018.09.007

Rotemberg, J.J. (1982). 'Sticky Prices in the United States'. *Journal of Political Economy*, 90(6): 1187–211.

Schmitt-Grohé, S., and M. Uribe (2003). 'Closing Small Open Economy Models'. *Journal of International Economics*, 61(1): 163–85. https://doi.org/10.1016/S0022-1996(02)00056-9

Sims, C.A. (1994). 'A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy'. *Economic Theory*, 4: 381–99. https://doi.org/10.1007/BF01215378

Sims, E., and C. Wu (2020). 'Are QE and Conventional Monetary Policy Substitutable?'. *International Journal of Central Banking*, 16(1): 195–230.

Smets, F., and R. Wouters (2002). 'Openness, Imperfect Exchange Rate Pass-Through and Monetary Policy'. *Journal of Monetary Economics*, 49(5): 947–81. https://doi.org/10.1016/S0304-3932(02)00126-5

Smets, F., and R. Wouters (2003). 'An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area'. *Journal of the European Economic Association*, 1(5): 1123–75. https://doi.org/10.1162/154247603770383415

Steinbach, M., P. Mathuloe, and B. Smit (2009). 'An Open Economy New Keynesian DSGE Model of the South African Economy'. *South African Journal of Economics*, 77(2): 207–27. https://doi.org/10.1111/j.1813-6982.2009.01212.x

Taylor, J.B. (1993). 'Discretion Versus Policy Rules in Practice'. *Carnegie-Rochester Conference Series on Public Policy*, 39: 195–214. https://doi.org/10.1016/0167-2231(93)90009-L

Tillmann, P. (2016). 'Unconventional Monetary Policy and the Spillovers to Emerging Markets'. *Journal of International Money and Finance*, 66: 136–56. https://doi.org/10.1016/j.jimonfin.2015.12.010

Tillmann, P., G.-Y. Kim, and H. Park (2019). 'The Spillover Effects of US Monetary Policy on Emerging Market Economies'. *International Journal of Finance & Economics*, 24(3): 1313–32. https://doi.org/10.1002/ijfe.1720

Uribe, M., and S. Schmitt-Grohé (2017). *Open Economy Macroeconomics*. Princeton, NJ: Princeton University Press.

Walsh, C.E. (2010). *Monetary Theory and Policy*, 3rd edition. Cambridge, MA: MIT Press.

Wang, X., J. Li, and G. Zhang (2022). 'Mixed Monetary–Fiscal Policies and Macroeconomic Fluctuations: An Analysis Based on the Dynamic Stochastic General Equilibrium Model'. *China & World Economy*, 30(2): 167–96. https://doi.org/10.1111/cwe.12414

Appendix A: Producing firms

There are two types of producing firms: a representative final-goods producing firm and a continuum of intermediate-goods producing firms.

A1 Final-goods firms

The representative final-goods producing firm operates in a perfectly competitive market. The firm aggregates domestically produced intermediate goods ($Y_t(j)$) into a final good (Y_t) using a CES technology production function:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}} \tag{33}$$

where the parameter $\theta > 0$ denotes the elasticity of demand for domestically produced intermediate goods.

The representative final-goods firm's optimization problem yields the following market demand function for intermediate goods:

$$Y_t(j) = \left[\frac{P_{d,t}(j)}{P_{d,t}} \right]^{-\theta} Y_t \tag{34}$$

where $P_{d,t}(j)$ is the price of domestically produced intermediate good:

$$P_{d,t} = \int_0^1 P_{d,t}(j) dj$$

A2 Intermediate-goods firms

A continuum of intermediate-goods producing firms indexed by $j \in [0,1]$ produce intermediate goods ($Y_t(j)$) using the following linear technology production function:

$$Y_t(j) = Z_t N_t(j) \tag{35}$$

where $N_t(j)$ is labour input and Z_t denotes technology, which grows at a constant rate of $\lambda_z = Z_t/Z_{t-1}$. For simplicity, capital is ignored in the standard NK-DSGE model specification (see, e.g., Gali and Monacelli 2005; Walsh 2010).

The intermediate-goods producing firm seeks to minimize the costs:

$$\frac{W_t}{P_{d,t}} N_t(j) \tag{36}$$

subject to the market demand function (Equation 34) and the production function (Equation 35).

We derive the following first-order condition for $N_t(j)$ from the firm's minimization problem:

$$w_t = \lambda_t^i \frac{Y_t(j)}{N_t(j)} \tag{37}$$

where the Lagrangian multiplier for the production function $\lambda_t^i = MC_{d,t}/P_{d,t}$ denotes the intermediate firm's real marginal cost.

A continuum of intermediate-goods producing firms operate in a monopolistically competitive market and face Rotemberg (1982)-type quadratic adjustment costs when setting their prices ($P_{d,t}(j)$):

$$\frac{\Omega_p}{2}\left(\frac{P_{d,t}(j)}{\Pi P_{d,t-1}(j)}-1\right)^2 Y_t \tag{38}$$

where the parameter Ω_p measures the size of the adjustment cost, and Π denotes steady-state gross domestic CPI inflation.

Thus, the intermediate-goods producing firm chooses optimal $P_{d,t}(j)$ by solving the problem:

$$\max_{P_{d,t}(j)} E_t \sum_{t=0}^{\infty} \Lambda_t \left[\left(\frac{P_{d,t}(j)}{P_{d,t}}\right)^{1-\theta} Y_t - \frac{MC_{d,t}}{P_{d,t}}\left(\frac{P_{d,t}(j)}{P_{d,t}}\right)^{-\theta} Y_t - \frac{\Omega_{p_d}}{2}\left(\frac{P_{d,t}(j)}{\Pi P_{d,t-1}(j)}-1\right)^2 Y_t\right] \tag{39}$$

where $MC_{d,t}$ denotes the nominal marginal cost for domestic intermediate-goods producers.

Given a symmetric equilibrium, the firm's optimal pricing decision gives us the following optimal domestic goods price:

$$P_{d,t} = \frac{\theta}{\theta-1} MC_{d,t} - \frac{\Omega_{p_d}}{\theta-1}\left[\left(\frac{\Pi_{d,t}}{\Pi}-1\right)\frac{\Pi_{d,t}}{\Pi} - \left(\frac{\Lambda_{t+1}}{\Lambda_t}\right)\left(\frac{\Pi_{d,t+1}}{\Pi}-1\right)\left(\frac{\Pi_{d,t+1}}{\Pi}\right)\left(\frac{Y_{t+1}}{Y_t}\right)\right] \tag{40}$$

where $\Pi_{d,t} = \frac{P_{d,t}}{P_{d,t-1}}$ is domestic inflation. Λ_t is the stochastic discount factor defined as: $\Lambda_t = \beta \frac{\lambda_{t+1}}{\lambda_t}$.

Appendix B: System of non-linear model equations

The model has a system of non-linear equations for 34 variables, $\tilde{y}_t$, N_t, $\tilde{c}_t$, $\tilde{c}_{d,t}$, $\tilde{w}_t$, $MC_{d,t}$, $\tilde{b}_t$, $\tilde{b}_t^*$, $\tilde{s}_t$, τ_t, $\tilde{g}_t$, P_t, $P_{d,t}$, $P_{f,t}$, $\P_t^*$, Π_t, $\Pi_{d,t}$, $\Pi_{f,t}$, R_t, $\tilde{\Phi}_t$, $\tilde{\Phi}_t'$, r_t, q_t, ε_t, ToT_t, $\tilde{x}_t$, $\tilde{im}_t$, $\tilde{ca}_t$, $\tilde{gdp}_t$, $\tilde{\lambda}_t$, $\tilde{\Lambda}_t$, R_t^*, y_t^*, Π_t^*. The system of equations on a balanced growth path is given below:

$$\tilde{\lambda}_t = \frac{1}{1+\tau_t}\left(\tilde{c}_t - \frac{h\tilde{c}_{t-1}}{\lambda_z}\right)^{-\sigma} \tag{41}$$

$$\tilde{\Lambda}_t = \beta\frac{\tilde{\lambda}_{t+1}}{\lambda_z\tilde{\lambda}_t} \tag{42}$$

$$1 = \beta E_t\left[\left(\frac{\tilde{\lambda}_{t+1}}{\lambda_z\tilde{\lambda}_t}\right)\left(\frac{R_t}{\Pi_{t+1}}\right)\right] \tag{43}$$

$$1 = \beta E_t\left[\left(\frac{\tilde{\lambda}_{t+1}}{\lambda_z\tilde{\lambda}_t}\right)\left(\frac{q_{t+1}}{q_t}\right)\right]\frac{R_t^*}{\Pi_t^*}\left[\tilde{\Phi}_t + \tilde{b}_t^*\tilde{\Phi}_t'\right] \tag{44}$$

$$\tilde{\Phi}_t = 1 + \Omega\left(\exp\left[q_t\left(\frac{\tilde{b}_t^*}{\tilde{y}_t} - \frac{b^*}{y}\right)\right] - 1\right) \tag{45}$$

$$\tilde{\Phi}_t' = q_t\Omega\left(\exp\left[q_t\left(\frac{\tilde{b}_t^*}{\tilde{y}_t} - \frac{b^*}{y}\right)\right] - 1\right) \tag{46}$$

$$\tilde{w}_t = \frac{\chi N_t^{\eta}}{\tilde{\lambda}_t} \tag{47}$$

$$\tilde{y}_t = N_t \tag{48}$$

$$\tilde{w}_t = \frac{MC_{d,t}}{P_{d,t}}\frac{\tilde{y}_t}{N_t} \tag{49}$$

$$P_{d,t} = \frac{\theta}{\theta-1}MC_{d,t} - \frac{\Omega_{p_d}}{\theta-1}\left[\left(\frac{\Pi_{d,t}}{\Pi} - 1\right)\frac{\Pi_{d,t}}{\Pi} - \left(\frac{\tilde{\Lambda}_{t+1}}{\lambda_z\tilde{\Lambda}_t}\right)\left(\frac{\Pi_{d,t+1}}{\Pi} - 1\right)\left(\frac{\Pi_{d,t+1}}{\Pi}\right)\left(\frac{\lambda_z\tilde{y}_{t+1}}{\tilde{y}_t}\right)\right] \tag{50}$$

$$P_{f,t} = \varepsilon_t P_t^* - \frac{\Omega_{p_f}}{\theta_f-1}\left[\left(\frac{\Pi_{f,t}}{\Pi} - 1\right)\frac{\Pi_{f,t}}{\Pi} - \left(\frac{\tilde{\Lambda}_{t+1}}{\lambda_z\tilde{\Lambda}_t}\right)\left(\frac{\Pi_{f,t+1}}{\Pi} - 1\right)\left(\frac{\Pi_{f,t+1}}{\Pi}\right)\left(\frac{\lambda_z\tilde{im}_{t+1}}{\tilde{im}_t}\right)\right] \tag{51}$$

$$\Pi_{d,t} = \frac{P_{d,t}}{P_{d,t-1}} \tag{52}$$

$$\Pi_{f,t} = \frac{P_{f,t}}{P_{f,t-1}} \tag{53}$$

$$\Pi_t = \frac{P_t}{P_{t-1}} \tag{54}$$

$$P_t = \left[\varphi(P_{d,t})^{1-\varphi} + (1-\varphi)(P_{f,t})^{1-\varphi}\right]^{\frac{1}{1-\varphi}} \tag{55}$$

$$ToT_t = \frac{P_{f,t}}{P_{d,t}} \tag{56}$$

$$\frac{q_t}{q_{t-1}} = \frac{\varepsilon_t}{\varepsilon_{t-1}}\frac{\Pi^*}{\Pi_t}, \tag{57}$$

$$\Pi_t^* = \frac{P_t^*}{P_{t-1}^*} \tag{58}$$

$$\tilde{b}_t + \tau_t\tilde{c}_t = \frac{R_{t-1}\tilde{b}_{t-1}}{\Pi_t\lambda_z} + \tilde{g}_t \tag{59}$$

$$\tilde{s}_t = \tau_t\tilde{c}_t - \tilde{g}_t \tag{60}$$

$$\tilde{g}_t = g_{ss}(\tilde{y}_t) \tag{61}$$

$$\frac{\tilde{s}_t}{\tilde{y}_t} = \left(\frac{s}{y}\right)\left(\frac{R_{t-1}\tilde{b}_{t-1}}{\tilde{y}_{t-1}}/\frac{Rb}{y}\right)^{\delta_b} \tag{62}$$

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R}\left[\left(\frac{\Pi_t}{\Pi}\right)^{\alpha_\pi}\left(\frac{\tilde{y}_t}{y}\right)^{\alpha_y}\right]^{1-\rho_R} \tag{63}$$

$$\tilde{im}_t = (1-\varphi)\left(\frac{P_{f,t}}{P_t}\right)^{-\varphi}\tilde{c}_t \tag{64}$$

$$\tilde{x}_t = \gamma(q_t)^{\upsilon}y_t^* \tag{65}$$

$$\tilde{ca}_t = \tilde{x}_t - \tilde{im}_t - \frac{q_t}{\Pi_t^*\lambda_z}(R_{t-1}^*\tilde{\Phi}_{t-1}-1)b_{t-1}^* \tag{66}$$

$$\tilde{ca}_t = q_t\left[\frac{\tilde{b}_{t-1}^*}{\Pi_t^*\lambda_z} - \tilde{b}_t^*\right] \tag{67}$$

$$\tilde{y}_t = \tilde{c}_{d,t} + \tilde{g}_t + \tilde{x}_t + \frac{\Omega_{p_d}}{2}\left(\frac{\Pi_{d,t}}{\Pi}-1\right)^2\tilde{y}_t + \frac{\Omega_{p_f}}{2}\left(\frac{\Pi_{f,t}}{\Pi}-1\right)^2\tilde{im}_t \tag{68}$$

$$\tilde{c}_{d,t} = \varphi\left(\frac{P_{d,t}}{P_t}\right)^{-\varphi}\tilde{c}_t \tag{69}$$

$$\tilde{gdp}_t = \tilde{c}_t + \tilde{g}_t + \tilde{x}_t - \tilde{im}_t \tag{70}$$

The foreign economy:

$$\log(R_t^*) = (1-\rho_{R^*})\log(R^*) + \rho_{R^*}\log(R_{t-1}^*) + \nu_t \tag{71}$$

$$\log(y_t^*) = (1-\rho_{y^*})\log(y^*) + \rho_{y^*}\log(y_{t-1}^*) \tag{72}$$

$$\log(\Pi_t^*) = (1-\rho_{\pi^*})\log(\Pi^*) + \rho_{\pi^*}\log(\Pi_{t-1}^*) \tag{73}$$

Appendix C: Data and sources

The data are obtained from the SARB website, except for the Federal funds rate, which is sourced from the FRED (2002Q1–2023Q4):

Real GDP by expenditure (y_t): real GDP: millions of South African rand, quarterly, seasonally adjusted.

Government expenditure (g_t): consumption expenditure by general government: millions of South African rand, quarterly, seasonally adjusted.

Exports (x_t): exports of goods and services: millions of South African rand, quarterly, seasonally adjusted.

Imports (im_t): imports of goods and services: millions of South African rand, quarterly, seasonally adjusted.

Public debt (b_t): total general government debt as a percentage of GDP: quarterly, seasonally adjusted.

Repo rate (R_t): repurchase rate: per cent, quarterly, not seasonally adjusted.

Inflation rate (π_t): consumer price index total for South Africa, growth rate same period previous year, quarterly, seasonally adjusted.

Federal funds rate (R_t^*): effective Federal funds rate: per cent, quarterly, not seasonally adjusted.

The following data are generated:

Consumption (c_t): consumption expenditure by households: millions of South African rand, quarterly, generated as real GDP minus government expenditure and exports, plus imports.

Primary surpluses (s_t): generated as the difference between tax revenue on consumption and government expenditure.